FOREST AND NATURE CONSERVATION CODE OF BEST MANAGEMENT PRACTICES OF BHUTAN

VOLUME V: CROSS-CUTTING MANAGEMENT REGIMES

Department of Forests and Park Services

DEDICATION

A tribute to our benevolent Druk Gyalpo, His Majesty Jigme Khesar Namgyel Wangchuck, for His Selfless Service and Leadership to the People and Country

རོ་རྒལ་དང་ནགས་ཚལ་ལྷན་ཐག།
ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture and Forests
Tashichhodzong
Thimphu:Bhutan

MINISTER

MESSAGE

I applaud the Department of Forest and Park Services for coming up with the Forest and Nature Conservation Code of Best Management Practices of Bhutan which is an updated version of the erstwhile Forest Management Code of Bhutan, 2004. The erstwhile code only covered sustainable management of Forest Management Units. However, with the shift of forest management paradigm to include other important aspects such as climate change, wetland and watershed management, biodiversity conservation & monitoring, agroforestry, payment for ecosystem services etc., a more comprehensive guideline has become imperative. The revised *Code* broadens the scope of applicability covering wide range of contemporary forestry practices providing detailed guidelines on the technical aspects of forest resources management and biodiversity conservation.

The revision of the *Code* is timely and will play a significant role towards sustainable management of our forest resources especially in light of the global climate change and its anticipated impacts on our fragile mountain ecosystems. The *Code* will also take into account the application of advanced technologies in forest management and biodiversity conservation and will provide strong emphasis on monitoring and evaluation of forest and forestry programs which has always been our weakness.

The revised *Code* will also become handy to our colleagues in the field as it will serve as the single source of scientific guideline for all forestry management regimes in the country.

With the publication of this *Code*, Bhutan joins many countries who manage their forest through such technical guidelines. Our country now establishes a robust technical guideline for management of all forest resources in the country and I am confident that it will fulfill our aspiration of bringing all forest resources under sustainable management fulfilling the objectives of our National Forest Policy and the Constitutional mandate of maintaining 60% of forest cover all times to come.

I would like to commend the efforts and hard work of our colleagues in the Department of Forest and Park Services, particularly those who were involved in the revision of this *Code* and I hope this code will be useful to wide range of stakeholders outside of the Department as well.

Tashi Delek!

Yeshi Penjor

སོ་ནམ་དང་ནགས་ཚལ་སྡེབ་ཁག།
ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture and Forests
Tashichhodzong
Thimphu:Bhutan

SECRETARY

MESSAGE

I commend the Department of Forest and Park Services in bringing out the revised Forest and Nature Conservation Code of Best Management Practices of Bhutan which presents a comprehensive technical guideline for sustainable management of forest resources and biodiversity conservation in the country.

The intricate combination of several programs and activities on sustainable forest management and biodiversity conservation is fundamental to sustainable development, from their vital role as climate regulator, carbon sequestration and the vital ecosystem services they provide. Sustainable management of these forest resources are therefore essential if these benefits for the environment and societies are to be maintained for future generations. Such long-term feats can be achieved only if we are able to manage the huge forest base resources holistically.

Such holistic achievement can only be possible through a science based technical guideline - the *Code*. Its implementation will also ensure that the forests in Bhutan are managed through the integration of good science, research, technology and decades of forest management experiences.

The code also provides consistent and transparent approach to planning and implementation of sustainable forest management plans, conservation plans and activities at all levels and across all other cross-cutting management regimes. The *Code* now provides the deep nexus in making appropriate science-based decisions on several forestry and conservation issues.

I would like to congratulate the Department and in particular the technical working group members for coming up with this code which is a milestone in our effort towards sustainable forest management and biodiversity conservation.

I urge all relevant stakeholders, government and non-government, besides the colleagues of the Department of Forest and Park Services to actively use and implement the Code in managing our forest resources for the benefit of present and future generations.

Tashi Delek!

Rinzin Dorji

འབྲུག་རྒྱལ་ཡོངས་གཞུང་། སོ་ནམ་དང་ནགས་ཚལ་སྡེན་ལས། ནགས་ཚལ་དང་སྐྱོང་གཅོས་ཀྱི་ལས་ཁུངས།

ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture and Forests
Department of Forests and Park Services
Thimphu: Bhutan

DIRECTOR

FOREWORD

Forests have always played a key role in the livelihood of Bhutanese and is intrinsically intertwined with the social, culture and tradition of our country. In view of its pivotal role not only on socio economic development but also on climate regulatory function through several means and vital ecosystem services, sustainable forest resources management has always played a key role in sustaining our natural forest resources. Bhutan is one of the few countries in the world that enshrines forest and environmental conservation aspects in its Constitution. Article 5 of the Constitution of the Kingdom of Bhutan reflects commitment to ensure that, in order to conserve the country's natural resources and to prevent degradation of the ecosystem, a minimum of sixty percent of Bhutan's total land shall be maintained under forest cover for all time. Bhutan also committed to remain carbon neutral at the 15th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2009 in Copenhagen, Denmark. In addition, the Intended Nationally Determined Contribution (INDC) submitted in September 2015 towards finalization of Paris Agreement further re-iterated Bhutan's pledge to remain carbon neutral.Today with over 71% of the total land of Bhutan under forest cover (2,717,161 ha), forests form an important and indispensable national asset sequestering around 8.5 million tonnes of carbon,, generating continuous water flow to sustain our hydro power systems, providing timber and firewood resources to Bhutanese citizens etc.. Out of the total forest area (2,717,161 ha) about 33.29% (904,423.78 ha) fallwithin thee Protect Area Systems (National Parks, Wildlife Sanctuaries and Strict Nature Reserve) and about 19.96% (542,346.32 ha) is managed as Forest Management Units, Community Forests and Local Forest Management Areas.

Therefore, in order to fulfill our international commitment to remain carbon neutral and constitutional mandate of maintaining 60% forest cover for all times to come besides harnessing other benefits such as social, cultural, economic and ecosystem services, it is imperative that the Department possesses a *Code* outlining science based management of the overall forests and biodiversity resources which will enhance the productive and ecological functions of our forest ecosystems. This *Code* has been developed through integration of good science, research, technology and decades of forest management experiences.It gives me a great pleasure in congratulating the entire Technical Working Group involved in the preparation of this *Code*. This *Code* will definitely strengthen the sustainable forest resources management and biodiversity conservation practices in Bhutan for eons to benefit the present and future generations.

Tashi Delek!

Lobzang Dorji

INTRODUCTION

The management regimes described in Volume III and Volume IV of the **Forests and Nature Conservation Code of Best Management Practices of Bhutan (**referred to as the *Code*) provide specific guidelines for sustainable management of forest and other biodiversity resources within area based management regimes. However, there exists many other important management aspects which crosscutacross the broad management regimes, which are critical for achieving the holistic sustainable forest andbiodiversity management goals.

The guidelines to prepare specific strategic interventions/ action plans to address these cross-cutting management aspects are covered by this Volume. This volume consists of the following cross cutting chapters.

Chapter 1: Watershed Management

Chapter 2: Payment for Ecosystem services

Chapter 3: Wetland Management

Chapter 4: NWFP management

Chapter 5: Pest and Disease Management

Chapter 6: Forest Fire Management

Chapter 7: Management of other Conservation Areas

Chapter 8: Plantation and Nursery Management

Chapter 9: Agroforestry

Chapters 1 to 7 deliberate on management of State Reserved Forest (SRF) Land through various cross-cutting management regimes and shall be a part of the area-based plan. Therefore, the cross-cutting management regimes shall not have a separate management plan but will be prescribed as a management intervention andprescriptions whereever applicable within the area based management plan covered under Volume IIIand Volume IV of this code. However, Chapter 8 and 9 provide technical guidance on the Plantation and Nursery Management and Agroforestry. This may not just pertain to the SRF Land but may correspondto private land as well.

ACRONYM

ArcSWAT	Arc GIS based Soil and Water Assessment Tool
BAFRA	Bhutan Agriculture and Food Regulatory Authority
BAU	Business as Usual
BSR	Bhutan Schedule of Rates
CBFFMG	Community Based Forest Fire Management Groups
CEPF	Critical Ecosystem Partnership Fund
CF	Community Forest
DDM	Department of Disaster Management
DDMC	Dzongkhag Administration
DFO	Divisional Forests Offices
DoFPS	Department of Forests and Park Services
DoL	Department of Livestock
DT	Dzongkhag Tshogdue
EoI	Expression of Interest
ES	Ecosystem Services
FFV	Forest Fire Volunteers
FGD	Focus Group Discussions
FMU	Forest Management Unit
FPED	Forest Protection and Enforcement Division
FRMD	Forest Resources Management Division
GNH	Gross National Happiness
GT	Gewog Tsogdue
ICC	Incident Command Center
IFFCG	Interagency Forest Fire Coordination Group
IPM	Integrated pest management
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KII	Key Informant Interviews
LFA	Logical Framework Analysis
LFMA	Local Forest Management Areas
LFMP	Local Forest Management Plan
LG	Local Governments
LULC	Land Use and Land Cover
MAB	Man and Biosphere
MoA	Memorandum of Agreement
MoU	Memorandum of Understanding
NCD	Nature Conservation Division
NRM	natural resource management
NWFP	Non-wood Forest Products
NWFPMG	NWFP Management Group
NWFP	Non-wood Forest Products
OCA	Other Conservation Area
OEACMS	Other Effective Area-Based Conservation Measures
OECMS	Other effective area-based conservation measures

PA	Protected Areas
PES	Payment for Ecosystem Services
PPE	Personal Protective Equipment
PRAS	Participatory Rural Appraisal
RBA	Royal Bhutan Army
RBP	Royal Bhutan Police
RGoB	Royal Government of Bhutan
RRT	Rapid Response Teams
RSPN	Royal Society for Protection of Nature
SFED	Social Forestry & Extension Division
SoP	Standard Operating Procedure
SRF	State Reserved Forest Land
TAC	Technical Advisory Committee
TCB	Tourism Council of Bhutan
ToR	Terms of Reference
UNESCO	United Nations Educational, Scientific and Cultural Organization
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
WMD	Watershed Management Division
WWF	World Wildlife Fund

Definition

Afforestation refers to the establishment of trees by sowing, planting or natural regeneration on an area from which trees have always or for very long been absent. Afforestation plantation can broadly be classified into normal and rehabilitation plantation.

Agroforestry refers to a land use systems where woody perennials (trees, shrubs, palms, bamboos, etc) grow on the same land management unit with agricultural crops and/or animals, this can either be in some form of spatial arrangement or in a time sequence.

Concessions refers to the tourism concessions whereby the agreement is made between the government and operators (individuals, community organizations, NGOs, FDIs, local entrepreneurs, etc.) to use the land, space or any property for tourism purposes to generate revenue and other benefits which can be directed towards supporting the conservation efforts in the management of the State Reserved Forests.

Concessionaires refers to private individuals, community, NGOs, etc. aware of the investment opportunities and adopt sustainable practices.

Damage refers to any adverse effects on a forest resources caused by pests and diseases or any other natural and man-made causes.

Ecotourism Product refers to natural, culture and man-made resources, attractions, facilities, activities and services which are used to meet the demand of tourists.

Hard soil refers to a fine texture soil, viz., clay or clay loam, characterized by low infiltration capacity, poor drainage and inadequate aeration. Such soils are difficult to till.

Loss refers to a measurement of damage (mortality, growth loss, deformation, etc).

Integrated Forest Pest Management refers to a part of forest management that deals with regulation of pest populations to minimize their effects on management objectives in an ecologically sound manner. It consists of a decision-making process and action alternatives.

Injury refers to an abnormality or dysfunction in a given host caused by a foreign agent, eg., canker, feeding on needles/leaves, larval galleries, galls. Injury does not necessarily imply damage.

Impact shall mean the net effects of pests or diseases on the productivity, usefulness and values of a given resource or resources with respect to specific resource management goals and objectives.

Pest refers to a plant, animal, insect, or pathogen, acting singly or in combination, often aggravated by environmental stressors, which by its presence, abundance, or activity interferes with accomplishment of resource management goals and objectives.

Pest Triangle refers to an interaction between pest, host and environment resulting in pest condition.

Pest complex shall indicate one agent affecting a host plant in a manner so as to predispose it to another pest.

Protected Area refers to an area, which has been declared to be a National Park, Wildlife Reserve, Wildlife Sanctuary, Biosphere Reserve, Nature Reserve, Strict Nature Reserve, and Critical Watershed, Biological Corridor or any other area meriting protection by the National Assembly of the Kingdom of Bhutan.

Reforestation refers to the re-establishment of tree on forest land.

Soft soil refers to a course texture soil, viz., sand or sandy loam, characterized by high infiltration and low water holding capacity (adapted from Glossary of technical terms, FRI, Dehradun 1983).

State Reserved Forest Land refers to any land and water body outside a *Thromde*, the ownership of which is not vested in any person and is under the custody of the State.

Technical Advisory Committee refers to the highest decision-making body within the Department, comprised of Chiefs and Specialists of various divisions which shall formulate guidelines, advice the Department on technical matters whenever required.

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1. Watershed Management

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1. Watershed Management

1.1. Management Context

1.1.1 Background

Well managed watersheds play a pivotal role in supplying a wide range of ecosystem goods and services especially for reliable supply of good quality water. Watersheds with good natural vegetation are also critical to regulate variations in water flows and to minimize erosion. Watershed management refers to the management of watersheds in a holistic manner taking into account all aspects that are likely to influence the quality and quantity of water flowing from the watershed.

Watershed management has now become more crucial to meet the increasing demand of water and other ecosystem services for hydropower plants development, agriculture intensification and rapid expansion of towns and cities. Moreover, with the increasing impacts of climate change such as drying up of water sources, incidences of droughts and forest fires, floods and landslides, watershed management is an important tool for climate change adaptation and mitigation.

For the watersheds that are identified as degraded or critical through assessment, watershed management intervention shall be designed and incorporated into the relevant area-based management plans. As forest act as water recharge areas, function mapping of the forest to locate the water recharge areas shall be essential part of the watershed management intervention measures. The recharge area identification and mapping shall be done using the steps outlined in Protocol for Reviving Springs in the Hindu Kush Himalaya: A Practitioner's Manual, ICIMOD as shown in Box 1.2 (Shrestha et al., 2018).

1.1.2 Objectives

The overall goal of watershed management is to plan and work towards an environmentally and economically healthy watershed benefitting all end users through reliable flow of good quality water and other ecosystem services. The specific objectives of watershed management are to:

- restore, protect and improve watershed conditions through participatory, integrated and adaptive management interventions;
- support sustainable livelihood options to enhance livelihood of local communities; and
- secure sustained watershed services for socio-economic development

1.1.3 General Principles

The following are some general principles that shall be considered for the watershed management. They are based on national level policy, and commonly understood practices.

Objective-led

Watershed management shall be objective-led. Identifying and starting with management objectives shall make the watershed management interventions more logical and concise. The objective setting and agreement on objectives is one of the first steps of the watershed management process and can be done in a participatory way with the relevant stakeholders.

All the activities identified for improving or protection of watersheds shall be determined by the need to address certain management objectives such as to address a degrading factor or protection of the water source. If activities are not necessary for the achievement of an objective, then they shall not be prescribed. Similarly, if certain activities necessary for achievement of an objective have not been prescribed, then this shall be corrected and included in the management interventions after getting approval from the Department.

Participatory Approach

Watershed management interventions shall be developed in a participatory manner, albeit with expert input. This participatory approach shall ensure the following:

- Concerns of a wide range of stakeholders are included.
- Consensus from key stakeholders and ownership of the outcomes by local decision makers for assured implementation success.

- Ensure the process is participatory and inclusive; various consultations at local, Dzongkhag and national levels shall be conducted.

Science based management

Watershed management interventions shall be designed based on scientific research covering the impacts of climate change and land use change on the watersheds. Further, scientific studies are required to understand the impacts of watershed management interventions in addressing the degrading influences.

1.2. Roles and Responsibilities

The field offices shall develop watershed management interventions to protect or improve watersheds. They shall incorporate watershed management activities in to their area-based management plans such as Forest Management Units (FMU), Community Forests (CF), Local Forest Management Areas (LFMA), Protected Areas (PA) and any other relevant area-based plans, and, ensure the implementation of watershed management activities in collaboration with relevant stakeholders. The detailed roles and responsibilities are provided in the Table 1.1.

Table 1.1 Roles and responsibilities of different stakeholders

Ofices	**Roles and Responsibilities**
Watershed Management Division (WMD)	• Educate and create awareness on watershed management • Technically backstop field offices/agencies in preparation and implementation of watershed management activities • Monitor and evaluate watershed management implementations
Field offices	• Carryout watershed assessments in their respective areas • Prepare watershed assessment reports • Develop watershed management interventions • Implement watershed management interventions in collaboration with other stakeholders
Other stakeholders	• Support in identification of issues and problems in the watershed • Appraise the Department about their local plans and programs • Provide inputs and feedbacks for watershed management • Support in implementation of watershed management activities • Collaborate in carrying out Monitoring & Evaluation

1.3. Watershed Management Process

Watershed management is an adaptive, comprehensive, integrated multi-sectoral management process that provides a framework for integrated decision-making to help assess the nature and status of the watershed; identify watershed issues through integrated and participatory manner involving all the stakeholders. It takes into account both ground and surface water flow, recognizes the interaction of water with plants, animals, human and various land use within the physical boundaries of a watershed. The watershed management process is summarized in Table 1.2.

Table 1.2 Watershed Management Process flow chart

Activity/Steps	Objective	Output	Lead agency	Collaborators	Comments
Watershed delineation	To identify watershed boundaries and to provide clear scope for watershed management interventions	Map showing number of watersheds	WMD	Field Offices	Watershed delineation at national level while sub-watersheds can be delineated by field offices
Watershed assessment and classification	To understand the conditions of the watersheds and to classify the watersheds in to "pristine", "normal", "degraded" and "critical" To identify watersheds which needs intervention measures	Assessment report on the status of the watersheds assessed with indicative issues & concerns in the watershed Number of degraded and critical watersheds identified	Field Offices	WMD	Watershed assessment and classification to be done as per Section 1.3.1
Function mapping	To identify the water recharge areas with management restrictions in the watershed	Map showing water recharge areas based on forest functions	Field Offices	WMD	Forest function mapping of recharge areas shall be done following the Springshed methodology adapted by Department.
Designing watershed management interventions	To identify degrading influences and prescribe appropriate intervention measures	List of interventions recommended to address the degradation	Field Offices	WMD	The Logical Framework Analysis approach shall be used.
Approval procedures	To ensure that the watershed management interventions are consistent with the agreed process and technical norms	Watershed management interventions approved by the Head of the Department for implementation	WMD	Field Offices	Interventions shall be reviewed before putting up to the Head of the Department for approval
Implementation framework	To provide guidance and ensure incorporation of watershed management interventions in to area-based plans	Watershed management interventions incorporated	Field Offices	WMD	The activities can be annexed to the existing plans or incorporated while revising the plans.
Monitoring and evaluation	To ensure proper implementation of the proposed measures and to assess the impacts of the interventions	M & E report along with recommendations for improvement	WMD	Field Offices	It shall be following the LFA matrix.

1.3.1 Watershed Assessment and Classification

Watershed assessment and classification shall be carried out to understand the conditions of the watersheds and classify them into 4 different categories, namely, "pristine", "normal", "degraded" and "critical". It is a rapid assessment and classification for identifying those watersheds which require interventions and remedial measures to improve the condition of the watershed.

Watershed Assessment and Classification Procedures

Preparation for the Watershed Assessment

Prior to field assessment, desktop analysis shall be carried out to generate information such as watershed boundary, watershed ID, number of Gewogs and Dzongkhags within the watershed. The 186 watersheds delineated with a threshold of 5000 hectares is currently used as a basis for assessment and classification of watersheds (Figure 1.1). All watersheds assessment and classification shall be carried out in the field after understanding the watershed boundaries.

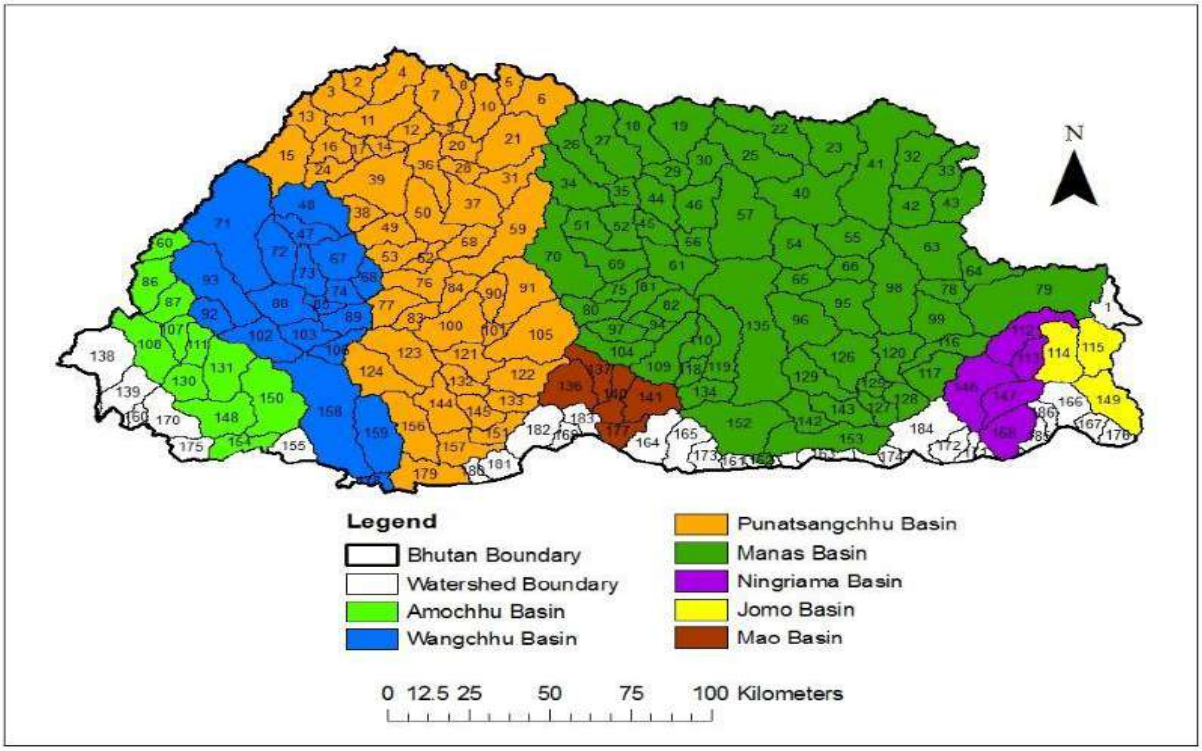


Figure 1.1 Map showing the 186 watersheds delineated in Bhutan

Participatory mapping of watersheds

As part of the assessment and classification, community level consultation meetings shall be organized. The community consultation shall focus on getting information such as number of sub-watersheds, number of dependent households, issues, identifying the degrading factors, understanding the probable causes and participatory water resources mapping.

Field assessment & classification

The field assessment and classification are done based on the condition of watershed and downstream water use. The condition of a watershed shall be assessed using the 28 criteria, grouped into four categories – "Biophysical", "Socio-economic", "Climatic" and "Demographic".

Individual criteria scores range from 1 (good condition, low risk) to 3 (degraded condition, high risk). If half scores of 1.5 or 2.5 may not be appropriate and the available information warrants such a rating, rounding

off the scores would be appropriate based on the professional judgement of field assessor. Guidance for scoring on each individual criterion is provided in Table 1.3.

Table 1.3 Condition Scoring

	Score = 1	Score = 2	Score = 3
BIOPHYSICAL			
Gully erosion	No gully erosion sighted	Small number of shallow gullies	Deep gullies, widespread sightings
Rill/Sheet erosion	None sighted	Infrequent and small	Significant and widespread
Mass movements/ landslide	None sighted	Infrequent and small	Large landslides
Debris flow	Waterway generally free of debris	Small debris in water and river banks	Tree trunks and other large debris along waterway
Turbidity	< 5 NTU in dry season, < 20 NTU in wet season	< 20 NTU in dry season, < 50 NTU in wet season	> 20 NTU in dry season, >50 NTU in wet season
Eutrophication	TP < 0.5 mg/L, TN < 2mg/L	TP < 2 mg/L, TN< 10mg/L	TP > 2 mg/L, TN> 10mg/L
Salinity	< 500 uS/cm	500-2500 uS/cm	> 2500 uS/cm
pH	pH 6.5 - 8.5	pH 6.0-6.5 or 8.5-9.0	pH < 6.0 or > 9.0
Forest cover	>60% coverage	25 - 60% coverage	< 25% coverage
Riparian vegetation (30 m on both banks)	Coverage on main river good and natural	Large bare areas and erosion	Banks are mainly bare and show significant erosion
Natural Wetlands (water ecosystems, marshes, lakes, rivers, streams, water bodies…)	Intact in the watershed	Fragmented	Wetlands converted to other land uses
SOCIO-ECONOMIC			
% of watercourse close to settlement	70% of the water course >100 m away from the Settlements	40% to 70% of the water course >100 m away from the Settlements	<40% of the water course >100 m away from the Settlements
Sewering of houses	Houses connected to centralized sewer system	Houses not sewered but no obvious offsite discharge	Houses not sewered, pollution to river is evident
Industrial use	None	Limited for cottage industry	High volume for large-scale industries
Irrigation	None	Limited extent, importance	Irrigation widespread, dominant
Extent of farm land	<10% of watershed used for agriculture / horticulture	10-30% of watershed used for agriculture/ horticulture	>30% of watershed used for agriculture/ horticulture
Degraded arable land	None apparent	<25% arable land is degraded	>25% arable land is degraded
SWC measures	Most agricultural land has SWC	About half have SWC	None have SWC
Use of pesticides/ herbicides/ fertilizers	None – organic farming	Limited use of fertilizers, no herbicides/ pesticides	Use of all three

	Score = 1	Score = 2	Score = 3
Livestock density	< 1 LU*ha^{-1}	1-3 LU*ha^{-1}	>3 LU*ha^{-1}
Grazing Intensity	Normal grazing (< 3months)	Moderate grazing (3-6 months)	Heavy grazing (> 6 months)
Mining Activities	No mining	Small scale mining, no apparent impacts	Large scale mining, potential runoff impacts
Forest degradation	Minimal collection of forest products	Some isolated small-scale degradation in pockets	Widespread, large-scale degraded forests
Roads (density and condition)	Density < 0.5km/km^2; Good drainage and hillside conditions	Density 0.5 - 2 km/km^2; Some inadequate drainage, landslides, barren dump slopes	Density > 2 km/ km^2; Generally poor drainage, frequent or severe landslides, etc
Man-made change in watercourses	Little change to main river and tributaries	Significant diversions for roads and irrigation	Main river has dams or hydropower
Incidence of forest fires	No or very low incidence	Low-moderate incidence	Area has high fire incidence
CLIMATIC			
Precipitation	Annual Rainfall < 1m	Annual Rainfall 1-3m	Annual Rainfall > 3m
DEMOGRAPHIC			
Population density / rural/ urban	Only scattered farm houses OR ≤ 5 people/km^2	Some small villages OR about 10-30 people/km^2	Large towns OR ≥ 40 people/ km^2

Weightings

Once the criteria have been scored, they are to be multiplied by a weighting factor (1, 2 or 3) to reflect the different importance of criteria on overall watershed condition and functions. Weightings also vary with water use to reflect the fact that some criteria may be very important for one water use, while less important for other water uses. For example, pathogen levels are very important (weighting of 3) for drinking water use but otherwise have very little importance (weighting of 1).

Suggested weightings are shown in Table 1.4. As explained previously, weightings are provided for the three highest water use priorities as per the Water Act of Bhutan, 2011. These are "drinking", "agriculture" and "energy (hydropower)".

Table 1.4 Suggested Weightings

CRITERIA

	Weightings based on water use	DRINKING	HYDROPOWER	AGRICULTURE
BIOPHYSICAL				
Erosion	Gully erosion	1	1	1
	Rill/Sheet erosion	2	2	2
	Mass movements/landslide	2	3	2
	Debris flow	1	3	3
Water Quality	Turbidity	3	3	1
	Eutrophication	2	1	1
	Salinity	3	1	3
	pH	2	1	3
Forest coverage		2	2	2
Riparian vegetation		2	2	2
Natural wetlands		2	2	2
SOCIO-ECONOMIC				
Settlements	% of watercourse close to settlement	2	1	1
	Sewering of houses	2	1	1
	Industrial Use	3	1	2
Agriculture	Irrigation	1	1	2
	Extent of farm land	2	2	2
	Degraded arable land	1	1	1
	SWC measures	1	1	2
	Use of pesticides/herbicides/fertilizers	3	1	2
Livestock density		3	1	1
Grazing		2	1	1
Mining Activities		3	1	2
Forest degradation		2	2	2
Roads (density and condition)		2	1	2
Manmade change in watercourses		1	2	2
Incidence of forest fires		2	1	2
CLIMATIC				
Precipitation		2	2	2
DEMOGRAPHIC				
Population density		2	2	2

Some watersheds may have other water uses such as for industry, tourism/recreation, environment, etc. Specific weightings for these uses shall vary on a case-by-case basis. For such cases, it may be appropriate to simply adopt the weightings supplied for "agriculture" or alternatively conduct a workshop with relevant stakeholders to agree on an appropriate set of weightings. For example, higher weightings may be agreed for certain water quality criteria if these are considered particularly important to a certain industrial water user.

Calculating the Total Condition Score

When all condition criteria have been scored and weighted, the total weighted score can be calculated by summing all the individual weighted scores. This can be represented as:

$$\text{Total condition score} = \sum [(\text{Individual Criteria Score}) \times (\text{Individual Criteria Weighting})] \quad (1)$$

This can then be represented as a percentage score by calculating the maximum possible score for the watershed. This maximum possible score is simply the total score that would be achieved if all individual criteria were scored as a 3. This can be represented as:

$$\text{Maximum Possible Score} = 3 \times \sum (\text{Individual Criteria Score}) \quad (2)$$

$$\%\ \text{Condition Score} = [\text{Total Condition Score}] / [\text{Maximum Possible Score}] \quad (3)$$

The Total Condition Score shall then classify the watershed under one of three categories of degradation:

< 50% Good condition, low level of degradation

50% – 75% Normal condition, medium level of degradation

> 75% Poor condition, high level of degradation

Overall Risk Rating

The overall risk rating for the watershed is determined based on both the CONDITION score and the WATER USE score using the risk matrix shown in Table 1.5.

Table 1.5 Risk Matrix for Determination of Overall Risk Rating

		Water Use Rating		
		1	2	3
Condition Score	<50%	PRISTINE	PRISTINE	NORMAL
	50-75%	PRISTINE	NORMAL	DEGRADED
	>75%	NORMAL	DEGRADED	CRITICAL

The following examples illustrate how to use the risk matrix:

Example 1. A watershed with a HIGH (3) water use score (say, drinking water supply for a large town) but LOW or GOOD (<50%) condition score would result in an overall risk rating of NORMAL.

Example 2. Similarly, a LOW (1) water use score (say, a small contributing watershed to a larger hydropower catchment) combined with a HIGH or DEGRADED (>75%) condition score would also result in an overall risk rating of NORMAL.

The assessment progression is then to develop a management intervention according to the overall risk rating. Watersheds with an overall risk rating of DEGRADED or CRITICAL shall be progressed to the next stage, which is preparation of an Integrated Watershed Management Interventions. Watersheds with a lower risk rating may still be addressed if required.

Field Worksheet

When assessing and scoring watersheds in the field, assessors shall use a copy of the field worksheet attached in Table 1.6.

Table 1.6 Field worksheet

TIER	SCORES			COMMENTS
Tier 1 - Basin				
Tier 2 - Sub-Basin				
Tier 3 - Watershed				
GPS Coordinates				**Elevation:**
Commentary on water use				
CONDITION ASSESSMENT	**SCORES**			**COMMENTS**
BIOPHYSICAL	Score	Weighting	**Weighted Score**	
Erosion Gully erosion				
Rill/sheet erosion				
Mass movements/landslide				
Debris flow				
Water Qu Turbidity				
Eutrophication				
Salinity				
pH				
Forest coverage				
Riparian vegetation				
Natural Wetlands				
SOCIO-ECONOMIC				
Settlemen % of watercourse close to settlement				
Sewering of houses				
Industrial use				
Agriculture Irrigation				
Extent of farm land				
Degraded arable land				
SWC measures				
Use of Pesticides/herbicides/fertilizers				
Livestock density				
Grazing				
Mining Activities				
Forest degradation				
Roads (density and condition)				
Manmade changes in watercourses				
Incidence of forest fires				
CLIMATIC				
Precipitation				

DEMOGRAPHIC				
Population density				
Total weighted score				
Maximum score				
% score				
Water use score				
Overall Risk Score				

The worksheet requires details of the watershed being assessed, the date and location of the assessment, names of assessors, as well as scores and commentary for each assessed criterion. While assessing the watersheds, it is important to measure discharge of the springs and streams. The method commonly used for discharge measurement is Velocity Area method and Volumetric method. *The details are provided in the* Box 1.1*:*

Box 1.1 Velocity Area method and Volumetric method (adapted from Othman et al., 2017 and Cairncross et al., 1985)

FLOAT METHOD (Velocity Area method)

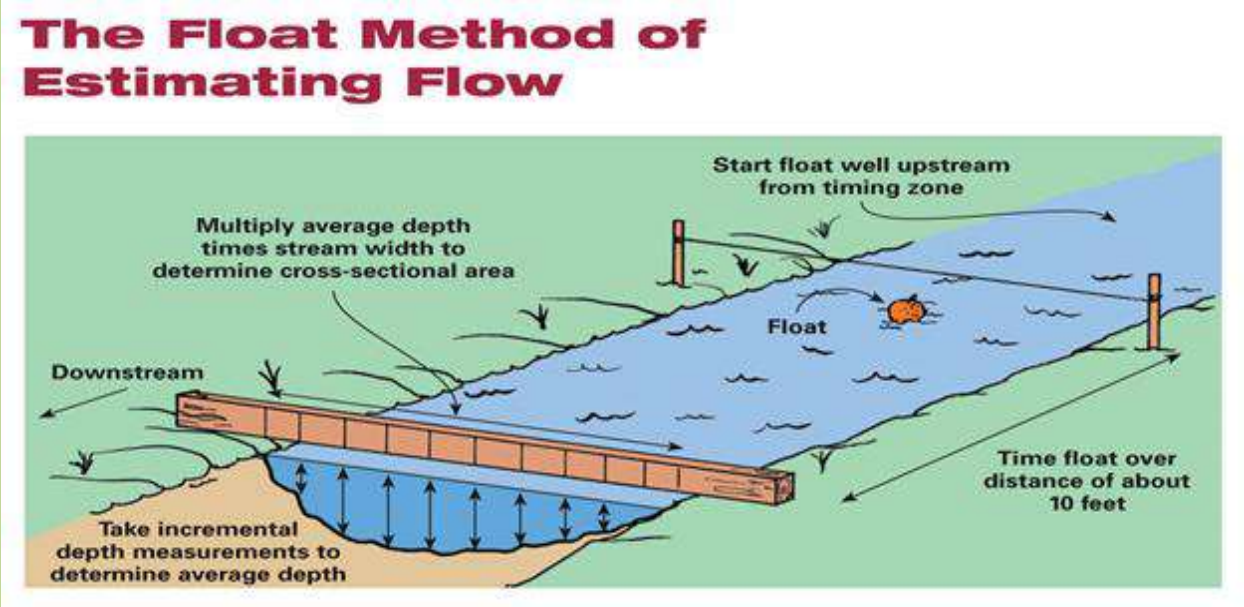
Float method is a practical and simple discharge measurement method. This method measures surface velocity. Mean velocity is obtained using a correction factor. The basic idea is to measure the time that it takes the object to float a specified distance downstream.

$V_{surface}$ = travel distance/ travel time = L/t

Because surface velocities are typically higher than mean or average velocities

$V_{mean} = k\ V_{surface}$

where k is a coefficient that generally ranges from 0.8 for rough beds to 0.9 for smooth beds (0.85 is a commonly used value).



Step 1. Choose a suitable straight reach with minimum turbulence (ideally at least 3 channel widths long)

Step 2. Mark the start and end point of your reach

Step 3. If possible, travel time should exceed 20 seconds.

Step 4. Drop your object into the stream upstream of your upstream marker.

Step 5. Start the watch when the object crosses the upstream marker and stop the watch when it crosses the downstream marker.

Step 6. You should repeat the measurement at least 3 times and use the average in further calculations.

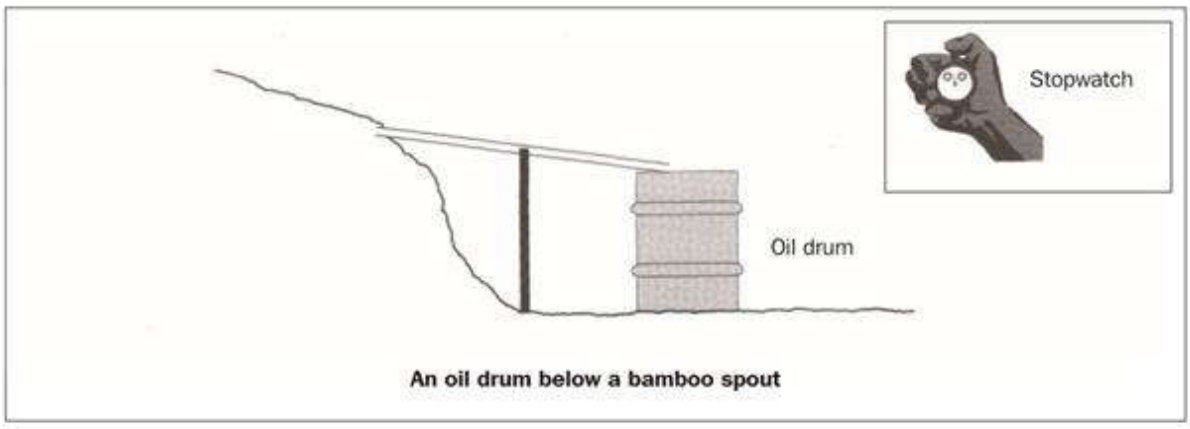
Step 7. Measure the cross-sectional areas at the start and end point of your reach. Average your cross-sectional areas: Using the average area and corrected velocity, you can now compute discharge, Q. Correction factors to convert surface velocity to average velocity typically range from 0.8-0.9. Many times, 0.85 is used, which is also adopted by WMD. In mountain streams with lots of roughness elements, the value may be much lower e.g. ~ 0.67.

With an estimate of cross-sectional area, discharge can be computed as Q = VA where V is average velocity

VOLUMETRIC METHOD (*adapted from Cairncross et al., 1985*)

The simplest way to estimate small flows is by direct measurement of the time to fill a container of known volume. The entire flow is diverted into a channel or pipe which discharges into a suitable container such as oil drum or bucket, and the time to fill is measured by stopwatch. For flows up to about 4 L/s, a bucket of 10 L capacity is suitable and shall fill in 2½ seconds. For larger flows, an oil drum of 200 L can handle flows up to about 50 L/s. The time to fill must be measured accurately, especially when it is only a few seconds. The variation between several measurements taken in succession shall give an indication of the accuracy of results.

Discharge or yield (l/s) = volume (litres)/time (seconds)



An oil drum below a bamboo spout

Data analysis and classification

Once the criteria have been scored, they are to be multiplied by a weighting factor (1, 2 or 3) to reflect the different use of water on overall watershed condition and functions. Suggested weightings and calculations of final scores are shown in the Table 1.6.

1. Validation of the identified degraded watershed

The watersheds which are identified as degraded and critical watersheds shall be taken up for detail assessment and validation. WMD shall present to the Technical Advisory Committee (TAC) of the

Department to inform on the status of watershed, the location of watershed indicating whether watershed is within or outside any forest management regimes. This shall enable better coordination in designing management interventions and incorporation into existing management regimes for implementation.

2. Monitoring of watershed assessment and classification

All watershed assessment and classification data shall be stored in the database and this shall help in tracking the watershed conditions while carrying out monitoring. The watershed assessed and classified as normal or good conditions shall be monitored periodically.

1.3.2 Designing Watershed Management Interventions

Watershed management shall also consider the management and conservation of all available natural resources in a comprehensive way to maintain or improve the conditions of the watersheds. Therefore, the purpose of this section is to describe the steps needed to plan interventions to be incorporated in the relevant area-based management plans.

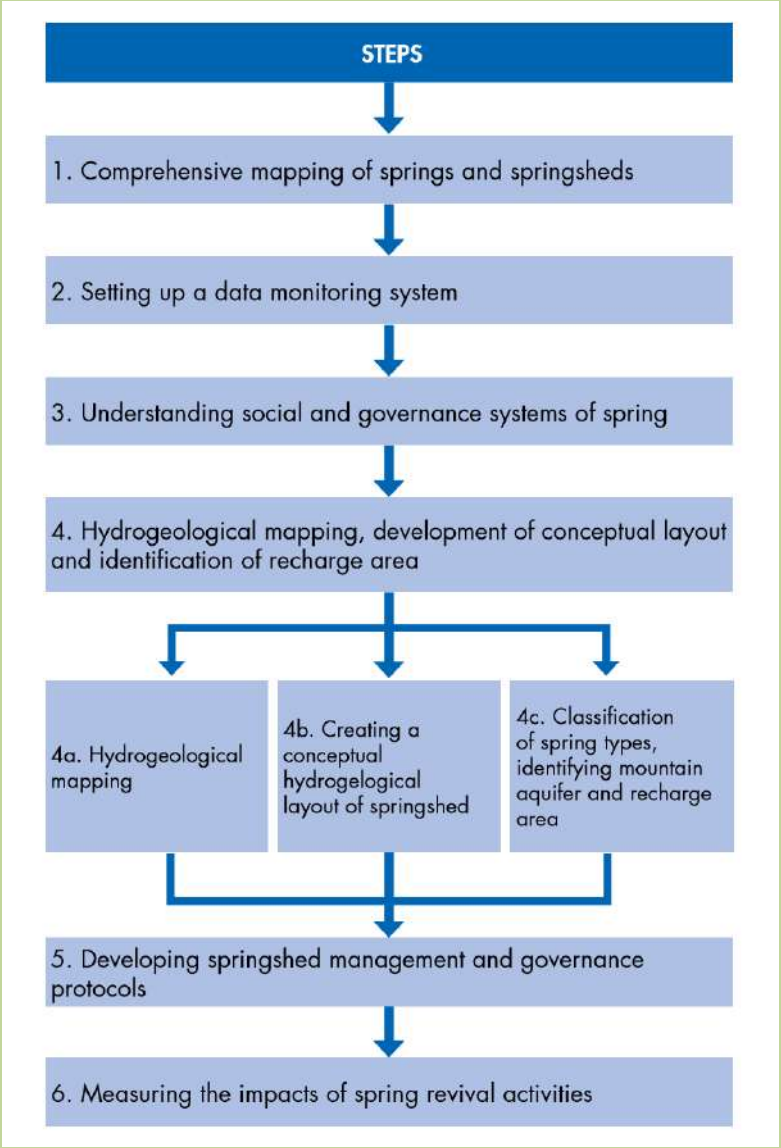
Set overall purpose of watershed management

In order to avoid a gradual shift in objective of the watershed management while identifying interventions, the purpose of the management shall be clearly set and agreed among the stakeholders. In most situations, the purpose shall be to establish a process to identify and address (remove or mitigate) degrading influences but, there may be situations where watershed shall be intervened because it is an important area for an urban or community water source. In such cases, even though the watershed is not degraded or critical, interventions may be required.

Function mapping

Function mapping shall be essential part of the watershed management. For watershed management purposes, forests which act as water recharge areas shall be identified and mapped. This shall guide the process of identifying issues and designing appropriate interventions. The recharge area identification and mapping can be done using the steps outlined in Protocol for Reviving Springs in the Hindu Kush Himalaya: A Practitioner's Manual as shown in Box 1.2 (Shrestha et al., 2018).

Box 1.2 Six-step Protocol for reviving Springs including identification and mapping of recharge area (Shrestha et al 2018)



Step 1: Comprehensive Mapping of Springs and Springsheds

Objective: To generate comprehensive information about the springshed – including web-based maps, GPS locations of springs, and basic socio-economic information.

Output: A comprehensive spring database with the GPS location of all springs, one-time discharge and water quality values, and basic socio-economic data, and a field report that documents these findings.

Step 2: Setting Up a Data Monitoring System

Objective: To collect long-term spring discharge data, water quality information, and rainfall data with the help of the local community by setting up instruments and data monitoring systems.

Output: Data stored in an Excel spreadsheet (or similar data software) on daily rainfall, bi-monthly or monthly spring discharge, and water quality. Rainfall and spring discharge hydrographs and water quality parameters should be plotted as graphs.

Step 3: Understanding Social and Governance Systems Related to Springs

Objective: A comprehensive understanding of current water use patterns and their socio-economic implications, and the institutions and governance systems that are in place for managing springs.

Output: A report that synthesizes the findings from focus group discussions (FGDs), key informant interviews (KII), and a questionnaire survey/interviews and presents various aspects of water use, institutions, and governance.

Step 4: Hydrogeological Mapping, Development of Conceptual Layout, and Identification of Recharge Area

In this step, the recharge area is identified using knowledge of the local hydrogeology. There are three sub-steps: field mapping of the geology; creating a conceptual hydrogeological layout of the springshed; and identifying the recharge area.

Step 4A: Hydrogeological Mapping

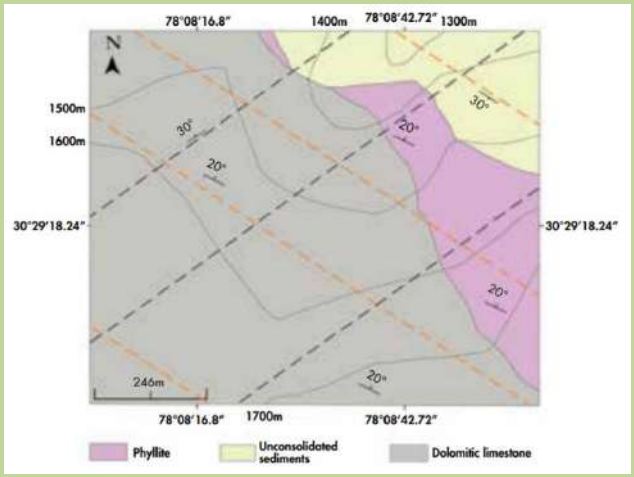
Objective: To undertake a detailed study of rocks, rock structures, streams, and springs in the springshed and prepare a geological map (and/or a cross section) of the springshed

Output: A geological map to support development of a conceptual hydrogeological layout

Applying hydrogeological principles through detailed study of the rocks, rock structures, streams, and springs in the springshed can significantly improve demarcation of the recharge zone for spring management and revival. The types of rock, their strike and dip (inclination), presence of openings, and structural features together govern the accumulation and movement of groundwater. The dip and strike of rocks and identification of openings forms the basis of geological mapping, especially in the Himalayan region. The steps involved in detailed hydrogeological mapping of a spring and its springshed are outlined in the following.

Obtaining a geological map of the area

Geological maps of the area of interest can be availed (if available) from different sources. In general, geological maps may be available from the Department of Geology and Mines, MoEA, RGoB. Such maps can be used for reference purposes and to gain a first cut idea about the regional geological conditions. These maps can provide information about the types of rock, their orientation, and broad geological structures present in the area of interest, before undertaking detailed hydrogeological mapping of springs and springsheds.



Geological observations during the transect walks

Information on spring location, rock type, and strike and dip values as well as land-use, land-cover, and forest types shall be collected during the transect walks across the springshed and noted in a field diary, together with values of latitude, longitude, and elevation for every location of interest.

The geological traverses shall be planned such that they cover the entire springshed (Figure 1.2). A geological map and geological cross section are prepared using the information collected. The map and section are essential for the development of a conceptual hydrogeological layout, and ultimately to identify the recharge area or protection zone.

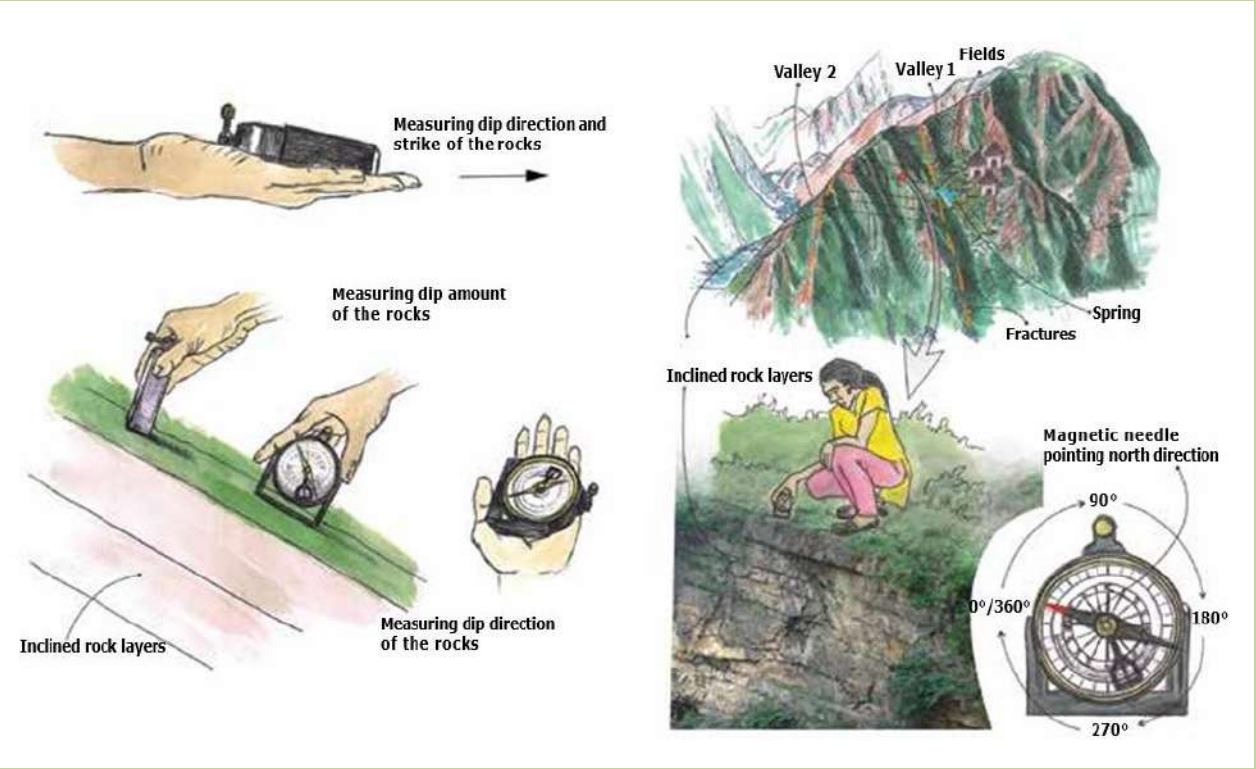


Figure 1.2 Measuring strike and dip using geological compass (clinometer or Brunton compass)

Creating a geological map (using Google Earth/Toposheet)

A geological map shows the distribution of different types of rock and their structural relationship with each other in the area of interest. Geological maps can be prepared at various scales, but for the purpose of hydrogeological mapping of a spring and springshed area, it is preferable to prepare the map at a scale of 1:10,000 or 1:25,000, depending on the detailed information required for spring revival activities.

All the information/observations gathered during the transect walk shall be transferred in a specific format to an MS Excel sheet. The Excel file is converted to a Google Earth file format (.kml) using an online converter such as Earthpoint (www.Earthpoint.us), which shall place all the information in the form of placemarks in Google Earth (Figure 1.3).

The attitude, i.e., strike and dip, of a particular rock at its place of observation in the field is plotted over the placemark in Google Earth representing its location (Figure 1.4). In this way, the observations made at the surface are built into a geological map incorporating structural and lithological observations. The integration of data on dip and strike with other standard observations made on rocks in the mapping enables interpolation and extrapolation of outcrop data to produce a geological map (Figure 1.5).

Figure 1.3 Geological information locations produced in Google Earth

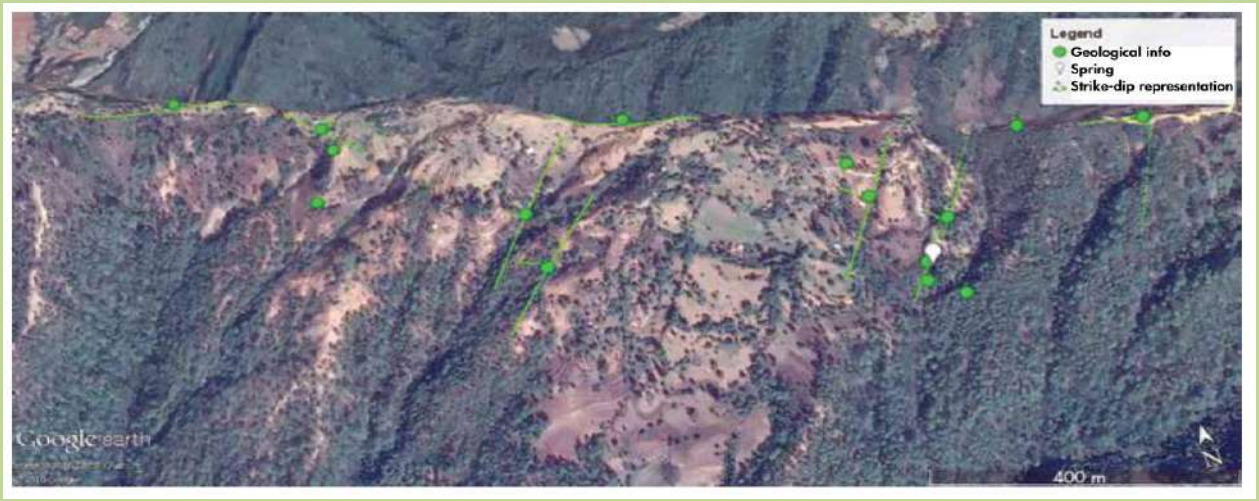


Figure 1.4 Plotting of strike and dip

Figure 1.5 Geological map in Google Earth

Resources Needed

The Table 1.7 gives a summary of the skills (human resources) and instruments (hardware, software) required to carry out the tasks outlined in Step 4A.

Table 1.7. Summary of requirements for Step 4A

Types of skill needed	Objective	Time estimate
Basic understanding of field hydrogeology along with hands on experience in using basic software such as MS Excel, Arc GIS, and Google Earth.	Collecting hydrogeological information from the field for developing hydrogeological maps	60 person-days for mapping springshed of 100 ha
Instruments required	Brunton compass/clinometer, hammer, GPS, field diary, base map like toposheet/ geological maps	
Software requirement	Microsoft Excel and Google Earth	

Step 4B: Creating a Conceptual Hydrogeological Layout of the Springshed

Objective: To prepare a geological cross section for the springshed and project it into a three-dimensional (3-D) conceptual hydrogeological layout

Output: A conceptual hydrogeological layout helps in the demarcation of the recharge zone for spring management and revival described in step 4C. It also helps in visualizing the area of interest in 3-D.

A hydrogeological layout of a springshed is actually a geological cross section depicting a spring and its relation to the surrounding geology viewed in 3-D. Thus, a geological cross section is first prepared from the geological map and then projected onto a 3-D image. The location of the spring is then marked on the 3-D layout to form a conceptual layout. The base map and geological map prepared from the field data are used to create the hydrogeological layout, including the cross-sectional view of the springs and springsheds. The hydrogeological layout helps in understanding the inclination of rock layers and structures with reference to the spring. These further guide demarcation of the recharge area for the spring. The steps involved in the preparation are described in the following.

Generating a cross section of the springshed

The geological map prepared in step-4A is used as a base for generating a cross section of the springshed using tools in Google Earth together with software support from CorelDRAW. A para-hydrogeologist can also hand-draw a hydrogeological layout and cross section while in the field without the use of computer software.

Using Google Earth, an elevation profile (also called a topography profile) is generated for the springshed of interest. The profile is then transferred to CorelDRAW software where the contrasts in lithology (contacts) are marked together with the locations of the spring and fractures or joints. This process yields a two-dimensional (2-D) cross section for the springshed (Figure 1.6) which is then integrated into CorelDRAW to produce 3-D conceptual hydrogeological layout.

Creating a 3-D conceptual hydrogeological layout

The cross-section profile represents all the geological information in 2-D including rock layers (showing dip direction and dip amount), spring location, and fracture/joint observation points. This section is integrated into a 3-D layout using CorelDRAW tools which displays the fracture trends, strike and dip of the rocks, and location of spring together with any additional observations and information from the field (Figure 1.7). This 3-D layout helps in developing understanding of the

geological setup of the springshed. The aquifer can be represented in the layout itself using the field information on spring typology and aquifer identification, which further helps in demarcating the recharge area for the spring.

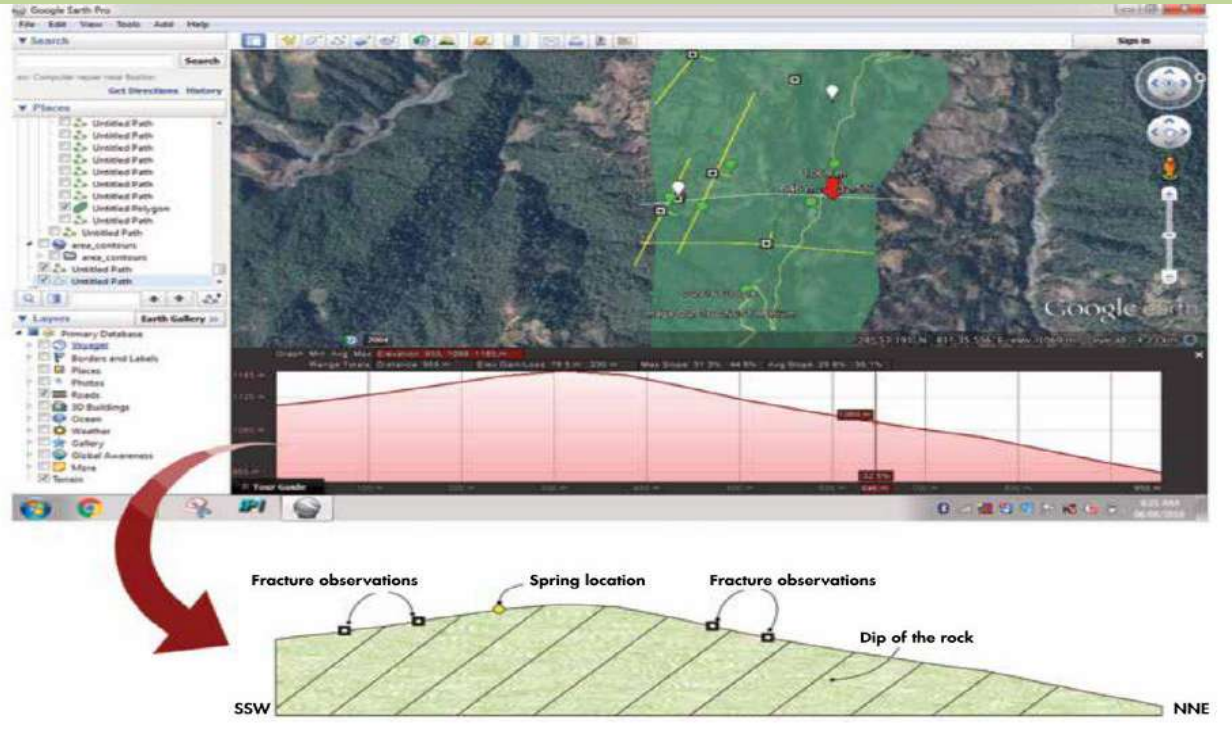


Figure 1.6 . Generating a cross section of the springshed

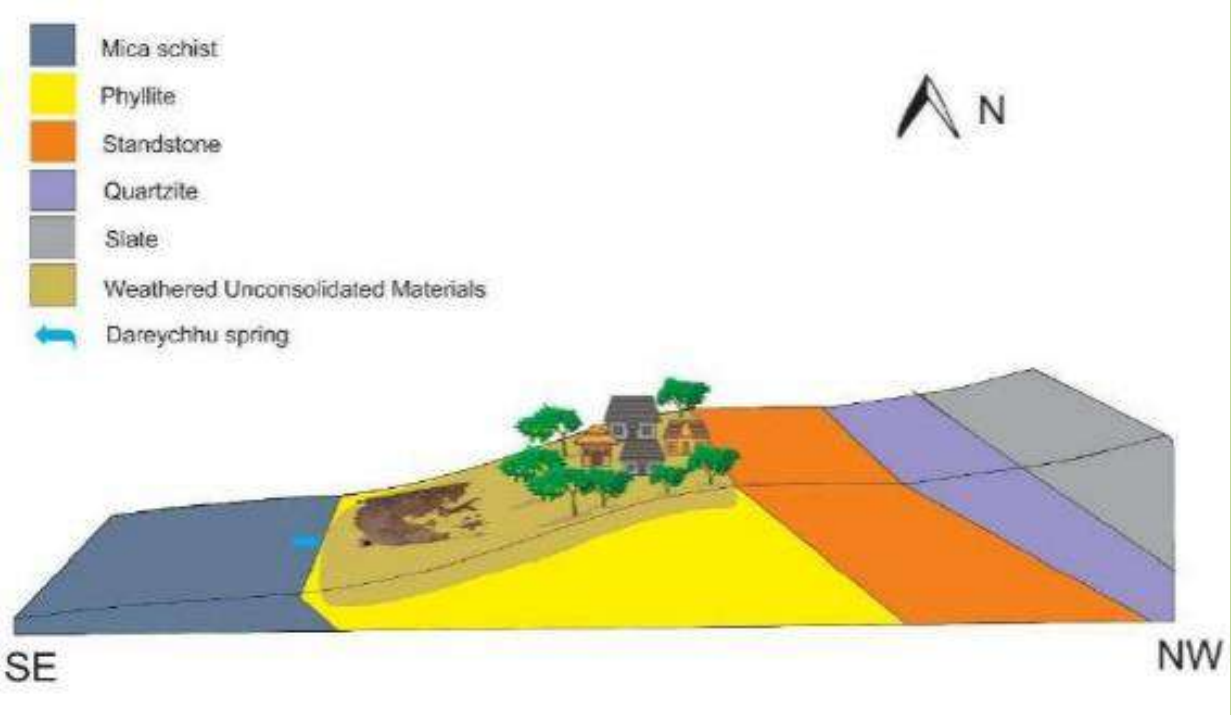


Figure 1.7 A conceptual hydrogeological layout of Passangchhu and Dareychhu (Gelephu)

Resources Needed

The Table 1.8 gives a summary of the skills (human resources) and instruments (hardware, software) required to carry out the tasks outlined in Step 4B.

Table 1.8. Summary of requirements for Step 4B

Types of skill needed	Objective	Time estimate
Ability to interpret field data in order to understand and draw the hydrogeological setting of the springshed, together with the capacity to work on various computer aids	Creating a geological cross section and developing a hydrogeological conceptual layout	30 person-days for a 100 ha springshed area
Use of software		Designing software like CorelDRAW and SketchUp, and Google Earth

Step 4C: Classification of Spring Type, Broad Identification of the Mountain Aquifer, and Demarcation and Analysis of the Recharge Area

Objectives: To identify the spring type and the aquifer feeding the spring and demarcate the recharge area for the spring based on various outputs from the previous steps, particularly the hydrogeological layout.

Output: The final output is identification of the recharge area(s), with various sub-outputs from different steps. The hydrogeological layout of a springshed helps in identifying the aquifer and recognizing the type of spring being studied, as well as progressing towards demarcating the recharge area for the spring as part of the springshed management activities. The steps involved are described in the following.

Identifying the spring type and aquifer

The hydrogeological layout described in the previous section is based on field observations and mapping. The broad location of the aquifer, the location of the spring, and other geological features indicates the hydraulic connection between the ground surface, the aquifer, and the spring. Different characteristics contribute to identification of the type of spring and type of aquifer, including the relation to geological features, and the discharge, water quality, and hydrograph.

Identification of spring and aquifer type from the hydrogeological layout

The hydrogeological layout developed from the observations is compared with the diagrams of spring-types and aquifer types in order to identify the basic spring type. Figure 1.8 shows an example where the spring emerges along a fracture (and mostly due to the presence of the fracture) trending roughly NE-SW from an aquifer defined by phyllite and fractured quartzite layers.

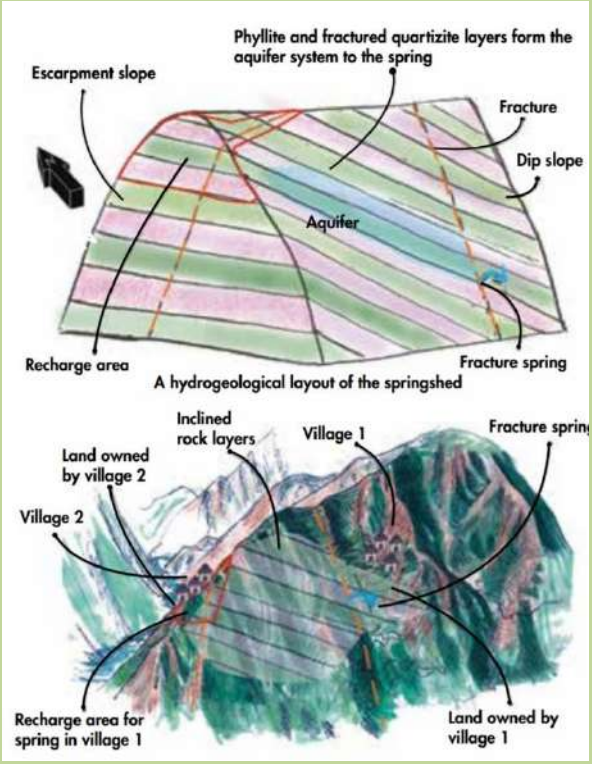


Figure 1.8 Conceptual layout showing a fracture spring and the aquifer feeding it

Identification of spring and aquifer type from the hydrograph and groundwater quality information

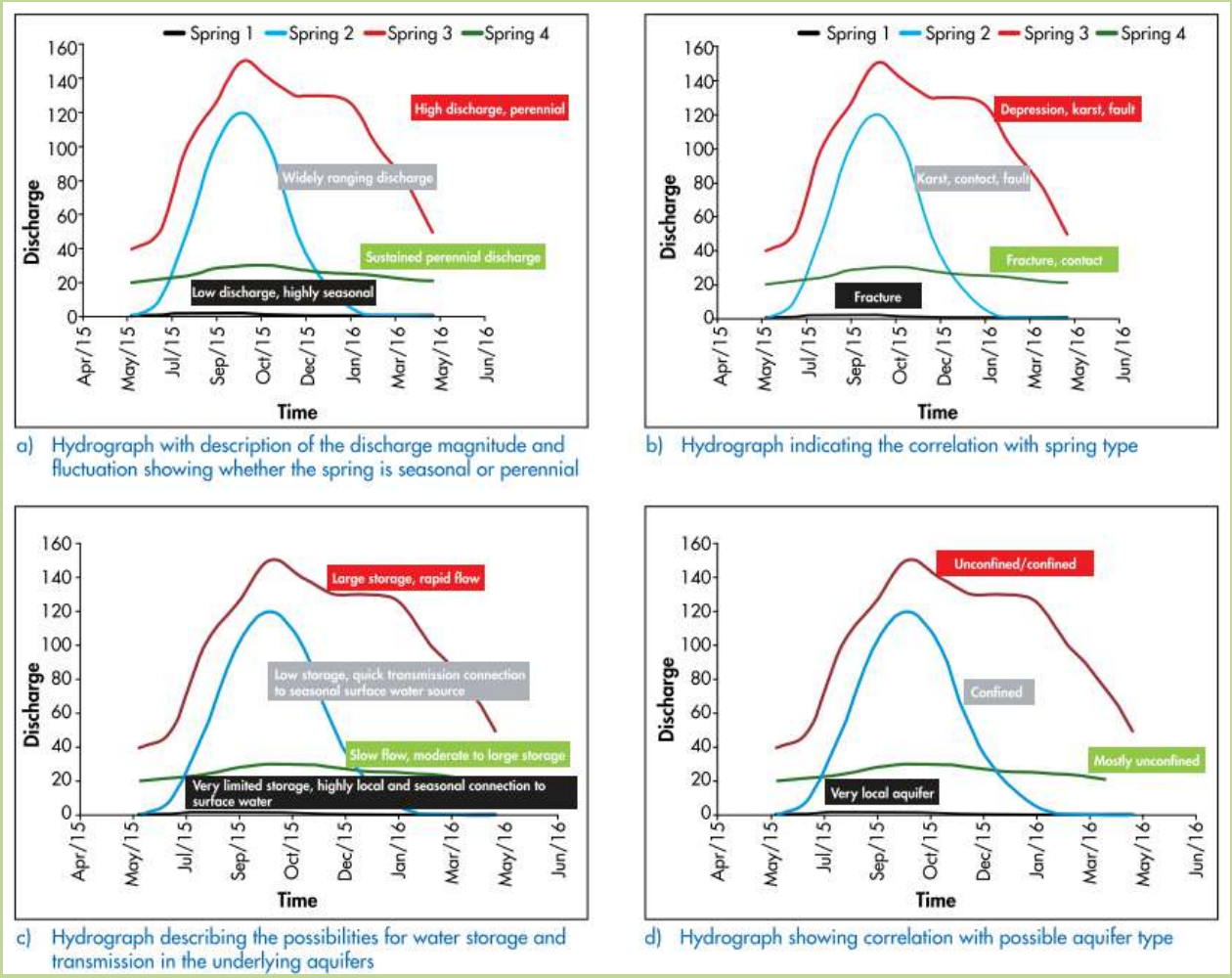
The type of spring (and aquifer) is also broadly correlated with the rainfall-discharge hydrograph, and with groundwater quality. Thus, the preliminary identification can be further confirmed using the data and information on spring discharge, rainfall, and groundwater quality collected during the monitoring activities (Protocol Step 2). It is useful to capture annual and longer-term trends in spring discharge through measurement, but approximate information can also be obtained by talking to the community who can create a narrative about the seasonal and long-term trends in springs that they use. Both types of information are used to help correlate the spring-type. Table 1.9 provides an indicator matrix for the correlation between spring type and the nature of the hydrograph and groundwater quality which can be used as a rule of thumb. While only indicative, this type of correlation helps strengthen the identification of spring and aquifer(s) type.

Table 1.9 Indicator matrix for spring type, discharge and spring-water quality

Spring type	Possible nature of hydrograph and groundwater quality
Depression spring	Seasonally high discharge; spring sometimes seasonal but often perennial Groundwater quality changes with season; the concentration of dissolved solids generally increases with drop in discharge
Contact spring	Seasonally high discharge but not as variable as in a depression spring; usually perennial Groundwater quality, particularly the concentration of dissolved solids, generally increases as discharge dwindles
Fracture spring	No major discharge variation, fairly constant, seldom with high discharge; usually perennial Groundwater quality fairly constant, with minor fluctuations
Fault spring	Sometimes with high and fluctuating discharge, particularly when fed by deeper confined aquifers; fluctuation typically doesn't follow the seasons Groundwater quality varies, sometimes with a high concentration of dissolved solids throughout the seasons
Karst spring	Seasonal or perennial with highly fluctuating discharge Groundwater quality is different in karst springs compared to other springs. Usually there is a higher concentration of dissolved solids and seasonal changes in groundwater quality are common.

Identification of spring and aquifer types from hydrograph typology

The 'type curves' of hydrographs can also be used to further delineate the typology of springs and aquifers, which is then used in the process of identifying recharge zones and management of the recharge process. The sequence of hydrograph type curves shown in Figure 1.9 illustrates how concepts, data, and hydrogeological interpretation can be used to develop a synopsis of the typology of springs and aquifers in a broad and indicative manner.



a) Hydrograph with description of the discharge magnitude and fluctuation showing whether the spring is seasonal or perennial

b) Hydrograph indicating the correlation with spring type

c) Hydrograph describing the possibilities for water storage and transmission in the underlying aquifers

d) Hydrograph showing correlation with possible aquifer type

Figure 1.9 Sequence of hydrographs illustrating how concepts, data, and hydrogeological interpretation can be used to develop a synopsis of the typology of springs and aquifers

Delineation of the recharge area

Identification and delineation of the recharge area(s) is the most important step in springshed management. It is crucial both for augmenting or restoring spring discharge and quality by increasing recharge to the aquifers feeding the spring, and for managing aquifers and springs by protecting the recharge area. The recharge area is identified from the hydrogeological layout and then located on the map and Google Earth image.

The hydrogeological layout is used to identify the area that supplies water to the aquifer that feeds the spring, i.e., the recharge area, by linking backwards from the spring through potential channels for the water along fractures and other rock formations to the location on the surface. Following careful identification, this area is indicated as the recharge area on the layout (Figure 1.10).

Once the recharge area has been marked on the hydrogeological layout, it can be located on the geological/ hydrogeological map (Figure 1.11).

The recharge area is then located on the Google Earth Image to provide a way of identifying the area for recharge interventions in a form that people are accustomed to (Figure 1.12).

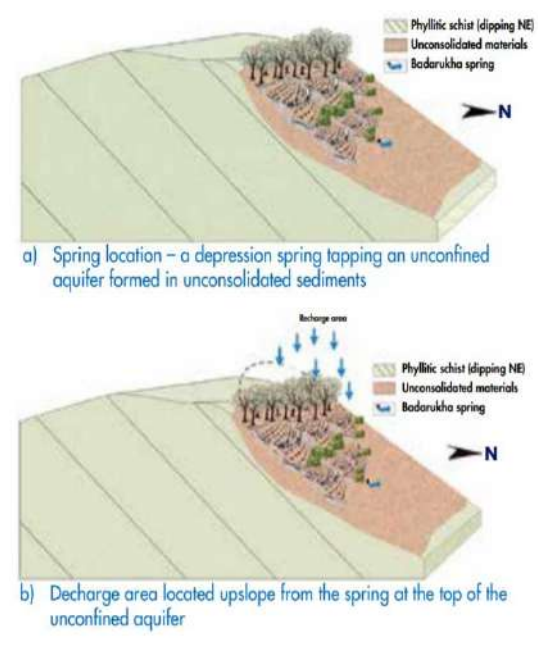


Figure 1.10 Hydrogeological layout showing identification of the recharge area for a spring based on the geology

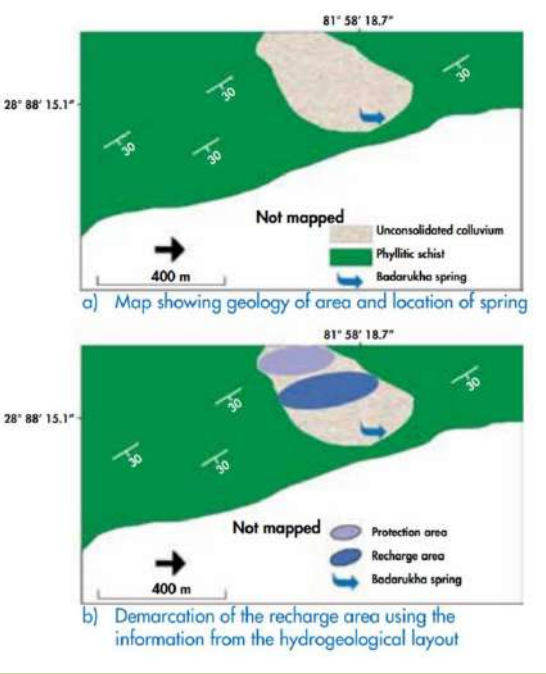


Figure 1.11 Location of the recharge area on the geological/ hydrogeological map

Collecting detailed information about the recharge area

Once the recharge area has been delineated, ground information shall be collected on land use and ownership of the site to help in the selection of recharge measures. The type of land cover (forest,

agricultural land, settlements, and so on) shall play a significant role in determining what activities are desirable and/or feasible.

The identification of spring types and aquifers and demarcation of the recharge area(s) is a prerequisite for the next step of developing the springshed management and governance protocols. The physical aspects of recharge augmentation and protection form a significant part of the protocols. However, implementation depends on community perception and understanding of the process of mapping, measurement and identification of spring typology. The maps developed in this step provide a basis for helping the community understand the location of the recharge area, the role of recharge in ensuring spring discharge, how spring revival measures can work, and how they can help improve and maintain their water supply. The springshed management shall link the technical and socio-economic aspects including understanding of the potential impacts of water augmentation. The impacts can include any of the following: increased spring discharge, improved water quality, more sustained discharge during the dry season, better management with more equitable access, and efficient distribution.

Figure 1.12 Location of the recharge area on the Google Earth image

Resources Needed

The Table 1.10 gives a summary of the skills (human resources) and instruments (hardware, software) required to carry out the tasks outlined in Step 4C.

Table 1.10 Summary of requirement for Step 4C

Types of skill needed	Objective	Time estimate
Interpreting field hydrogeology and spring discharge hydrographs – geologist and hydrogeologist	Identifying and demarcating potential recharge sites	One person-day for a trained person per spring
Social scientists and forester	Collecting detailed land use and land change information on recharge areas. Remote sensing maps are a good tool	1-4 person days per spring recharge area, depending on the size of the recharge area.
Software requirements	Microsoft Excel, Remote Sensing maps, if available, CorelDRAW and Google Earth	

Identify degrading influences (problems)

Watershed management is generally described as being "holistic." This can have a multitude of meanings, but in Bhutan's context, taking a "holistic" approach to watershed management means taking into account all aspects that are likely to influence the quality and quantity of water flowing from the watershed.

The issues that are identified during all stages of the watershed management process shall be considered when identifying degrading influences. In general, these shall include issues/problems that are identified during:

- watershed assessment and classification
- field verification and other field visits
- local stakeholder consultations

Designing interventions to address (mitigate or remove) degrading influences

This step is the most important and culmination of all the processes undertaken in the above steps and it shall determine the success of the watershed management interventions. The aim of this step is to apply a logical approach to identify what interventions are needed to remove or mitigate the degrading influences and improve the condition of the watersheds using a logical framework analysis (LFA) approach. LFA is a useful tool to conceptualize issues/problems, systematically analyses them to determine causes and effects and translate these into goal, objectives and outputs.

The summarized list of issues/problems identified shall be used to develop a "focal problem". Once issues and focal problems are identified, details assessment and verification of the degrading influences shall be carried out.

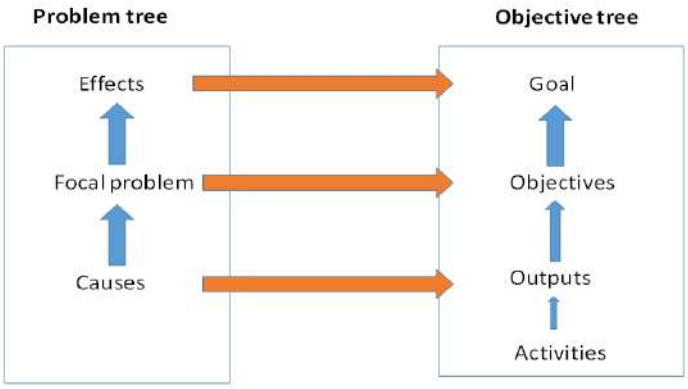
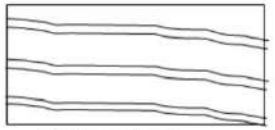
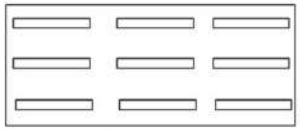
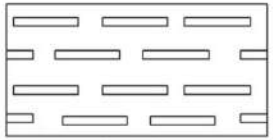
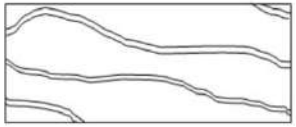


Figure 1.13 A Logical Framework Analysis (LFA)

Activities, outcomes and objectives are designed through the application of an LFA approach to address the core or focal problem. This is a systematic problem-solving approach to planning that is well suited to involving stakeholders in a participatory manner. The resulting Logical Framework (logframe) Matrix summarizes the results and shows the linkages between: activities—outputs—objectives—goal.

The Department shall manage and provide prescriptions for critical issues for watershed management such as forest degradation, landslides/erosion and drying water sources. However, the Department shall encourage and recommend prescriptions for other identified issues (Table 1.11) which shall be implemented by relevant sectors. The interventions proposed here is site specific and expert judgment has to be used to decide which type of interventions is feasible.

Table 1.11 Table showing broad issues and relevant prescriptions

Sl. No.	Issues	Probable Causes	General Prescriptions
1	**Shortage of water for drinking and irrigation**	Drying up of water sources	Scoping study to validate the claim and causes of drying, Identification of recharge areas to be carried out as per the guidelines described in Box 1.2. After identification of recharge areas, possible interventions could be following activities: The interventions could be either structural measures or vegetative measures or a combination of both. **STRUCTURAL MEASURES** **(i) TRENCHES/PITS** Trenching shall be required in open areas (where there is no vegetation cover) to trap the surface runoff and enhance infiltration. Trenches can be dug along contour lines in a staggered or continuous pattern. However, the size of the trench shall be determined based on the site conditions.  Continuous Trench  In line Trench  Staggered Trench  Contour Trench The number of trenches/pits shall depend on size, annual precipitation and the slope gradient of the recharge area. Trenches are recommended in larger open area, while pits in smaller area. Wedge shaped trenches (Figure 1.14) are recommended for open areas while staggered or continuous trenches are recommended on slopy areas.

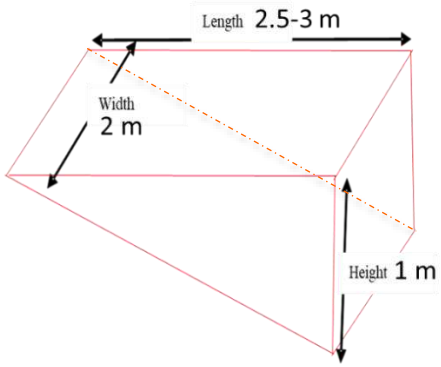


Figure 1.14. Design for the trenches as adapted from spring revival pilot site at Lholing, Paro (WMD, 2019a)

(ii) ROADSIDE DRAINAGES

If there are farm roads/forest roads in the recharge areas, then the following design could be proposed to trap surface run off and enhance filtration (Figure 1.15).

Figure 1.15. Road side drainages design adapted from spring revival pilot site at Lholing, Paro

(iii) TERRACES AND SOIL BUNDING

Inwardly sloping terrace guide water towards the hillside rather than down the slope. Level terraces with riser bunds impound water for paddy cultivations and also facilitate recharge. Old terraces can be modified to make inwards sloping with gentle gradient. Therefore, terracing with soil bunding shall be made looking at the applicable sites in recharge area.

(iv) CHECK DAMS

As part of gully treatment and to increase water infiltration, check dams shall be constructed. The details of the check dams are provided under prescription section under serial number 4: Landslides/Erosions of this table.

VEGETATIVE MEASURES

(i) Forest management and plantation

Locally available forest resources shall be managed sustainably. Degraded areas shall be planted with appropriate species to capture surface runoff and enhance infiltration.

Native and indigenous trees species and shrubs must be selected for afforestation. Having good vegetation cover can enhance recharge and improve lean season flow. The afforestation and reforestation shall be carried out as per the guidelines specified in Chapter 8, Plantation and Nursery Management.

Sl. No.	Issues	Probable Causes	General Prescriptions
			(ii) Maintain humus layer in the recharge area Humus layer is an important element of forest floor that help in retaining soil moisture, recharge ground water by increasing infiltration and reducing surface runoff velocity. Therefore, leaf litter collection in the recharge areas must be managed. To maintain humus layer, it is important to protect the forest areas (recharge areas) from grazing and other disturbances. Other vegetative measures as described under the serial number 4 (***Landslides/Erosion***) of this table can also be recommended to trap the surface runoff and increase filtration.
		Poor water management	Identify problem related to poor water management and accordingly recommend interventions. These interventions shall be recommended for implementation by relevant agencies. Interventions would depend on the site and type of the problem: **(i) Poor infrastructure leading to water loss** Map out all infrastructure network in the watershed to identify problem areas. Recommend improvement activities to be carried out by relevant agencies **(ii) Multiple tapping points in the water source** Map out tapping points in the watershed. Recommend for consolidated tapping point and distribution points for implementation by relevant agencies.
2	**Forest degradation**	Forest fires	Forest fire management interventions to be proposed as per the guidelines prescribed in Chapter 6, Forest Fire Management.
		Overharvesting of forest resources	• Carry out forest resources mapping in the watershed to understand resources availability and use by the communities; • Clearly demarcate the recharge areas in the watershed and minimize resources extraction from the recharge areas; • Strengthen participatory forest management activities; • Promote traditional and cultural beliefs on natural resources protection; • Advocacy on forest conservation and management; • Restock the degraded areas; and • Resources management and extraction to be planned as per the specific guidelines provided in the *Code*.
		Grazing	• Minimize grazing intensity in the recharge areas; • Encourage stall feeding and rearing of improved livestock breeds; and • Silvo-pasture development, fodder development and other interventions to be recommended for implementation by relevant agencies

Sl. No.	Issues	Probable Causes	General Prescriptions
3	**Drying up of lakes**	Forest degradation	Identify the causes and recommend interventions prescribed for Issue no. 2 (Forest degradation).
		Invasive species	• Assessment study to determine the extent of invasive species and potential economic use. • Remove the invasive species. For eg. *Eichhonia spp.* (Water hyacinth), *Brasenia spp.* (water shield) have to be removed before fruiting. • Monitor regularly • Conduct awareness campaign
		Siltation/Sedimentation	Determine the cause of the siltation. The common causes of siltation are (not limited to): 1. Landslides and erosion 2. Flashfloods 3. Grazing 4. Forest degradation 5. Improper drainage systems Based on the cause of the siltation, following recommendations could be adopted: • Protection of forests from grazing and other disturbances • Construction of sediment traps like checkdams (structural as well as vegetative- refer section under Landslides/Erosion section) and sediment retention tanks. The retention tanks must be maintained regularly to avoid runoff into the lake (WMD, 2020b). • Plantation of native grass/shrubs/trees species in degraded areas to reduce sedimentation through surface runoff and to increase soil moisture through increased vegetative cover.
4	Landslides/erosion	1. Natural events 2. Poor farm road/ improper land management/ poor or unmanaged infrastructure	While major landslides and erosion shall require detailed survey and engineering design, smaller landslides/erosions and improper land management practices can be controlled through simple structural and vegetative measures as follows: **(i) CHECK DAMS** As part of gully treatment and to increase water infiltration, check dams shall be constructed based of the dimension of gullies found in an area. Check dam includes log check dam, stone check dam and bamboo check dam based on the availability of local resources (Figure 1.16). These check dam can be combined with bioengineering measures which shall further increase the water retention and infiltration.

<table>
<tr><th>Sl. No.</th><th>Issues</th><th>Probable Causes</th><th>General Prescriptions</th></tr>
<tr><td></td><td></td><td></td><td>
The table below details the type and design of check dams:
<table>
<tr><th>Gully class</th><th>Gully depth (m)</th><th>Gully drainage area (ha)</th><th>Recommended check dam</th></tr>
<tr><td>Small gully</td><td>< 1</td><td>< 2</td><td>Palisade (vegetative check dam)</td></tr>
<tr><td>Medium gully</td><td>1 to 5</td><td>2 to 20</td><td>Loose stone check dam</td></tr>
<tr><td>Large gully</td><td>> 5</td><td>> 20</td><td>Gabion check dam</td></tr>
<tr><td colspan="4">Source (classification): Frevert et al., 1955</td></tr>
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Figure 1.16. Stone and Log check dams

(ii) ROADSIDE DRAINAGES

Improve drainages and cross drainages to capture runoff and enhance infiltration of run-off water.

(iii) PLANTATIONS

Broadcast seeds or plant cuttings/seedlings of native grasses & plants along the landslides and the exposed landslides areas eg: Willow (Salix spp.), Himalayan coral tree (Erythrina arborescens), Toricellia tiliifolia, etc. Plantation of shrubs and bamboos to stabilize the landslides.

(iv) HEDGEROWS
</td></tr>
</table>

Sl. No.	Issues	Probable Causes	General Prescriptions
			Contour hedgerow can be used to construct terraces that hold back the water. Fast growing native nitrogen-fixing trees or shrubs shall be planted along the contour lines to create living barrier that traps sediments and gradually transformed the slopes land to terraces. Hedgerows reduces runoff, soil erosion and improves infiltration. Eg: Napier grass, broom grass, etc. **(v) BRUSH LAYERING** Live wood cutting shall be laid in line across a slope with soil in between contour. As the root grows, they anchor and reinforce the upper soil level. Brush layering can be used for well-drained slope of less than 45° in recharge area. This structure reduces runoff velocity and increases infiltration.
5	Pollution of the streams, springs and marshes	Improper waste management	• Map out pollution sources in the watershed • Implement waste management interventions • Carry out awareness programs

Integration of interventions in broad management regimes

Watershed management interventions shall be included within the other broad management regimes / area-based management Plan.

Review of intervention measures with relevant stakeholders

The concerned field offices shall review the identified intervention measures with WMD and relevant stakeholders to ensure that the objective and prescriptions of watershed management interventions are met.

All these interventions shall be integrated into the specific area-based management plans during the planning phase. The main plan, incorporating prescriptions of all relevant cross cutting issues, shall be endorsed and approved as per the procedures in Volume III & Volume IV and implemented holistically.

1.3.3 Monitoring and Evaluation

The monitoring and evaluation shall be carried out based on the LFA Matrix included in the proposed watershed management interventions in the area-based plans.

Monitoring

Field Offices (DFOs and PAs) shall regularly monitor the implementation of the watershed management interventions. WMD shall annually monitor the implementation of watershed management interventions. The monitoring shall focus on the implementation of the planned activities, and achieved outputs.

Evaluation

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall intervention. It shall focus on the extent to which the degrading influences have been addressed (mitigated or removed) and the rate of return of the watershed to “normal” or “pristine” condition.

The overall evaluation of the watershed interventions shall be done as part of the evaluation process of the area-based plan as described in Volume III and IV of the *Code*.

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2. Payment for Ecosystem Services

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2. Payment for Ecosystem Services

2.1. Management Context

2.1.1 Background

Ecosystem Services are defined as all benefits that humans receive from the environment. Examples include the supply of food, water and timber (provisioning services); regulation of air quality, climate and flood risk (regulating services); opportunities for recreation, tourism and education (cultural services); and essential underlying functions such as soil formation and nutrient cycling (supporting services). They make significant contributions to human welfare, some are essential and have no substitutes, and almost all are becoming increasingly scarce. This important ecosystem services needs to be managed by taking on board all relevant stakeholders such as upstream and downstream linkages using mechanisms such as Payment for Ecosystem Services (PES).

PES is a "pay-for-performance" approach to financing conservation of natural resources whereby Ecosystem Service (ES) providers receive payments [economic incentives] from ES beneficiaries/users that are conditional on specific conservation performance.

The common types of PES schemes are:

- **Watershed services:** mainly on the protection and conservation of water resources for drinking, irrigation and hydropower generation;
- **Biodiversity protection:** PES for biodiversity protection (e.g., protection of habitats for the rare species like Black-necked Crane).
- **Scenic/landscape beauty:** PES scheme on scenic/landscape beauty which are potential for eco-tourism.
- **Carbon sequestration:** PES for regulating services such as carbon sequestration.
- **Bundled Ecosystem services:** Sometimes two or more ES can be combined and transacted as a package (e.g., biodiversity protection with scenic beauty or watershed services with carbon sequestration).

PES schemes are designed to help change the practices of individuals who carry out detrimental activities governed by the right to use resources, recognizing that what they do contribute to providing services that are valuable to others. For example, downstream communities can pay those up-stream communities for carrying out conservation activities in the watershed. This allows them to continue earning a living while improving the ecosystem conditions of their community without harming other communities.

In Bhutan, investment into conservation and natural resource management (NRM) activities is mostly financed by way of the central budgetary system. The integration of PES as a conservation and community development financing tool can complement the government revenue in implementing some of the activities in conserving the ES in the PES sites which shall help ease the near-exclusive dependency on government revenue to conduct such activities. In aggregate, the scaling up of PES across the country can serve as one way for the Royal Government of Bhutan (RGoB) to address resource constraints, while achieving targeted investment in conservation and NRM at various scales. Accordingly, there are several policies, legislations and regulations such as National Forest Policy, 2011, Water Act, 2011, Sustainable Hydropower Development Policy, 2008 etc., that favor establishment and upscaling PES schemes in Bhutan.

2.1.2 Objectives

The goal of PES is to foster partnership among relevant stakeholders and promote stewardship of resources by local communities to ensure effective conservation of natural resources. The specific objective of PES may include the following:

- Strengthen collaborative and participatory approach towards the conservation of natural resources;
- Improve supply of ecosystem services through adoption of appropriate natural resource management practices; and
- Generate financial resources through conservation of forest ecosystem services.

2.2. General Principles of PES

PES schemes shall be based on the following principles:

***Voluntary**:* stakeholders enter into PES agreements on a voluntary basis depending on willingness to pay from ES users and willingness to accept from ES providers;

***Beneficiary pays**:* payments are made by the beneficiaries of environmental services (individuals, communities and businesses or governments acting on behalf of various parties);

***Direct payment**:* payments are made directly to environmental service providers by service users;

***Additionality**:* payments are made for actions over-and-above those which land or resource managers would generally be expected to undertake;

Conditionality: payments are dependent on the delivery of environmental service benefits. In practice, payments are made only if the agreed conditional conservation activities are being implemented and verified by verifying committee;

***Ensuring permanence**:* management interventions paid for by beneficiaries shall not be readily reversible, thus providing continued service provision; and

***Avoiding leakage**:* PES schemes shall be set up to avoid leakage, whereby securing an ecosystem service in one location shall not lead to the loss or degradation of ecosystem services elsewhere.

Any successful PES scheme must provide a win-win situation for both service providers and users. PES may be positive from a user's perspective if the payments are less than those associated with any alternative means of securing the desired service. For example, it may be less expensive for a water utility to pay land owners for improved watershed management than to pay for additional water treatment plants.

PES can only work where there is transparent institutional capacity, where there is no dispute in terms of resource access and benefit distribution. PES needs to be part of policies and conservation programs that are designed with participation of local communities.

2.3. Roles and Responsibilities

The field offices shall propose the establishment and implementation of PES schemes while the Watershed Management Division (WMD) shall provide technical support.

Table 2.1 Roles and responsibilities

Agency/ Offices	**Roles and responsibilities**
WMD	• Provide technical backstopping on establishment of PES schemes • Provide capacity building support
Field Offices	• Institute the PES implementation team (Box 2.1) • PES Planning, Designing and Implementation • Support development of annual plan of operation • Periodical monitoring and facilitate flow of PES fee to the service providers.

Box 2.1 Roles and responsibilities for the PES team

The roles and responsibilities for the PES implementation team may include some or all of the following:

a. Scoping the suitability/feasibility of PES.
b. Identifying the obstacles that need to be addressed in order to implement activities. These may include: capacity, equipment, financing, time and disputes.
c. Assembling technical teams and resources to address PES project needs.
d. Designing sound science-based PES activities to provide the ES being transacted.
e. Developing budgets for all aspects of the project, including project start-up, operations and transaction costs.
f. Supporting ES providers as needed in projecting and planning for PES revenues with related Benefits Distribution Systems (BDS).
g. Identifying and convening all affected stakeholders and technical partners throughout the design, implementation, M&E and verification processes, as required.
h. Providing all required technical inputs internally or by recruiting external expertise as required.
i. Evaluating ES bundling opportunities for the same land area as one or more PES schemes.
j. Providing all relevant data (e.g. meeting minutes, monitoring and verification reports, and other collected information) to the representative of the ES buyer and provider and available to all other stakeholders.
k. Building community awareness and capacity regarding direct and indirect benefits and costs of the PES process, including transfers, the value of conservation, governance, gender and social inclusion, financial management and reporting, negotiations, land tenure and resource rights, and M&E related activities.
l. Building capacity of local PES facilitators, extension officers, multiple levels of RGoB agencies, NGOs, partner institutions and community leaders to;
    i. Conduct analytical work and research on designing and operationalizing PES schemes.
    ii. Ways to use participatory approaches to assess ES status,
    iii. Design/conduct PES and M&E activities and
    iv. Evaluate other project impacts.
m. Designing and implementing a participatory M&E plan that includes roles and responsibilities for ES users and providers and other agencies to build the capacity of stakeholders and transfer project ownership. The transition of the management, monitoring and verification of the PES scheme to the local, Dzongkhag, Thromde and regional RNR centres shall make the project more efficient and possibly more effective in the long-term. These measures shall also reduce the transaction costs of the project.
n. Facilitating the fair, transparent negotiation of PES agreements between the ES users and providers.
o. Facilitating support and endorsement for the PES agreement from ES users, providers, the appropriate units of government and all other stakeholders.
p. Preparing agreements with the landholders (or groups of landholders) for the provision of the services (by specifying activities, quality standards and timelines).
q. Transferring payments to the landholders subject to compliance with agreements.
r. Facilitate verification and compliance monitoring to ensure that the agreed activities are being carried out as reflected in the M&E plan.

s. Providing reports to the users of the ES and all relevant agencies regarding the outcomes of the M&E activities and verification report.
t. Convening annual participatory evaluations of the PES scheme to enable communities to discuss lessons learnt, results, difficulties, issues related to specific interventions, and adapt action plans on the basis of each year's lessons and findings.
u. Generating lessons learned briefs and case studies to enhance the integration of PES into Bhutan's conservation, NRM and sustainable development strategies.

2.4. PES Planning, Designing and Implementation

The PES planning, designing and implementation shall be based on the following steps;

Table 2.2 Steps to develop PES

Step 1	Feasibility assessment
	✓ Identifying the potential ES ✓ Identifying potential ES users ✓ Identifying potential ES providers ✓ Assessing legal, policy and land ownership context
Step 2	Sourcing projects & project development finance
	✓ Identifying Project Financing Sources
Step 3	Assessing capacity & context
	✓ Evaluating existing institutions and technical capacity gaps ✓ Surveying available PES support services and organizations ✓ Capacity development for both ES providers & users
Step 4	Structuring agreements & supporting analysis
	✓ ES valuation and opportunity cost analysis ✓ Reducing transaction costs ✓ Reviewing options for payment types ✓ Equity, fairness & distribution of net benefits accruing from PES ✓ Designing resource management & M&E plan ✓ Designing verification protocols and teams
Step 5	Implementing PES agreements
	✓ Key elements of PES agreements

2.4.1 Feasibility Assessment

The first step involves determining the prospects for establishing a PES scheme in the proposed sites. This includes identifying a potential environmental service(s) (i.e., a potentially deliverable service of value to at least one user); the range of possible users of that service(s); and the prospects for trade between them.

To do this, an initial site visit is required to assess PES scheme feasibility whenever a prospective project is sourced. This initial evaluation shall address the following:

Identifying the potential environmental services

.1. Can the ES be defined in terms that are understandable to the user and provider? If not, identify the deficiency and possible resources to address this gap.
.2. If the problem is technical (i.e., the current team is unable to define the ES because of the lack of training or equipment), who can provide this training and equipment? Engage technical experts and resources in the comprehensive assessment.
.3. Are there more than one ES that could be bundled into the agreement for a particular PES project? For each ES, answer question (a).
.4. Are the beneficiaries of the ES clear? Provide a detailed response for each ES.
.5. Is the supply of the ES threatened by current activities? Provide the details of the threats for each ES.
.6. What are the drivers of the ES degradation? Meaning, what are the pressures and activities that are leading to degradation of the ES?
.7. Who are the agents of the ES degradation? Meaning, who are the individuals/groups who are degrading the ES?

Identifying potential ES users

To define potential ES users, the key question is: Who is benefiting from the ES, and is there a reasonable mechanism for converting their received benefit into a payment? Always start with the ES user, because if there is no user, PES won't work. To answer this question, first list the individuals/entities benefiting from the provision of the ES. Users can be public or private individuals or entities, domestic or international. Then, consider the distinct interests and set of motivations for engaging in PES deals (or preferring not to engage in them). Beneficiaries of ES are often downstream dwellers away from the source of the service. A full evaluation of all potential ES users is needed.

The PES project team needs to engage with the ES users to build their capacity and interest regarding various related issues (conservation, PES, sustainable development, legal rights, governance, financial) and to understand their needs and requirements.

a. Is there at least one potential ES user, i.e. an entity who would benefit from better provision of the ES in question, and for whom some likelihood exists of creating a mechanism to share the benefits. List all such individuals/entities. If you cannot define at least one ES user, this site may prove infeasible at this time.
b. For the most promising potential users, describe all relevant information, including contact information of the person who represents them. Consider all potential public, private and nonprofit entities.
c. What is the potential ES users understanding of PES and other related elements (conservation, PES, sustainable development, legal rights, governance, financial, etc.)? Is additional awareness and capacity building required? If yes, what type and how shall you address this need technically?
d. What are the motivations of the ES users to engage in the agreement?
e. Could the reduction in the quantity or quality of the ES affect interest of ES users?
f. Could the users achieve regulatory compliance by participating in the PES scheme?
g. Are there entities who would view participation in the PES scheme as a positive outcome for them in improving their relationships with participating communities?
h. Are the ES users expressing their willingness to participate in a PES scheme for some other reason?
i. Do the identified ES users have the means to participate in the PES agreement? Consider both user wealth/cash flow, and likely benefit cost ratio of participating in PES. If not, are there other avenues to make them feasible ES users, including government support, other support mechanisms, or less costly benefits that could be offered to the ES providers?

Identifying potential ES providers

a. Is there at least one ES provider?
b. If not, who shall conduct the required PES activities? Consider all possible individuals/entities (public, private and non-profit).
c. Are the identified ES providers willing to participate in a PES scheme? Remember that there could also be more than one ES provider, particularly if the PES scheme covers a large land area, affects many different communities and/or includes bundles of ES (more than one ES in the same land area).
d. Besides the users, are there other users of the land/resource being considered for PES and how would the activities of the PES scheme affect them? If yes, shall these individuals also be considered as ES providers within the PES scheme? How do their resource rights compare to that of other ES providers? If the project proves feasible, this information shall contribute to determination of equitable benefits distribution.

Assessing legal, policy and land ownership context

The individuals may or may not have land or resource rights in the PES scheme area, but the activities still result in a loss or opportunity cost for them that may require offsetting via the PES scheme. If the needs of all affected stakeholders are not addressed in the PES design process, then unaddressed issues may lead to disharmony in the community and, among the ES providers, resulting in obstacles to achieving the commitments of the PES agreement. It may also reduce functionality and sustainability of the PES scheme. All claims to land and land-use rights, therefore, must be understood in order to ensure that all parties with a legitimate stake in the resources at a particular PES project site are involved in any prospective PES discussion. This broadening of the discussion to include traditional users can, in some cases, deliver the additional benefit of promoting clarity and legal certainty in land tenure and resource rights issues.

a. Are there other stakeholders in the public, private and non-profit sectors that may be affected by the PES scheme? Make sure to engage all possible stakeholders that may be affected by the PES scheme. Ensure to keep documentation to provide evidence of these actions.
b. Will the act of managing the land to provide the ES detract from the ecosystem's capacity to provide other services?

2.4.2 Sourcing Projects & Project Development Finance

Sourcing potential PES projects can be a result of internal agency review of existing resources and plans that prioritize sites and related environmental resources/services for conservation and consider PES as one possible approach. Further, the on-going PES capacity building activities at the Gewog, Dzongkhag, Thromde, regional and national levels shall/can generate additional potential PES schemes. As such, PES shall be considered as a possible conservation finance approach within any development project.

Identifying project financing sources

PES projects shall require start-up financing and the proponent shall identify sources of financing for rolling out PES. While the recurring costs of PES schemes shall be addressed as costs within the scheme, start-up financing is required before funding from actual transactions can flow. This financing shall ideally be available either on completion of the feasibility study or shortly thereafter to ensure efficient project development and that ES user and provider expectations are addressed.

Possible sources of start-up financing for PES projects in Bhutan may be derived from the annual budgetary system, Dzongkhag, Thromde and/or local development funds, prospective domestic or international donor support or via reallocation of part of the 1% Royalty as stipulated in the Sustainable Hydropower Development Policy 2008.

2.4.3 Assessing Capacity & Context

The amount of specialized information needed to design and operationalize PES schemes shall often require investment in technical support to address capacity gaps of the project team. The necessity of this support shall be largely dependent on the size of the project, the complexity of defining the ES, and the monitoring, evaluation and verification requirements of the ES users. For example, a water-related hydropower PES

scheme may require a range of support services that are at times highly technical. A local watershed services drinking water scheme, as in Mongar and Pasakha, shall require fewer resources and support services.

Evaluating existing institutions & technical capacity gaps

In order to scale-up PES, the PES focal agency, WMD, shall continue to transfer its capacity to various agencies. In this way, they can leverage their capacity by training the trainers to design and operationalize PES schemes based on the guidance provided in the Field Guide. The PES scheme development process requires the project team to align all PES activities with the capacity of ES providers, users, intermediaries and other participating entities. Therefore, it is critical that any support institutions that ES providers and communities engage also transfer the required expertise to the community members.

To keep transaction costs low, interagency and domestic sources of capacity shall be explored as a first step. The required technical capacity must be addressed so as to be able to develop the PES schemes and to avoid technical pitfalls that limit project benefits and sustainability. Additional technical support for PES project design and development may be required and shall be sought from relevant agencies within and outside the government.

Areas where competence shall be essential, either from the ES providers/users or externally are listed below and are adapted from the "PES Framework for Bhutan.".

Assessing Capability Context and Institutional Set-ups

Before proceeding with the establishment of the PES scheme, the implementing agency must assess and evaluate the capacities of the existing institutions including ES providers and ES beneficiaries. Training shall be provided as per need to help better understand PES concepts and principles.

PES schemes often function more effectively and efficiently if there are local institutions that represent their collective needs such as Community Forest Management Group, Water user Association, etc. Usually, establishing a PES scheme in a place without a local institution with multiple individuals comprising the ES providers shall take more time to formalize and may require more resources (time, money, staff and capacity building). If not, field offices shall take time to generate a functioning local institution or process that represents the needs of the ES providers.

2.4.4 Negotiations (Initiating engagement and dialogue)

The negotiation process shall involve bringing together ES providers and ES users to a common platform to agree on the conditional activities to be implemented and decide on the fee structure for each activity.

Before the negotiation, stakeholders shall be made to understand the condition of the PES sites, threats under Business as Usual (BAU) scenario, opportunity costs for ES providers, and benefits for the service users under PES terms.

Designing of PES Agreement

While contracts and agreements for PES vary widely, some elements are typically common to all. The options include the following:

- Memorandum of Understanding (MoU) or Memorandum of Agreement (MoA),
- Legal contracts
- Customary law agreements
- 'Handshake' agreements
- Quid-pro-quo arrangements

However, the most appropriate PES agreement which suits local context shall be selected.

Table 2.3 Structure of a PES Agreement

The structure of PES agreements shall encompass the following:

- Description of ES, ES providers and ES beneficiaries
- Roles and responsibilities of ES providers and ES beneficiaries
- List of PES conditional activities and their fee structure
- Roles and responsibilities of intermediaries
- Payment modalities and fee revision if agreed
- Conditionalities
- Key signatures in the agreement
- Validity and renewal of PES agreement
- Monitoring and Evaluation process
- Dispute settlement mechanisms
- Terms of reference for the verification team

Signing of PES Agreement

Upon review of PES agreement in presence of both ES providers and ES beneficiaries, the lead agency shall facilitate agreement signing on a suitable day in presence of all the signatories. A copy of the agreement needs to be provided to both parties including relevant agencies.

2.4.5 Implementation of PES schemes

Implementation of PES Schemes shall consist of the following.

- Field Offices shall ensure the implementation of activities in the PES agreement by the services providers
- Joint verification shall be carried out to verify the implementation of agreed activities by the team identified in the agreement (Table 2.4). The verification report is pre-requisite for releasing the annual payment.

Table 2.4 Verification format

Date of Verification……. Quarter of reporting……..……

Agreed PES activities	Verifiable indicators	Assessment	Remarks
Activity one (specify)	Eg: Area planted and managed	Done/not done/incomplete	Eg. Survival %
Activity two (specify)	Presence of stumps within buffer area	Yes/No	Exclude those in baseline
Activity three (specify)	Presence of trees, branches, debris in the stream	Yes/No	
Activity four (specify)	Signs of night grazing/Presence of cow sheds	Yes/No	

2.5. Monitoring and Evaluation

In order to ensure effective implementation of the PES scheme, the following aspect shall be considered.

Table 2.5 Consideration for M&E

Aspect	Complementary aspect
a. Outline the cause-and-effect relationships that occur within the ecosystem;	
b. Select relevant biophysical, management, and socio-economic indicators to monitor. All indicators should be (SMART):	1. **S**pecific 2. **M**easurable 3. **A**greed-upon 4. **R**ealistic & Reliable 5. **T**ime-constrained
c. What are the M&E indicators that shall be monitored related to ES provision?	These indicators are derived from the scientifically-based resource management plan and, by evaluating the effects of the PES activities on ES provision, help to improve the management plan over time.
d. What are the social indicators that the M&E protocol shall monitor?	One important dimension for community-based projects is the extent to which investments are meeting community goals, as determined by a cross-section of the community (including women, lower-income members and marginalized groups)? Another is the extent to which there is equity in PES benefits distribution at the household and community levels.
e. What are the roles and responsibilities for each individual who is conducting the M&E activities for each indicator throughout the lifespan of the PES scheme?	Ensuring that agreed activities are implemented according to the terms and conditions of the agreement
f. What type of local capacity building activities are required to transition the responsibility for a set of the M&E activities to the ES providers?	Creating awareness on the concepts of PES; Making them understand the their roles and responsibilities
g. Which experts shall be required for conducting which activities?	Consider both technical and capacity building activities in your evaluation. To the extent possible, source these experts locally to reduce project transaction costs.
h. What is the M&E schedule and frequency for each activity?	As per contractual agreement
i. Where appropriate, what are the specific fixed locations of monitoring sites for your indicators?	This is often a "stratified random sampling" that reflects the overall distribution within the project area; and ensures that the monitoring sites are sufficiently spread out.
j. What is the expected scale and impacts of the resource management plan and ES provider activities on the condition of the ES?	
k. What are the costs of the M&E activities?	Provide details in the PES scheme financial report.
l. How does the M&E plan respond to changes in the environment?	
m. Has the PES project team factored in M&E financing into the PES scheme project costs?	Note: Apart from these core elements of a PES monitoring scheme, M&E parameters can include not just the type of ecosystem services, but also other stakeholder concerns, such as: • Total project costs • Timeline of financial disbursements • Performance of various support services or financial intermediaries • Protection of local ecosystem values

2.5.1 Monitoring

Field Offices shall regularly monitor the implementation of the PES management interventions. WMD shall annually monitor the implementation of watershed management interventions. The monitoring shall focus on the implementation of the planned activities, and achieved outputs.

2.5.2 Evaluation

Evaluation shall be carried after the completion of the implementation of PES schemes. Evaluation of the PES schemes shall be done as part of the evaluation process of the area-based plan as described in Volume III and IV of the *Code*.

It is important that PES schemes are periodically evaluated in light of the data collected through verification reports and other relevant information. The evaluation shall focus on both site-based objectives of managing the ecosystem services as well as the overall objective of the PES Scheme establishment.

In particular, evaluations can highlight any shortcomings in scheme design and see whether the objectives are fully achieved or not and recommend changes accordingly.

The evaluation report shall serve as a basis for renewal of PES schemes and help design viable schemes based on previous experience and lessons learnt. It is important that any evaluations undertaken are communicated and disseminated to parties involved.

2.6. Bibliography

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3. Wetland Management

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3. Wetland Management

3.1. Management Context

3.1.1 Background

Wetlands include rivers, streams and springs with associated riverine and riparian zones; lake, pond, swamp, marsh, fen and peatland with water that is static or flowing with distinct floral and faunal communities. Functional wetlands are critical segments of watershed, as they support a high level of biological productivity and diversity. They provide habitat for flora and fauna, maintain local and regional hydrological regimes, remove nutrients and pollutants, act as stores for rain/flood water and support human activities and values. Wetlands provide fundamental ecosystem services, such as water regulation, filteration and purification, as well as numerous scientific, cultural and recreational values. Wetlands are important for maintenance of the broader ecosystem's health.

With rapid developmental activities and climate change, wetlands in Bhutan are under immense pressures leading to fragmentation and disappearance of some of the significant wetlands. The loss of wetlands shall have a detrimental impact on the ecosystem and the livelihoods of the communities. Therefore, proper management and conservation of wetlands is critical to ensure supply of ecosystem services for all times.

3.1.2 Objectives

The overall goal of wetland management is to conserve and enhance the health of the wetland's ecosystems for continuity of its services. The specific objectives of wetland management are to:

- Assess the status of wetland condition and identify activities to restore, improve and maintain the ecological integrity of wetlands;
- Maintain and improve the ecosystem functions;
- Monitor changes in the ecological character of the wetlands; and
- Support sustainable livelihood and enhance the quality of life of the communities.

3.2. Roles and Responsibilities

The roles and responsibilities of the main stakeholder involved in Wetland management are shown in Table 3.1 Roles and responsibilities

Table 3.1 Roles and responsibilities

Agency	**Roles and Responsibilities**
WMD	• Provide technical backstopping to the field offices in designing and implementing wetland management activities. • Monitor and evaluate implementation of activities in wetland management and conservation. • Educate and create awareness on wetland management and conservation
Field offices	• Carry out wetland assessment and propose for designation of wetlands of national importance. • Develop wetland management interventions, • Facilitate incorporation of wetland management activities into area- based plans such as Forest Management Units (FMUs), Community Forests (CFs), Local Forest Management Areas (LFMA), Protected Areas (PA) or other area-based plans and implement the activities.

3.3. Designation of Wetlands

A national wetland inventory is a fundamental requirement for the identification of wetlands of national and international importance, which is essential for management, monitoring and regulation purposes. The national wetland inventory (NWI) conducted as per the guidelines prescribed in Volume II of the *Code*, provides information to designate wetlands of national and international importance. Management interventions to conserve and manage these wetlands shall be accordingly identified and implemented. The designation of wetlands can be summarized as shown in Figure 3.1.

Figure 3.1 Step for designation of wetlands

3.3.1 Wetlands of national Importance

A wetland can be designated as wetlands of national importance if the particular wetland fulfills all the following set of criteria (Criterions 1 to 6):

1. Two or more out of nine criteria for the designation of Ramsar sites (Box 3.1) are met.
2. Plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
3. Is an important habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as droughts prevail.
4. Supports native plant or animal taxa or communities which are considered endangered o vulnerable at the national level.
5. Covers an area of more than 0.5 Ha, individually or as a system/complex.
6. Provides significant contributions or directly benefits the people's livelihood.

Box 3.1 Criteria for designation of wetlands of national importance (adapted from Ramsar)

Criterion 1: Site containing representative, rare or unique natural wetland types- A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural wetland type found within the appropriate biogeographic region.

Criterion 2: Rare species and threatened ecological communities- A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Criterion 3: Biological diversity - A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

Criterion 4: Support during critical life cycle stage or in adverse conditions - A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Criterion 5: >20,000 waterbirds - A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds. This is a specific criterion based on waterbirds.

Criterion 6: >1% global waterbird population (migratory birds) - A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species of waterbird.

Criterion 7: Significant and representative fish - A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families,

life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

Criterion 8: Fish spawning grounds, etc. - A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Criterion 9: >1% non-avian animal population - A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species of wetland-dependent non-avian animal species.

3.3.2 Wetlands of International Importance

Designating wetlands of international importance (Ramsar sites) shall be determined and decided by the Technical Advisory Committee (TAC) of the Department, from the lists of wetlands designated as nationally important. Upon the recommendation of the Department, a detailed assessment (Ramsar Information Sheets) and mapping and stakeholder consultations workshops shall be conducted at local and district levels and secure legally binding consensus from local communities for designation as Ramsar site. The proposal to designate wetlands as Ramsar Sites shall then be submitted by the Department to the Ministry. The Ministry shall endorse and forward to the Parliament for declaration of the Ramsar site.

3.4. Designing Wetlands Management Interventions

Wetlands management interventions are designed for maintaining the health of wetlands by the application of wetland sciences and management. The steps required to plan interventions to be incorporated in the relevant area-based management plans are described below;

3.4.1 Set Overall Purpose of Wetlands Management

The purpose for the management of wetlands shall be clearly set and agreed among the stakeholders to address or mitigate the issues. The focus and adoption on the type of interventions shall be influenced by the specific purpose of the wetland being managed.

3.4.2 Wetlands Function Mapping

Function mapping of wetlands is an essential part of the wetland management interventions and is the process of defining the sites, based on its protective, productive and social functions. The recharge areas to the existing wetlands shall also be identified and mapped using springshed methodology adopted in 0 Function mapping (Page 14) for Designing Watershed Management Interventions.

3.4.3 Identify Issues Impacting Wetlands

The issues that are identified during all stages of the Wetland management process shall be considered when identifying issues impacting wetlands. In general, these include issues raised/identified during;

- community and stakeholder consultations; and
- field verification and other field visits.

3.4.4 Designing Interventions to Address Issues Impacting Wetlands

This step is the most important and culmination of all the processes undertaken in the above steps and shall determine the success of the management interventions. The aim of this step is to apply a logical approach to identify what interventions are needed to remove or mitigate the issues and improve the condition of the wetlands using a logical framework analysis (LFA). The summarized list of issues shall be used to develop core problems. Once core problems are identified, detail assessment and verification of the core problems shall be carried out.

The activities, outcomes and objectives shall be designed through the application of LFA approach by addressing the core problems.

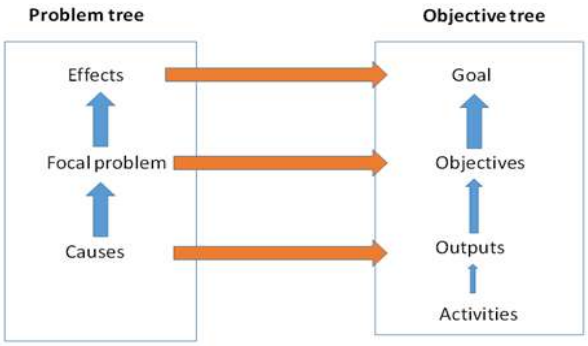

Figure 3.2 Logical Framework Analysis

LFA is a systematic problem-solving approach to planning that is well suited to involving stakeholders in a participatory manner which shall be followed.

The broad issues and relevant prescriptions that shall be taken up, are described in Table 1.11 of Chapter 1 Watershed Management of this Volume.

3.5. Integration of Interventions in Broad Area-based Management Plans

Wetland management interventions shall be included within the other broad area-based management regimes. The concerned field offices shall review the identified intervention measures with WMD and relevant stakeholders to ensure that the objective and prescriptions of the wetland management interventions are met. All these interventions shall be integrated into the specific area-based management plans during the planning phase. The main plan, incorporating prescriptions of all relevant cross cutting issues shall be endorsed and approved as per the procedures in Volume III and Volume IV and implemented holistically.

3.6. Monitoring and Evaluation

3.6.1 Monitoring

Field Offices shall regularly monitor the implementation of the wetland management interventions. WMD shall annually monitor the implementation of wetland management interventions. The monitoring shall focus on the implementation of the planned activities, and achieved outputs.

3.6.2 Evaluation

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall interventions. Evaluation of the wetland interventions shall be done as part of the evaluation process of the area-based plan as described in Volume III and IV of the *Code*.

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4. NWFP Management

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4. NWFP Management

4.1. Management Context

4.1.1 Background

"NWFP consists of goods of biological origin other than wood derived from forests, other wooded land and trees outside the forest" (FAO, 1999).

There are hundreds of Non-wood Forest Products (NWFPs) in Bhutan such as medicinal and aromatic plants, wild vegetables, mushrooms, incense, dyes, gums, fruits, essential oils, fibres, ferns, cane and bamboo, etc. In the absence of adequate/complete knowledge on these resources, their ecology and availability, habitats, opportunities and threats, the Department of Forests and Park Services (DoFPS) has been following the precautionary principle of limited utilization of these resources.

For the overall community benefit, NWFP resource management is encouraged on community based rather than issuing individual permits to collectors, traders or exporters. The sustainable management of NWFP in Bhutan shall be guided by the National Strategy for the Development of NWFP.

4.1.2 Objectives

The main objective of NWFP management are to;

- strengthen the sustainable management and marketing of NWFPs;
- define clear roles and responsibilities of different stakeholders involved in NWFP management, marketing, monitoring & evaluation;
- improve/value add NWFPs product development, efficiency and effectiveness of marketing; and
- promote domestic and cultivation of high value NWFP

4.2. Roles and Responsibilities

The various roles and responsibilities of different stakeholders involved in the NWFP process are as mentioned below in Table 4.1.

Table 4.1 Roles and responsibilities

Offices	Roles and Responsibilities
Social Forestry & Extension Division (SFED)	• Provide technical backstopping to field offices for preparation and implementation of NWFP activities • Coordinate product development trainings for community forest and NWFP group members • Monitoring and Evaluation of NWFP groups • Facilitate enterprise development and marketing of NWFP products
Field Offices	• Facilitate NWFP group formation (new and revision), boundary survey, resource assessments, framing By-Laws • Provide technical backstopping for the preparation and implementation of the management plans • Facilitate in resolving conflicts • Facilitate in record keeping and capacity development of the NWFP group members. • Monitor and evaluate NWFP group in their respective jurisdiction and submit report to SFED
Local Governments (LGs)	• Mainstream NWFP program into the Gewog Plan • Provide guidance and support in resolving conflicts within NWFPMG. • Support budget for NWFP program wherever possible.

NWFP Management Group (NWFPMG)	• Seek support from LG and integrate NWFP activities in the Gewog Plan. • Implement activities according to the management plan and By-laws • Develop and market NWFP Product.
NWFP Management Group Committee Members	• Oversee the overall wellbeing and functioning of the group • Coordinate annual survey of resource avavilability in NWFP collection area • Ensure equitable access and benefit sharing • Ensure sustainable utilization of NWFP as per management plan. • Explore market for the NWFP in coordination with line agencies • Ensure timely submission of NWFP collection and sale report to the respective field offices.

4.3. NWFP Management Planning

4.3.1 Resource Assessment and Mapping

Owing to the difficult nature of NWFP resource mapping, various methods have been set to verify the availability of NWFPs in an area. These include conducting Resource Assessments, Assessment of Harvesting Records and carrying out a Participatory Resource Mapping for a NWFP group.

Objective: To provide field officials with the technical methods to assess resources for sustainable management.

Participatory resource mapping

Identification of the NWFP production areas starts with participatory resource mapping. Ask people who know the area very well and who represent different interest groups (men and women, from different villages involved in collection) to draw map of different collection areas. Try to clearly determine the boundaries by indicating well known existing features (Gewog boundaries, roads, trails, ridges, rivers, Chortens, etc.). Make a field visit with people who drew up the sketch map of different production areas and make a visual estimation of the available quantities that can be harvested from each collection area. Record data of each collection area. Data of the estimated productivity shall be added and depicted on the sketch map. The sketch map itself might also be modified during the field visit to better represent ground reality.

The estimated quantities can be verified during the early collection season (after seed dispersal) by collecting the NWFP in one of the locations and cross checking the actual collection with the estimated collection.

If the actual quantities are similar to estimations it may be assumed that other estimations for the same resource are also reasonably accurate. If there are severe deviations, the estimations have to be corrected and another trial in the same way as described above shall be carried out.

The participatory resource mapping shall be conducted once every three years, that is, three times over a 10-year plan period for area-based management plan.

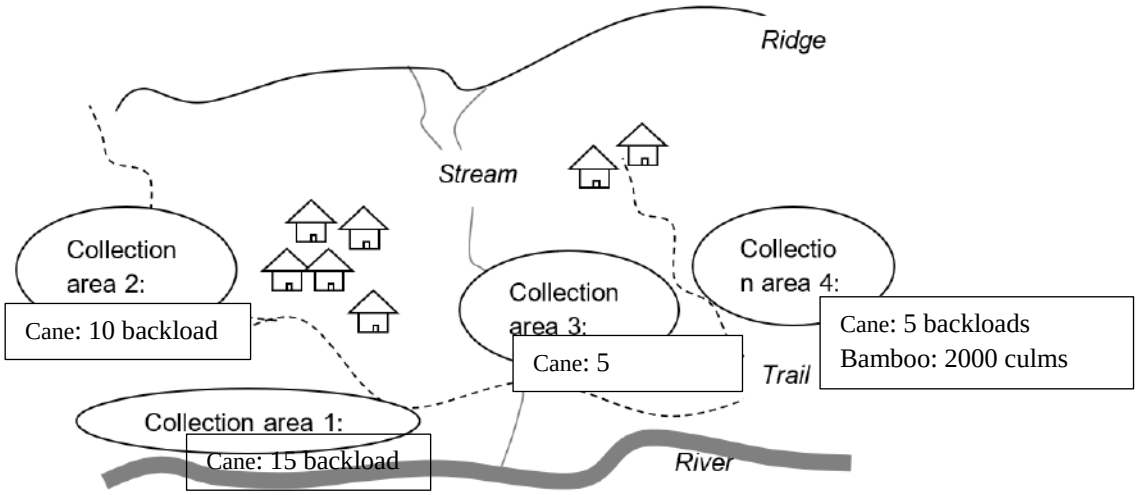

Figure 4.1 Sketch map showing estimated NWFP resource per location

Note: Different species of NWFP shall require different sampling design based on their behaivour or occurence in nature. Currently, transect method is used to estimate NWFP. In the long run, appropriate sampling design shall be developed.

Assessment of NWFP productivity based on harvesting records

The performance or collection trends of the last three years is tabulated and analysed. If harvest records are available for a period of about three years or more, the average can be calculated and used as a reliable resource assessment (Table 4.2 and Table 4.3). Detailed scientific assessment to calculate annual harvesting limit is not reuired for those species which has charatersitics of weeds and which usually grows in disturbed habitats such as edges of forests/agricultural fields. Sustainable management can be ensured by implementing guidelines for sustainable harvesting and rotational harvesting.

Table 4.2 NWFP data collection for a particular species

Name of Dzongkhag:
Name of Gewog:
Name of Species:
Records available over period/years:

Village	***Quantity of harvested dried NWFP (kg) over last 3 years***			***Average dried NWFP production (kg)***
	Year 1 …	**Year 2 …**	**Year 3 …**	

Table 4.3 Production area description

Annexure 2: Production area description form for NWFP

Date:

Village/ Gewog:

Collection site name:

Access	*Walking distance from the nearest village to the collection area?*		
	Less than 3 hours	Within a day	More than a day
	Walking distance from the collection area to the nearest road?		
	Less than 3 hours	Within a day	More than a day

Slope	Very steep >100%	Steep 70-100%	Moderate 45-70%	Gentle < 45 %

Collection site description	Dominant and associate species, canopy cover:

Productivity	Estimated quantity that can be collected from the collection site

Current management	Current management practices in collection site if any:

Current threats/ challenges	***Threat***	***Description***
	Fire	
	Grazing	
	Illegal exploitation	
	Over-exploitation	
	Other:	

Opportunities	Future opportunities in the collection site:

Resource Assessment in the Field

Due to the varying nature of NWFPs in the wild, a variety of resource assessment methods must be applied wherever necessary. Detailed field resource assessment guidelines available for the following species shall be used for their management.

- *Borinda grossa*
- *Swertia chirata*
- *Piper pedicellatum*
- *Neomicrocalamus andropogonifolius*
- *Illicium griffithii*
- *Rubia cordifolia*
- *Paris polyphylla*
- *Plectocomia himalayana*
- *Daphne spp. and Edgeworthia gardneri*
- *Cymbopogon flexuosus*

4.3.2 NWFP Harvesting

Harvesting guidelines of Non-Wood Forest Products have been framed for sustainable harvesting of NWFPs. Table 4.4 provides prescriptions for management and marketing of 62 key NWFP species and shall be updated regularly.

Table 4.4 Guideline for management and marketing of 62 key NWFPs

Sl. No	Name		Part(s) used	Use(s)	Purpose		Time of harvesting	Guidelines for harvesting	Remarks
	Scientific	Local			Domestic	Export			
01	*Fritillaria delavayi*	Tseka (Dz.)	Bulb	Medicine	√	×	September to October	• Collect the bulb when the upper plant parts deteriorate and natural seeding takes place. • Leave the bulb let formed around the mother bulb in the soil for regeneration in the following year. • Refill soil after digging bulb.	Listed in schedule II of Forest and Nature Conservation Bill of Bhutan (FNCBB), 2019. Found in SRFL.
02	Nardostachys grandiflora	Jatamansi (Lh) Pangpoe(Dz)		Incense	√	×	Sept-October	• Do not uproot the entire plant. • Replant the upper parts and the top 2cm of rhizome. • Should be harvested following five years rotation period.	Listed by CITES in annexure II and schedule II of F NCBB, 2019. Found in SRFL. Need to seek collection approval from CITES signatories before collection.
03	*Neopicrorhiza scrophulariiflora*	Putising (Dz), Kutki or kutaki (Lh)	Rhizome	Medicine	√	×	September-October	• Harvest rhizomes only during the harvesting season. • Do not uproot the entire plant.	Listed by CITES in annexure II and Schedule II of FNCBB, 2019. Found only in SRFL. Need to

								• Replant younger shoot after collecting matured rhizomes.	seek collection approval from CITES signatories before collection.
04	*Ophiocordyceps sinensis*	Yar-tsha guenbub (Dz), yar-tsa gumba (Lh)	Entire form	Medicine	√	√	May to July	• Collect only during the one month restricted harvesting season as set by the DFO / PM / Gups. • Fill up the holes after digging up *Cordyceps*. • Harvesting of other medicinal plants is strictly prohibited. • Do not visit the same area twice for harvesting. • The concerned Gup or his / her representative shall implement these harvesting rules.	Listed in schedule II of FNCBB, 2019. Found only in highland of SRFL.
05	*Paris polyphylla*	Satuwa (Lh) Thoksampa(Sh) Dhoo(Dz)	Rhizome	Medicine	√	√	October-November	• Harvest only in time specified for collection. • Leave some portion of the rhizome with freshly emerged bud underground while harvesting the rhizome of the plant. • Do not harvest the plant before the seed dispersal	Listed in schedule II of FNCBB, 2019.Found mostly in SRFL.
06	*Podophyllum hexandrum*	Bamarpoo (Dz)	Seed	Medicine	√	×	August to September	• Since each plant normally yield one fruit, collect fruits from 50 percent of the plants from the area.	Included in schedule III of FNCBB, 2019. Found in SRFL.

07	*Rheum nobile*	Chukkha metog(Dz.)	Leaves and flower	Medicine	√	×	June to July	• Use a sharp knife to be for cutting the leaves and flower. • Leave behind 50 percent of the plant in the area for regeneration	Listed in schedule III of FNCBB, 2019. Found only in SRFL.
08	*Aconitum laciniatum*	Bong ngag (Dz), Maanchhen (Sh) Bekma(Lh)	Root / tuber	Medicine, also used for making poison for arrows	√	√	September to November (When upper part of plant withers)	• Dig up only mature roots / tubers during the harvesting season • Leave the plant (upper part) intact with small part of the roots or tubers in the soil (this left part of roots / tubers shall regenerate in the following years) • Do not uproot the entire plant • Do not dig up all roots / tubers.	Found only in SRFL
09	*Aconitum orochryseum*	Bongkar (Dz), Bongkar Med) Bekma(Lh)			√	√			
10	*Aconogonon tortusum*	Ngalachog (Dz.)	Root	Medicine	√	×	July to September	• Root should be harvested after seeds are matured and dispersed. • Leave 30 % of the roots for regeneration	
11	*Acorus calamus*	Chudar or chudala (Dz), bojo or bojho (Lh), bar-tsi (Sh)	Rhizome	Medicine	√	√	October to March	• Dig up only mature rhizomes without uprooting the whole plant • Leave the plant (upper part) intact with small part of the rhizomes in the soil (this left part of rhizomes shall regenerate in the growing season)	Found on both SRFL and private registered land.

12	*Artemisia spp.*	Khempa (Dz), Titey-pati (Lh) Maringma(Sh)	Leaf, twig and stem	Medicine, essential oil	√	√	August to September	• Cut the plant at 15 cm above the ground • Use a sharp knife or scissors to cut the upper parts of the plant • Leave at least 10% of the plants without collecting or harvesting any raw materials from them (these plants shall act as seed plants for natural regeneration.	Found in both private registered land and in SRFL.
13	*Asphaltum punjabinum /A.amomalutum*	Shilajit(Lh) Drakzhu(Dz) Brakzhu(Sh)	Refine part / processed	Medicine	√	×	October-March	• Should collect the exude that are fallen on the ground. • No blasting and/or excavation of rocks should be done in order to collect shilajit. • Surrounding area shouldn't be disturbed while collection Shilajit	Not abundantly found
14	*Bambusa clavata*	Chiley bans (Lh), Pagshing (Dz), Gook(Kh), Soo (Sh)	Culms, young shoots	Weaving, construction materials etc. Young shoot edible.	√	√	For culms: October to Feb	**For culms:** • Cut culms above one node from the ground level • Do not cut culms less than one year old • Retain 50% of healthy culms from a clump • More than three years old culms should be removed annually.	Most found cultivated in private land.
15	*Bambusa nutans/Bambusa*	Zhushing (Dz), Mal bans (Lh), Zhuushing / Gren (Kh)	Shoot Culms	Construction	√	√	For shoots: May to September	Harvest culms in condensed / congested clump in "U" or horseshoe form. Use	Mostly found in private land

	nutans (thorny variety)	Leeshing(Sh)		Bow making				otherwise single culm selection method. Older culms in center should be cut annually. **For shoots:** • Collect bamboo shoots to a maximum of 25% from a clump • Cut bamboo-shoots with a proper cutting tools at the ground level without damaging or wounding the other healthy ones • After cutting and collecting the bamboo-shoot, cover that void place with top soil • Protect the remaining shoots and let them further develop into culms	
16	*Borinda grossa*	Baa (Dz); rhui (Bu & Kh) shee / shi (Sh) Malingo(Lh)	Culms	Mats and other products	√	√	December to February (Not during bamboo-shooting period)	• Cut culm at the base or at the first long internodes above the node • Leave bamboo shoot or culm of less than one year old intact. • Cut at maximum 33% of the 1+ year and 2+ year old culm per clump. • Do not cut culm when new shoots are sprouting.	Guidelines for resource assessment and management are in place, FRDD, 2008.

17	*Cassia fistula*	Golden shower (En), Rajbriksha or Rajbrikshay (Lh), Donka sey or Donko shing (Sh), Donga (Med)	Pods and seeds	Medicine	√	√	During winter when pods are smooth, hard and changed colour to pale or dark brown (fully ripe)	• Collect pods from the ground by handpicking. • Pod can also be detached from trees using long bamboo poles with a hook.	Mostly found in SRFL. Sometimes cultivated by farmers in Private land. Propagation by seeds and vegetative through cutting and layering; coppices well
18	*Choerospondia axillaris*	Lapsi(Lh) Phrumchungshing(Sh) Kruthmala(Kh)	Fruits	Fruit is eaten fresh or Pickeling / Dye/	√	√	December to February	• Collect fruits by shaking trees. • Use long bamboo poles to detach fruits form the trees. • If the fruits are collected for nursery raising purpose, pick fruits when it turns yellow.	Trees are found growing in association with other broadleaved trees.
19	*Cymbopogon spp.*	Sorbhang (Sh) Lemon grass (En)	Upper parts	Essential oil	√	√	Mid July to November	• Collect lemon grass at maximum 2 times per year • Cut the grass at a height of 20 cm. • Leave at least 3 to 4 flower stalks / tillers per entire clump.	Guidelines for resource assessment and management are in place, FRDD, 2008.
20	*Daphne spp.*	Dheynap (Dz), Kaga-tey, Kagati, Lokta in (Lh) Shigushing(Sh)	Bark	Traditional Bhutanese paper	√	√	March to June	• Cut the plant at 10 cm above the ground level to produce coppice in the following growing year. • Cut only stems that are more than 3 cm in diameter.	Extensive research on Daphne has been carried out by RNR-RC Yusipang.

								• Do not damage the remaining young stands, seedling and /or saplings • Divide collection area into 5 blocks. Harvest bark only from one block. • Daphne stem attains 3 cm diameter in 5 years.	
21	*Edgeworthia gardneri*	Dheykap (Dz), Argaylee (Lh) Shugushing(Sh)	Bark	Traditional Bhutanese paper	√	√	March to June	• Cut the plant at 10 cm above the ground level (the left stump shall regenerate in the following growing season). • Cut only stems that are more than 3 cm in diameter. • Do not damage the remaining young stands, seedling and /or saplings • Do not fell the surrounding trees in order to clear the area to ease harvesting Divide harvesting area into 5 blocks for Daphne. Harvesting is rotated over the 5 blocks so that harvesting takes place only in one block per year (Daphne takes 5 years to produce stems of more than 3 cm in diameter).	

22	*Dendrocalamus hamiltonii*	Pagshi (Dz), Tama, choya or jungali bans (Lh), Soo(Sh)	Culm, young shoots	Weaving, construction materials, etc. Young shoot edible.	√	√	For culms: November to Feb For shoots: June-September	**For culms:** • Cut culms above one node from the ground level • Do not cut culms less than one year old • Retain 50% of healthy culms from a clump • Harvest culms in condensed / congested clump in "U" or horseshoe form. Use otherwise single culm selection method • Collect maximum of 50% from first flush of shoot in the clump. • Collect 25% of 2nd second flush of shoot in the clump. • Cut bamboo shoots with sharp knife at the ground level without damaging or wounding the other healthy ones. • After cutting and collecting the shoot, cover that void place with top soil. • Retain all the shoots coming in third flush.	More in SRFL. Few cultivated in Private Land.
23	*Diplazium esculentum*	Nakey(Dz) Dhawai(Sh) Ningoro(Lh) Zhima(Kh)	Young shoots	Vegetable	√	√	March to September	• Harvests young shoot that are 15cm length. • Don't harvest the entire shoot coming up in season.	Found in SRF mostly in shady and marshy area.

								• Retain at least 50% of young shoot of last flush for the development of leaves. • Don't harvest the shoots that have developed to leaves. • Don't cut down trees which provide shade to the plant.	
24	*Diploknema butyracea (Syn. Aesandra butyracea, Bassia butyracea)*	Chiuri (Lh), Butter tree (En), Yega shi (Dz), Pin-shing (Sh) Khaima(Kh)	Fruits	oil used for cooking/ butter lamp or as ointment, ingredient to soap and candle making, seed cake used as fertilizer	√	√	April to May	• Collect fruits when fully ripped by; ✓ hand pick after bending branched using hook. ✓ shaking the branches. • Collect about 75% of the fruits as seeds are required for regeneration. • Do not fell trees to harvest fruits. • Do not lop branches to harvest fruits. • Prevent fire outbreak (Butter tree is very susceptible to fire)	Available in SRFL.

25	*Elatosteme lineolatum*	Dham-boor(Dz) Drimom or Dreema-mom(Sh) Chhotey gaglata(Lh) Dhamroo(Kh)	Stem and leaves	vegetable	√	√	Any time	• Collect plants that are 15cm and above. • Retain stump of around 3" for sprouting of new shoots. • Don't uproot whole plant. • Shouldn't cut down trees and create more opening. • Shouldn't disturb its catchment area.	This plant grows only in shady area along stream and requires shade all the times.
26	*Entada rheedii*	Pangra or Pangro (Lh), Kolokpo (Sh), Ngingshosha (Med) Yangkaling(Kh)	Bean	Medicine	√	√	When climber dries off	• Collect fallen beans from the ground • If beans are still hanging on the supporter (tree) then use long bamboo poles with a hook to let the dried bean fall on the ground • Leave 20% of the beans on the ground floor and cover them with top soil to allow natural regeneration • Do not uproot the climber for the sake of collecting the beans	Found both in SRF and PRL.
27	*Gaultheria fragrantissima*	Chamze Kam (Dz), Dhasingre, Dhasingare or Machino (Lh)	Leaves and twigs	Essential oil	√	√	June to February. Best time is from June to September when plant has higher oil content	• Collect leaves by hand picking or collect leaves and twigs by cutting with a sharp knife or pruning scissors • Collect at maximum 50% of the leaves and	Found mostly in SRF

								twigs from a single plant or shrub • Do not uproot or cut down the whole plant or shrub for the sake of collecting the leaves and twigs	
28	*Himalayana. hookerianus*	Pah ryang (Lh)	Culms, young shoots	Weaving, construction materials, etc. Young shoots edible.	√	√	Culms: Nov to Feb to April and November to January Shoots: July to September	**For culms:** • Cut culms at 30-50 cm above the ground. (No young shoots shall sprout if culms are cut below this level, and ultimately the whole clump would die). • Retain 50% of healthy culms from a clump • Harvest culms in condensed / congested clump in "U" or horseshoe form. Use otherwise single culm selection method **For shoots:** • Collect bamboo shoots to a maximum of 25% from a clump • Cut bamboo-shoots with a sharp knife at the ground level without damaging or wounding the other healthy ones. After cutting and collecting the bamboo-shoot, cover that void place with top soil	Found both in SRF and PRL

								• Protect the remaining shoots and let them further develop into culms	
29	*Hippophae salicifolia*	Tareytsang	Berries	Juice and and medicine	√	√	September-October	Berries should be handpicked early in the morning Donot cut down trees Collect berries using mineral water bottle cut in "U" shape fan in bottom.	Found along with SRFand in PRL
30	*Illicium griffithii*	Doomleeshing (Dz), Wounba chinang or Khaila chinang (Sh)	Seedpod	Not clear	√	√	October to December (or when fruits are matured)	• Harvest seedpods by handpicking, collection from forest floor or lopping outer branches. • Do not cut down the tree for harvesting of seedpods.	Guidelines for resource assessment and management are in place, FRDD, 2008.
31	*Juglans regia*	Tago(Dz) Kheshing(Sh) Okhar (Lh)	Fruit	Carnal	√	√	September to October	• Hand pick fruits only when fallen on the ground, or • Use long bamboo poles to shake off fruits from the trees. • Don't cut tree or branches to collect fruits.	Found in state reserved forest and in private
32	*Litsea cubeba (Syn. L. citrate)*	Siltimbur (Lh), Nenshing (Sh)	Fruit	Essential oil, medicine	√	√	August; harvest fruit when it turns black	• Harvest fruit by handpicking or by lightly lopping of outer branches. • Do not cut down the tree for harvesting of fruit.	Mostly found in GRF. Sometimes cultivated by farmers in PRL
33	*Meconopsis paniculata*	Upel serpo (Dz)	Flower	Medicine	√	×	June to July	• Use sharp knife to harvest the flower	Found only in SRFL

								• Leave 30% of the plants per collection site intact for seed production	
34	*Myricaria rosea*	Wombu(Dz)	Whole plant	Medicine	√	×	July to August	• Use sharp knife to cut the upper portion of the plant • Leave the roots undisturbed while cutting down the plants.	
35	*Neomicrocalamus andropogonifolius*	Langma (Lh); Ringshu (Sh), Yula (Kh)	Culms	Bangchungs and other handicraft items	√	√	December to May (Not during bamboo shooting season)	• Harvest only culm from clump that has more than five culms. • Harvest culm when it produces secondary shoot at the top. • Retain at least two to three young healthy culms in each clump to favour more shooting in the following season.	Guidelines for resource assessment and management are in place, FRDD, 2008.
36	*Pedicularis longiflora*	Lugru serpo(Dz)	Leaves and flower	Medicine	√	×	June to July	• Collect 50 percent of the plants from the area without disturbing the area.	
37	*Pedicularis megalantha*	Lugru marpo	Leaves and flower	medicine	√	×	June to July	• Harvest 50 percent of plants from the area without destroying the habitat •	
38	*Persia Spp*	Gooli(Dz, Sh) Phulchey(Lh)	Fruit	consumption	√	√	October - January	• Collect fruits when it is fully matured.	
39	*Persea gamblei*	Kawla or kathe kaulo (Lh) Pragoli(Kh) Zala Goli	Bark	Adhesive, Incense	√	√	October till February	• Handpick fruits that are fallen on the ground.	

		Pchagoli(Dz)						• Don't cut down tree and branches for collection of fruits. • No collectors shall climb on trees and shake fruits for collection. • Shaking of branches of trees shall lead to downfall of un-matured fruits.	
40	*Phyllanthus emblica (Syn: Emblica officinalis)*	Amala (Lh) Chorgensay (Sh) Amla(Dz) Goose berry(En)	Fruit	Vitamin C, medicine	√	√	November to February. (Fruits have highest ascorbic acid content in February)	• Collect only bark from trees with a DBH of more than 10 cm. • Collect the bark in strips with a maximum of 6 cm in width. But, avoid damaging cambium layer • Strip the bark from down to up to avoid damaging the roots. • Harvest a maximum of two trips per tree trunk from opposite sides. • Do not strip off the tree bark for 4 years after the first harvest from the same tree (it takes a tree about 4 years to heal / recover from stripping). • Collect the bark every four years from opposite sides of the same tree.	Harvesting should be undertaken on a trial basis in one designated place on a small scale

41	*Piper betleoides*	Pani or paney (Dz), Pan (Lh)	Leaf	Stimulant	√	√	Throughout the year	• Harvest fruits by shaking the tree, handpicking and / or use bamboo poles with a hook. • Do not cut down trees for the harvesting of fruits	Mostly found in SRF. Sometimes found in abandon PRL
42	*Piper hamiltonii*	Jungali pan (Lh) Shingzem(Dz) Shingpan(Sh) Shingpan/Thopan (Kh)					Mid March to mid April	• Collect leaves only by hand picking without damaging the climber and its tender buds. • Harvesting of leaves from a single (same) climber shall be allowed to maximum of 4 times per year. • Collect at maximum 80% of the leaves from a single climber. • Do not cut down the host tree to ease harvesting.	Mostly found in SRF. Sometimes cultivated by farmers in PRL
43	*Piper longum*	Pipla / peepla (Lh), Pipla (Ctn)	Fruit / spike	Medicine, sometimes used as spice	√	√	Mid July to mid September.	• Do not uproot or cut down the entire climber.Collect fruits only when fully mature. • Harvest fruits only after the announced staring date for harvesting (Date is usually announced by the coordinator / GFEO).Harvest fruits / spikes by hand picking without damaging the plant or by cutting a few fruit bearing branches.	These two *Piper* species are mostly cultivated in southern Bhutan. Not found in abundance in SRF.
44	*P. peepuloides*								

								• Do not cut down the host tree to ease harvesting. Do not cut the entire fruiting portion of the plant.	
45	*Piper pedicellatum*	Bhui pipla(Lh) Raktang(Kh)	Fruit	Spice/ medicine	√	√	When fruits are fully mature (September onwards)	• Collect fruits only when fully mature. • Harvest fruits only after the announced staring date for harvesting (Date is usually announced by the coordinator / GFEO generally in September). • Harvest fruits only by hand picking without damaging, cutting or uprooting the entire plant	Guidelines for resource assessment and management are in place, FRDD, 2008
46	*Plectocomia himalayana*	Patsha (Dz), Phegkray, tokri, tara, damley, dhoray bet (Lh) Phashi(Sh) Ray(Kh)	Young shoot as well as matured stem	Young shoots used as vegetable. Matured stem used to produce handicraft items	√	√	Winter time for mature stems For shoot April to August	**For mature stems** • Cut cane stem only when mature, to be recognized by: ○ Loosening of leaf sheath from the lower part of the cane stem ○ Exposure of lowest part of the stem ○ Turning to yellow-reddish along the entire stem length ○ Diameter over the entire length of the cane is the same (the diameter at the lower part of the cane is reduced)	Available in SRF. These guidelines are applied only to *Plectocomia himalayana* and do not apply to other species of cane.

								• Pull down as much of the stem as possible (avoid leaving cane parts high up in the tree) • Cut only canes with a usable length of at least 10 m. Discard at maximum 1.2 to 1.5 metres from the top end. Harvest during winter as canes have a better quality during this season (lower water content and more durable) **For cane shoots** Cut young shoot by bending the cane stem with the help of a long and strong stick with a hook • Do not cut the entire cane to collect the shootsCut the leading shoot with a sharp knife diagonally (not straight in order to avoid rotting of the remaining stump); leave lateral shoots • Care shall be taken to avoid damaging sucker buds (these shall later develop into lateral shoots) **Guidelines for both mature stems and cane shoots**	

								• Uprooting, cutting of rhizomes / suckers shall be avoided. • Trees supporting the canes shall not be felled The debris after harvesting canes should be taken outside the cane area in order to avoid infection with insect borers or fungi •	
47	*Pouzolzia spp.*	Chipley (Lh), Yongjiba or Yangziba, Yongeebu (Sh)	Bark	Adhesive, Incense	√	√	August to February	• Cut the plant at 10 cm above the ground level • (the left stump shall coppice in the following growing season). • Do not damage the remaining young stands/ seedlings/ saplings • Felling of surrounding trees to ease harvesting is prohibited. • Leave at least 10% of the plants to allow natural regeneration. • Harvesting of roots is strictly prohibited for ecological reason	Present in both SRF and PRL.
48	*Princepia utilis Royle*	Dushi Tsang(Dz)	Fruits	Oil	√	√	April-May	• Hand pick fruits from trees. • Spread tarpaulin and shake or gentle beat on branches with long poles.	Found in Thimphu, Paro and Haa and Chukha area in both SRF and private land

								• Don't cut down trees or branches to ease collection.	
49	*Rheum australe*	Chutsa(Dz)	Root	Medicine	√	×	September-October	• Harvest after the seeds are matured and dispersed. • Fill the hole after extracting the roots	Found in SRF
50	*Rhododendron anthopogon*	Balu (Dz), Dali metog (Med),	Leaves and twigs	Incense	√	×	October to November	• Use a sharp knife/secateurs to cut branches in order to collect leaves and twigs	
51	*Rhododendron setosum*	Soonpati or sunpatey (Lh)Sulu (Dz)	Leaves and twigs	Incense	√	×	October to November	• Use a sharp knife/secateurs to cut branches in order to collect leaves and twigs • Collect at maximum 20% of the leaves and twigs from an individual shrub in order to avoid over harvesting.	
52	*Rubia cordifolia*	Tsoy (Dz), Majito (Lh), La-nyi-roo (Sh) Tsuth(Kh)	Entire plant	Dye, Medicine	√	√	November to February	• Use sharp scissors for the harvesting of the upper part of the plant. • Cut the plant at 5 cm above ground level. • Leave at least 10% of the plants without collecting or harvesting any raw materials from them (these plants shall act as seed plants for natural regeneration). • Do not collect roots.	Available in both SRF and PRL. In India it is depleted due to the harvesting of roots.

								• Do not uproot entire plants	
53	*Sapindus mukorossi*	Soapnut (En), Ritha (Lh), Nakapani (Dz, Med), Kiling shing (Sh) Nakuni(k)	Nut	Natural detergent, Medicine	√	√	October to November	• Collect nuts by handpicking or from the forest floor • If nuts are still on the tree then use long bamboo poles with a hook for picking. • Do not fell trees to ease harvesting • Collect about 75% of the fruits and leave at-least 25 % to allow natural regeneration	Available in both SRF and PRL. (Seeds germinate easily: soak seeds in lukewarm water for 24 hours before sowing).
54	*Swertia chirayita*	Chirata (San) Chiraito (Lh) Khalu(Sh)	Entire plant	Medicine	√	√	November to January	• Collect Chirata only after seed dispersal commenced. • Harvest plant only after the announcement of harvesting date (It is usually announced by the coordinator / GFEO, generally in November). • Do not collect the plants late in the season (February) because at that time there is a high risk of damaging the germination of new seedlings	Guidelines for resource assessment and management are in place, FRDD, 2008.
55	*Symplocos paniculata*	Pangtse-shing (Dz), Zim-shing (Sh), Gunilo (Nepal)	Fruit/ Seed, leaves	Vegetable oil, dye	√	√	November-December	• Do not fell trees to ease harvesting • Collect the fruits by handpicking or from the ground	Available mostly in PRL along the agricultural fields.

								• Collect about 75% of the fruits and leave at least 25% to allow regeneration	
56	*Taraxacum eriopodum*	Khurmong (Dz)	Whole plant	Medicine	√	×	June to August	• Harvest 50 percent of plants from the area without destroying the habitat	
57	*Terminalia bellirica*	Baru, Baroo (Dz, Sh, Med,Kh),	Fruits	Medicine, essential oil,	√	√	December onwards (fruits start falling)	• Collect the fallen fruits from the ground. Collect about 75% of the fallen fruits and leave at-least 25 % to allow natural regeneration.	Available in both SRF and PRL
58	*Terminalia chebula*	Aru, Aroo (Dz, Sh, Med,Kh), Har-ra or Har-ro (Lh), Black Myrobalan (En)	Fruits	Medicine, Incense	√	√	November onwards (fruits start falling on the ground)	• Collect the fallen fruits from the ground. • Collect about 75% of the fallen fruits and leave at-least 25 % to allow natural regeneration.	Available in both SRF and PRL.
59	*Thysanolaena latifolia*	Tsakusha (Dz, Sh), Beyshawa (Sh), Kucho or amliso (Lh)	Upper parts, inflorescence	Fodder, Soft broom.	√	√	December to March	• Do not damage the rhizomes in order to allow natural regeneration • Cut the matured stem right from base • Apply prescribe burning every after three years	Available in both SRF and PRL.
60	*Tricholoma matsutake*	Sangay shamu (Dz)	Entire mushroom	Vegetable ~~(delicacy in Japan)~~ and soup	√	√	July till September	• Dig out the mushroom with a flattened stick and replace the soil in order to protect the mycelium.	DoFPS and the National Mushroom Centre (NMC) monitor the harvesting during the

								• Do not collect mushrooms less than 7.5 cm in length or height. • Collect only within the designated season i.e. the opening and closing dates set by NMC. • Do not scratch and disturb the soil while searching for mushrooms. • Do not use a knife for the harvesting of mushrooms. • Do not cut branches from trees or shrubs while searching for mushrooms. • Use a bamboo basket rather than plastic bags for the collection and transportation of mushrooms. • Mount leave mould in collection area after harvesting	harvesting season. NMC also provides training on sustainable harvesting of matsutake.
61	*Tupistra nutans*	Wangpem(Dz) Nakeyma(Lh)	Flower				September_ October	• Cut only the flowers • Leave 2 flowers for seed production • Do not uproot entire plant.	Found in SRF
62	*Zanthoxylum armatum (Syn. Z. alatum)*	Zhung Thhey (Dz), Timbur or Timur (Lh), Khe Gi (Sh) Nam chawa(Kh)	Fruit	Essential oil, medicine, pickle	√	√	August to September	• Harvest fruit by handpicking if possible climbing on trees.	Available in both SRF and PRL.

				& spice, water purifier				• Use long bamboo poles with a hook to facilitate picking of the fruit. • Collect only 70% of the fruits and leave 30% to allow natural regeneration. • Do not lop or cut branch to collect fruit if such method practice, the production in the following years shall reduce. • Do not cut down the tree for collection of fruit.	
63	*Zizyphus mauritiana*	Bayer(Lh) Tshoshing (Dz) Khangaling sey(Sh)	Fruit	Pickle	√	√	January to March	• Use hook to pull branches for collection of fruits. • Don't break branches in the process of fruit collection. • Don't cut down whole tree to ease collection work.	
Note: Dz = Dzongkha, En = English, Lh = Lhotshampkha, Sh = Sharchopkha, Med = Medical, Kh = Khengkha, San = Sanskrit, GFEO = Geog Forestry Extension Officer, DBH = Diameter at breast height (1.3m), Ctn = Common trade name									

4.3.3 Formation of NWFP Management Group

The establishment of NWFP Management Groups is an integral part of the NWFP management process. NWFP groups are formed through a participatory approach with members of the Community.

Interested communities shall approach the nearest Field Office with request to establish a NWFP Management and Marketing Group. The Field Office shall determine the feasibility of the area and carry out a consultation meeting with the community members. Here participatory resources maps shall be drawn after which the Field Office shall conducts a resource assessment of the area. Finally, by-laws shall be formed to determine the details of NWFP management.

By-laws

The rights to use resources could be handed over to members of rural communities for a 10-year period until the revision of the area-based plans. By-laws are a critical component of the NWFP Management and Marketing Plan. By-laws shall be formulated in a consultative manner, to ensure transparency and equity for access and benefit sharing. As far as possible, the executive members shall be elected by either a secret ballot, or a simple show of hands.

By-laws shall be comprehensively detailed out through a consultative process and general consensus of members. Provision of membership arrangements, fines and penalties, fund collection and utilization, number of meetings to be held in a year, terms and conditions for executive members as well as general members, etc., shall be included in the By-laws (Table 4.5).

Table 4.5 General template for the By-laws

Membersof the NWFP management & marketing group	Village	Number of member households	Gewog
	Responsibilities and rights of members: *(For example: Permitted to harvest and market NWFPs as per this plan)*		

Executive committee	
Chairperson	Name of Chairperson:
	Responsibilities of Coordinator/ Chairperson: *(For example: To chair all meetings related to this plan, resolve disputes and conflicts among members, maintain contacts with traders, to arrange & coordinate marketing of NWFPs, record data, etc.)*
Secretary	Name of Secretary:
	Responsibilities of Secretary: (*The group shall discuss if they are interested in having a Secretary for to example support the Chair-person and to make records of meetings)*

Treasurer	Name of Treasurer: Responsibilities of Treasurer: *(The group shall discuss if they are interested in having a Treasurer to maintain cash transaction records, to collect membership fees and take care of financial arrangements)*
Possible additional executive committee members	Name(s): Responsibilities: *(The group shall discuss if they want additional executive committee members)*
Compensation to the executive committee for marketing	*(The group shall discuss if they want to compensate the executive committee for arranging the marketing of products; e.g. certain percentage of sales)*
Membership fee and purpose	*(The group shall discuss if they want to levy a membership fee, the amount of the fee and the purposes for which the fee shall be used (e.g. deposit in Community Development Fund, for pre-financing marketing costs, etc.)*
Community development fund and utilization of fund	*(The group shall discuss if they want to have a community development fund and contribute a certain percentage of the NWFP sales to this fund; the group shall also discuss how they intend to use this fund)*
Conflict resolution	In case disputes or conflicts arise among communities about access to certain areas for NWFP harvesting; the matter shall be put to the Gewog Tshogchung (GT) or Dzongkhag Tshogdue (DT) for further decision. Conflicts or disputes within the NWFP Management Group, which cannot be resolved by the group members shall be forwarded to the Coordinator for settlement. If the case still cannot be resolved by the Coordinator, it shall be forwarded to the Gewog Administration. In case there is a conflict between the NWFP Group and outsiders, the case shall be forwarded to the CFO and Gewog Administration by the Coordinator.
Penalties	In case of any violation of the harvesting rules by a member of the NWFP Group, it shall be dealt as per the By Laws. (*Describe other penalties if desired*)

Membership registration

Sl. No	Date	Name	Address	Designation/Position	Signature or thumbprint

4.3.4 Management Prescription

NWFP management shall be a part of the area-based management plan and the standard format developed (Table 4.6) shall be adopted for incorporation in the main plan.

Table 4.6 Contents of NWFP Management Prescriptions

Sl. No.	Title	Description
1	**Introduction**	An opening paragraph highlighting the need for the management of a particular NWFP, the status of the communities, a brief description of the boundaries of the area as well as any other general context in relation to the area-based plan.
2	**Management and Marketing Plan**	First major portion which contains the following components.
	Goals and Objectives	The primary reasons and end results desired by the management of a NWFP.
	Description of NWFPs	A table showing the name and key details of the NWFPs as well as the estimated quantity that can be collected by the group.
	Harvesting prescriptions for sustainable NWFP harvesting	Harvesting guidelines for each species derived as far as possible from the Interim Framework for the Management and Marketing of Non-Wood Forest Products in Bhutan, 2011
	Sketch map of the NWFP harvesting areas	A participatory map formed with the community based on traditional boundaries, customary practices and availability of NWFP resources
	Marketing and sales plan	A table describing the products, the potential markets where the group intends to sell their products, the estimated quantity, the price per unit and the total value of the expected sales
	Marketing arrangements	A description of how marketing of NWFPs shall be organised and arranged; e.g. harvesting and marketing as a group and equal sharing of income; harvesting individually & marketing as a group with the chairperson marketing NWFP produce on behalf of the group and deducting costs such as transport, community development, compensation for work done by executive committee, before reimbursement of income to individual members, etc.
	Benefits to the members (optional)	An optional description where the benefits to the members is given in a few sentences.
	Financial projection of benefits to the members from NWFP sales (optional)	A table showing predictions of financial returns the group may acquire and how the earnings and input costs can be calculated to determine final profit.

3	**By-laws**	The laws that shall govern the group during the implementation of the MP. This is the second major section of the MP as it highlights the roles and responsibilities of all the actors in the group such as the chairperson, treasurer, secretary, member, etc. This section also details the fines and penalties as well as any funds collected by the group and its utilization for the benefit of its members.
	Membership registration	A table showing the names of different member households in the group.

4.3.5 Implementation Framework

The detailed NWFP management prescriptions and implementation framework shall be included as a separate chapter within the broad area-based management plan, and the operation plans. The activities shall be implemented as per the By-laws, prescriptions and the provision of the FNCRR 2017 or any other revisions hereafter.

Box 4.1 Guidance for the Movement and Export of NWFPs (FNCRR 2017)

Guidance for the Movement and Export of NWFPs

Once an NWFP has been harvested the NWFMG or any member of the NWFMG shall obtain transit permit for movement of NWFP for commercial purposes from the CFO as per Annexure XI, XVIII of the FNCRR, 2017 and any other requirement specified by the Department;

Any NWFP/CF groups/ traders/ individuals transporting NWFPs from SRF, Private Registered Land and Community Forests shall obtain a transit permit as per FNCRR, 2017 or any other revision herafter. The transit permits shall be issued by the CFO/RO upon payment of royalty.

The Ministry may approve the export of any NWFP and its product from State Reserved Forest Land, for those species listed in the schedule approved by the Department.

NWFP originating from registered land/private forest/community forests shall be allowed for export with proper transit permit issued by the CFO after verification.

Upon obtaining export permit, the applicant shall process for Material Transfer Certificate and Phytosanitary Certificate from the relevant agency.

4.4. Monitoring and Evaluation

Monitoring and Evaluation is critical to gather information on the performance of a group, its products & production and provide suggestions for improvement of management in the future.

4.4.1 Monitoring

Field Offices shall regularly monitor the implementation of the NWFP management interventions. SFED shall annually monitor the implementation of NWFP management interventions. The monitoring shall focus on the implementation of the planned activities, and outputs which have been achieved or not acheved.

4.4.2 Evaluation

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall interventions. Evaluation of the NWFP interventions shall be done as part of the evaluation process of the area-based management plan as described in Volume III and IV of the *Code*.

Monitoring and evaluation of an NWFP group shall be carried out as per the Table 4.7 Questionnaires for Monitoring and Evaluation.

Table 4.7 Questionnaires for Monitoring and Evaluation

Questionnaire for monitoring and evaluation for Non-Wood Forest Product Management Group

Name of the Group:……

Dzongkhag:……..

Village……Gewog:…… ……Date:……..

I. Non wood Forest Products Management and Collection

Sl #	**Questionnaires**	**Answer (*Please tick only one box*)**
01	Which NWFP Spp. are collected for sale by the group in last three years?	1) 2) 3) 4) 5)
02	When do group collects NWFP products?	☐ Based demand from trader ☐ Based on demand from end users ☐ Even if there is no demand
03	Which collection system the group follows?	☐ Only in group ☐ Interested individuals
04	How many people from the household are eligible for collection?	☐ All able people ☐ Only experience ones ☐ One to two person from the household
05	Do you follow any harvesting guideline mentioned in plan during collection?	☐ Yes ☐ No
06	Did the group carried out plantation of important NWFP spp inside the collection area?	☐ Yes ☐ No
08	How often the group patrol collection area?	☐ Monthly ☐ Quarterly ☐ Annually
09	What is the group's experience on management of public resource by the group?	☐ Better protection ☐ Better regeneration ☐ Very challenging

II. Marketing and benefit sharing

01	Has group sold any NWFP so far?	☐ Yes ☐ No
	To whom the products were sold by the group?	☐ Within group member ☐ Through Auction ☐ Direct to traders by individual ☐ Trade fair ☐ On road side to buyer
03	Which species of NWFPs are mostly sought by trader/buyer?	1. _____2_____ 3_____ 4_____
	Who decides on price for the products?	☐ Individual collector ☐ Group ☐ Traders/buyer
05	If the price is decided by trader, was price offered by them to your expectation?	☐ Yes ☐ No
06	Who chooses trader for the group?	☐ Committee ☐ General members
07	Do the group have fund in savings?	☐ Yes ☐ No
08	Has group shared fund so far?	☐ Yes ☐ No

III. Group governance

01	How often general members meet in a year?	☐ Once a year ☐ Twice a year ☐ Thrice a year ☐ As and when required
02	How often the committee members meet in a year?	☐ Once ☐ Twice ☐ Thrice ☐ More than tree
03	What agendas are discussed in	☐ Work plan and implementation ☐ Related to acount and benefit sharing
04	How many members attend meeting?	☐ All ☐ Half

		☐ More than half
05	Who decides on sharing of resources and benefits derived from sale of NWFPs?	☐ Committee members ☐ General consensus
06	Could the group enforced by laws framed in the management plan?	☐ Yes ☐ No
07	Who conducts auditing of group activities?	☐ Forest officer ☐ Dzongkhag Internal Auditors ☐ Group's auditing team

IV. Resource condition in the forest and way forward

01	What is the group's view on the condition of resources in the collection area?	☐ Increasing ☐ Decreasing
02	If the resources in the forest are decreasing do the group have plan to do plantation?	☐ Yes ☐ No

4.5. Bibliography

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5. Pest and Disease Management

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5. Pest and Disease Management

5.1. Forest Pest and Diseases

5.1.1 Management Context

5.1.1.1 Background

Disturbances from forest insects and pathogen can severely disrupt forest ecosystem by causing mass mortality of trees. While insects and pathogens have co-evolved with its host species and are established elements of ecosystem; which play an important role in forest rejuvenation and nutrient recycling, it can cause serious problems when it attains the status of pest and interfere with the management objective and goals. An insect or pathogen becomes a pest only when it causes unacceptable negative impact to the conservation and management objectives. Nevertheless, it is difficult to determine, when and under what circumstances, an insect and pathogens can be considered a pest. Forest pests are an intrinsic part of forest network as they affect and get affected by the ecosystem. Pest condition can only exist when proper condition such as the causal agent, appropriate host and suitable environment coincide. By understanding the conditions which lead to pest situation, we can reduce the losses by altering any of the three conditions such as reducing the population of the causal agent, improving the vigor of the host plant or by altering the stand and site condition.

For Bhutan where livelihood and economy of the country is intricately intertwined with forest, it is vital to ensure that flow of ecosystem services are not perturbed by biotic disturbances (plant, animal, insect or pathogens). Outbreak of *Ips schmutzenhoferi* on *Picea spinulosa* and *Pinus wallichiana* and *Ips longifolia* on *P. roxburghii* during early 1980's indicated that pest and disease can pose a great threat to forest management, conservation and biodiversity of Bhutan (Donaubauer, 1986). In addition, climate change directly impacts the plants, animals and the functioning of entire ecosystem resulting in alteration of migration, flowering and development. The frequency, intensity and timing of drought events, forest pests and diseases outbreaks may be altered which may make forest ecosystem more vulnerable against aggressive forest pests and diseases.

Early detection and reporting of insects and pathogens which could potentially attain pest status under favorable conditions could help in preventing loss and minimizing ecological damage. Normally, during pest and disease outbreak, the purpose is not to eliminate the insect or pathogens but to bring down the impact to acceptable or manageable level. It is necessary to detect the forest health problems early on to ensure necessary steps can be taken to mitigate the loss and impacts. It is, therefore, important to incorporate forest health surveillance into the daily activity of the field officials, build their capacity in detection and identification of problems so that it can properly evaluated for appropriate actions.

5.1.1.2 Objectives

The main objectives of forest pest and disease management are to:

- keep forest healthy and improve resilience to pest and disease and other environmental stressors; and
- prevent insect and pathogen outbreak and mitigate impact on forest ecosystem productivity.

5.1.2 Roles and Responsibilities

The roles and responbilities for different offices under the Department under described in Table 5.1.

Table 5.1 Roles and responsibilities

Offices	**Roles and Responsibilities**
Forest Protection and Enforcement Division (FPED)	• Focal agency for Forest Pest and Disease Management. • Coordinate forest pests and diseases management activities. • Collect information on the forest pest and disease outbreak from field offices. • Provide technical prescription in consultation/colloboration with UWICER and FRMD.

Forest Resources Management Division (FRMD)	• Liaise with FPED and UWICER for forest pests and diseases management. • Review and process approval for sanitation operations.
Ugyen Wangchuck Institute of Conservation and Environment Research (UWICER)	• Conduct research on the insects and pathogens. • Presrcibe technical recommendation for pest and disease management. • Impart training to forestry professionals on management of forest pest and disease.
Field Offices	• Monitor pest and disease outbreak in their jurisdiction • Report any incidences of pest and disease outbreak to the FPED • Conduct impact and damage assessment • Conduct sanitation operation in coordination with authorized agency.

5.1.3 Causes of Plant Injury

Both biotic and abiotic factors may cause injury and mortality of trees. Some common causes of tree injury in Bhutan are listed in Table 5.2.

Table 5.2 Common causes of plant injury in Bhutan

Biotic			Abiotic		
insects	Pathogens	Wildlife	Weather	anthropogenic	natural calamities
bark and wood boring beetles	Root fungi	Ungulates (deers)	drought	fire	land slides
Defoliator	Blue stain fungi		wind	pollution	poor soil
Gall producers	Blister rust fungi		frost and snow	chemical	floods
White grubs	Blight fungi			mechanical injury	
Surface caterpillars	Leafy mistletoes				
	Dwarf mistletoes				

5.1.4 Integrated Pest Management in Forestry

Integrated pest management (IPM) is not a technique or action when dealing with pest situation but an approach considering all aspects of the pest triangle. It consists of a decision-making process and strategies to regulate pest population to minimize the effects in an ecologically sound manner. The decision-making process considers the interaction of agent with host and its environment, the management objectives, economic scale of the resource. Such information is required to decide on the alternative action or strategies to prevent loss. While one or more approaches may be used, emphasis shall be to retain the natural systems and include cultural, mechanical, chemical, regulatory or biological tactics. The best IPM practice depends on the habitat, forest and the forest management practices applied, and therefore vary from region to region.

IPM is a continuous process and shall include monitoring to measure success, gather additional information, identify knowledge gaps and implementation of new know how.

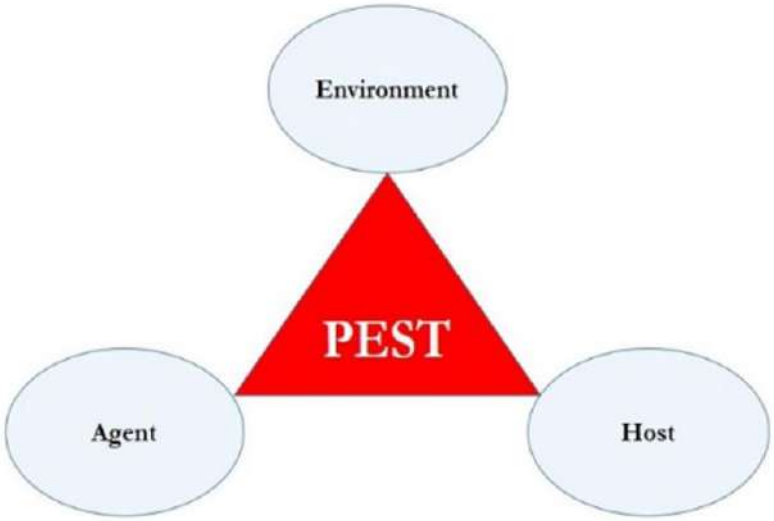

Figure 5.1 The Pest Triangle

5.1.4.1 Components of Integrated Pest Management

Broadly, the IPM can be classified into five steps which function as a part of a continuum. It includes prevention/avoidance, detection, evaluation, suppression and monitoring.

Prevention/ Avoidance

Taking necessary steps to avoid any pest situation is the essential step of IPM. These measures include:

i. Quarantine to avoid introduction of alien species

ii. Cultural measures to improve site and stand condition

iii. Removing alternate host

iv. Avoiding mechanical injury to host trees

v. Using chemical control

vi. Using natural predator and bio controls

vii. Tree improvement or planting disease resistant trees.

Detection

Detection is the discovery, identification and recording of insects, pathogens, animals, plants and environmental stressors which could cause potential damage to forest. Generally, detection of pest can be done through surveillance which is a part of regular duty of forestry officials or through planned surveys which are organized for specific purposes. The field offices shall submit the inspection report (Form 5.1 and Form 5.2) to the Department.

Form 5.1 Inspection Report for Forest Pests and Diseases

Inspection Report for Forest Pests and Diseases

ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF AGRICULTURE & FORESTS

Department of Forests & Park Services

This inspection report shall include the following;

1. **Division/Park**……..**Forest Range/Park Range**: ……

2. **Forest pests and diseases outbreak site**

Dzongkhag:……...Gewog:…… Village: .....……

Location…….. Area:……Ha Boundary shape file:…….……

3. **Detail on site parameters:**

Elevation……Aspect……

4. **The details on forest pests and diseases:**

Sl.No	Name of pests/disease if known	Forest types	Host	Severity	Approximate Area affected (Ha)	SRF/CF/FMU/PF

Symptoms and signs:

5. Photographic evidence

6. Remarks from of the Inspection team:

Form 5.2 Damage assessment report

Damage Assessment Report for Forest Pest sand Diseases

ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF AGRICULTURE & FORESTS

Department of Forests & Park Services

This inspection report shall include the following;

1. **Division/Park**……..**Forest Range/Park Range**: ……

2. **Forest pests and diseases outbreak site**

Dzongkhag:……...Gewog :…… Village: .....……

Location …….…….Area:……...(Ha) Boundary map……...

3. **Detail on site parameters:**

Elevation……Aspect……

Soil moisture…….Litter thickness……

4. **The details on forest pests and diseases:**

Sl.No	Name of pests/disease if known	Forest types	Host/species	Severity	Area affected (Ha)	LFMP/SRF/CF/FMU/PF/PA

5. **Tree description:**

Sl.No	DBH	Tree Ht(m)	Severity (light, medium & heavy)	Other visible infestation/damage (symptoms and signs)	Remarks

6. Collect affected sample including soil:

7. GPS Map polygon attached.

8. Photographic evidence

9. Remarks from of the Inspection team:

Box 5.1 Do's and don'ts for sample collection

- Samples must be collected and stored properly to be useful for these more detailed investigations.
- Collect a number of plants with a range of symptoms. Include a range of healthy, symptomatic, and recently killed plants.
- Deliver samples as soon as possible after collecting.
- Soft plant tissues, mushrooms, vascular tissue, samples containing microorganisms, and living insects should be shipped overnight/next day when possible
- Do not seal samples in plastic bags for more than a few days.
- Pack samples in a sturdy box adequately filled with packing material so that sample does not get crushed.
- Keep the sample in a leak-proof plastic bag or container.
- Include all relevant documentation and pictures in a sealed plastic bag.

Evaluation

This process includes collecting adequate data on the pest situation, analyzing the available information, predicting damage and propose remedies. Evaluation considers all aspects of pest triangle (Figure 5.1) and offers management strategies that are economically, biologically and environmentally feasible. Evaluation process shall provide forest managers with sufficient information to make a decision to deal with the problem.

Suppression

Suppression is reducing pest related damage to acceptable levels by applying various techniques separately or in combination such as silvicultural, biological, mechanical and chemical. The intent is not to completely eliminate the pest but to reduce the damage to an acceptable level defined through expert judgement, so that management and conservation objectives are met.

Monitoring

Monitoring is an assessment to determine how the prevention and suppression methods used have met the intended objective. Notwithstanding, in the context of IPM, it is preferred to evaluate the whole process rather than just the elements of prevention and suppression to improve implementation of IPM.

Figure 5.2 explains process for effective pest and disease management in Bhutan.

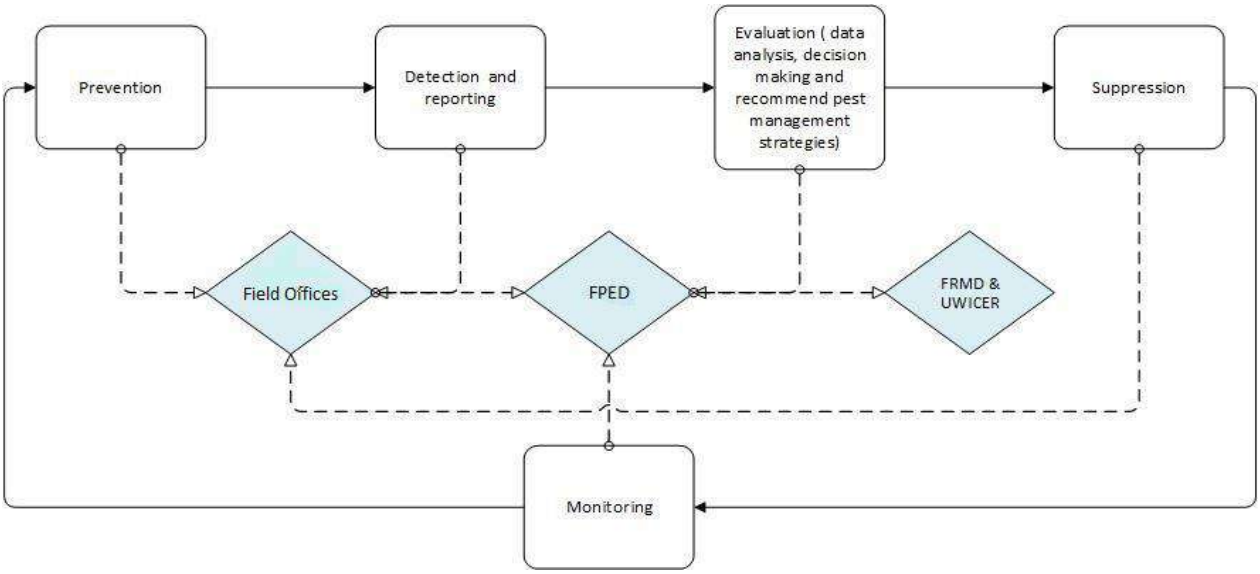

Figure 5.2 Forest Pest management Process

5.1.5 Management of Important Forest Pests and Diseases

Table 5.3 describes the descriptions and management of important Forests Pests and diseases in Bhutan

Table 5.3 Important Forest Pests and Diseases

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
1	***Ips schmutzenhoferi*** (Bark beetle)	Eastern Himalayan spruce (*Picea spinulosa*), blue pine (*Pinus wallichiana*), and larch (*Larix griffithiana*).	-The green tree changes colour of the needle (grey, yellow brown or red) -There is flow of resin from the attack hole. -Saw dust seen on the bark, at the base of the trunk and on surrounding bushes and weeds -Falling of needles from the attacked trees. -Formation of galleries or tunnels inside the bark and on cambium or sapwood portion. -Presence of eggs/larvae/adult (depending on season) under bark and outside trunk confirms infestation by the beetle. -Wood peckers feed on larvae/pupa/ adult beetle.	-Immediate removal of wind thrown, suppressed, dead, diseased, weak, broken and hanging spruce or bark beetle/blue pine trees to reduce source of infestation. -Proper debarking of logs and stumps, lops and tops and branches up to 10cm diameter -Regular patrolling for detecting attacked trees.	***a. Sanitation measures*** -Felling, debarking and crosscutting of attacked trees shall be organized immediately. -If the attacked logs harbor adult beetle gunny bags or tarpaulins shall be spread below the logs before debarking to prevent beetles from escaping. -All bark, wood dust and beetles collected are burnt in case there are adult beetles. -If larvae are found in the bark, they shall be exposed to sun heat for killing -Debarking of all fresh timber from stump to lops and tops up to 10 cm diameter shall be done. -Initial marking shall be guided by an experienced forester to identify the affected trees. -Freshly attacked trees shall be removed on priority basis ***b. Use of trap log system*** -A sound host tree for beetle is felled and cut into logs after debranching. -The stumps, lops and tops and any cracked part of the tree are debarked to prevent breeding of beetles. -The logs with bark intact can be covered with branches to avoid surface drought and to improve attractiveness. -The trap logs shall be placed at a distance of 5-1- m from the standing host tree.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
					-The logs must be numbered and registered to monitor the attack of beetles. -The logs are debarked when they are fully attacked and larva development starts. -Trap logs shall be debarked before larvae turns into pupae. -White larvae shall be exposed to sun heat. Then burning of bark is not necessary. ***c. Use of Pheromones and pesticides*** Insect pheromones are chemical substances which the insects use to attract their partners for aggregation, mating and to invade the host. Artificial pheromones are produced to attract insects in this way. Bark beetles can be trapped in large numbers and later destroyed. Some form of pesticides can be also used in controlling the population of bark beetles. The pesticides cannot penetrate deep into the bark, but have to be applied before the new bark beetles leave the host or logs to attack next green trees. The beetles get poisoned and die while leaving the tree. The advantage of this method is that no debarking is needed. As the application of pesticides is not environmental acceptable, its use is very limited. The use may only be recommended, when there is no other option and the chemical has the least effect on the environment. ***d. Integrated methods*** This method combines the use of the trap log system, pheromones and pesticides

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
					application on a single control venture of the beetles.
2	***Hoplocerambyx spinicornis*** (Sal borer)	*Shorea robusta* (Sal)	-Dying-off from the crown (Reddish or yellowish) downwards by sudden withering of the foliage in autumn or spring and profuse exudation of resin at points where the first stage larvae bore through the bark -Old attacked trees usually have completely dead top but the lower branches are still green. -In freshly trees lots of frass at the base of trunk and undergrowth is visible. -Presence of tunnels like holes of larva in the sapwood. -Matured larva in the tunnels of sap/heartwood when the tree is spilt. -Dark colour of wood dust indicates that the larva has penetrated into the heartwood. -A large number of wood peckers holes on the tree due to feeding on the larvae.	-Regular patrols must be carried out to check borer infestation -The felled or wind-fallen or infested standing timber shall be debarked and dispose immediately to prevent breeding of borers. -Sal plantation shall be thinned from time to time to reduce over stocking and to increase the vigor of the stock. -Remove dead, weak, suppressed, damage and disease trees for improving the future growing stock and to prevent breeding of borer. -The most effective protection is to undertake felling during October to March when borer are not on wings and are not laying eggs. -Debark all logs, stumps, big branch wood, butts, forks, off-cuts, slabs etc. up to 8 inches diameter	-The attacked trees shall be felled and debarked to expose the larvae to predators. -In case of severe infestation of beetles in the forest, one trap log per hectare may be provided in the affected area. The beetles are attracted by the freshly oozing sap and get intoxicated by drinking the sap. The beetles are then collected by laborers before sunrise every day and killed by dropping in kerosene oil. The trap log shall be disposed off after completion of trapping operations. -The infested logs if not spilt to expose larvae shall be taken at least 5KM away from the sal forest. -The population of the borers can be biologically controlled by raising and releasing of parasites like *Ichneumon* and *Bothrideres* fly. The grubs of these flies are either external or internal parasites of the larvae of *Holocerambyx*. (Trap log method: A log is cut from a freshly felled tree. The bark of one end of the log is smashed 1-2 feet in length to produce sap that can attract the beetles. When the beetle catch lowers, additional bark is smashed 1-2 feet from the earlier smashed end. It is continued till the entire log is completed. If beetles persist in the area, start with a new trap log. Do not forget to check for beetles in the logs which are felled, but not to use as trap log.)

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
				that is left in the forest after felling.	
3	***Hyblea puera*** **(**Teak defoliator)	*Tectona grandis* (Teak)	-Due to excessive feeding by the defoliators, complete defoliation of the tree can be seen leaving only branches and stems. -In extreme cases, it can cause diebacks and forking of branches. -If the tree is repeatedly attacked by the defoliation, there shall be development of epicormic.		Since the life cycle is very short and infestation expected to be high, the pest must be controlled soon after observation. Never give time for the pest to build its population. ***a. Silvicultural control*** -Large pure teak plantations shall not be raised. -Pure teak stands shall be separated by strips or zones of natural forests. -The strips may be further strengthened by eradicating the food plants of the pest by introducing certain desirable species. -There shall be strict fire protection in the area. ***b. Biological control*** The pest maybe controlled by breeding and release of *Cedria paradoxa*. The fly is predator of the larvae of the pest. ***c. Chemical control*** As the pest has quick succession of generations covering up to 14 generations annually, it is not very economical to use chemicals for controlling the pest. Some chemical sprays may only be recommended in nurseries and small scale plantations.
4	***Urostylis punctigera***(Champ defoliator)	*Magnolia pterocarpus, M. insignis,*	-Wilting and crinkling of young leaves.	-The best way of preventing the damage by the nymphs is	-Young plantation shall be regularly inspected in order to discover the incidence of bug.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
		Michelia champaca, M. excelasa, and *M. oblongata*	-The brown spots are seen on lower surface of older leaves and gradually spread to upper surface and adjacent spots coalesce to form a brown patch which shall ultimately turns white except at the edge. -In extreme case, the leaves turn yellow and later fall. -Attacked leaves have the smell of bug. -The leaves that are severely attacked turns yellow and fall. -The attacked shoots show brown patches and bands just below the epidermis.	shaking the infested portion	-Operations shall be concentrated on early stage nymphs clustered on young leaves. -Smoking shall be done by burning thatch grass or straw or cowing cakes. When the smoke reaches the young nymphs, the bugs starts falling on the ground. -In order to protect tree from re-ascending by the nymphs, circular band of sticky substance or grease or fresh cow-dung has useful effect.
5	*Labeda nobilis* (Chir defoliator)	Chir pine	-Attacked trees have very less or no needles. -Trees look totally dead when it is severely defoliated. -Hairy caterpillars can be seen crawling down or climbing up on the tree trunk and branches and even on the ground. -Lot of fallen needle on the ground. -The sound of falling larval droppings. -Attack can be noticed in patches form. -Cocoons can be noticed on the ground as well as on branches in later stage.	-Strict fire protection in order to promote biotic control. -Promote regeneration of broad leaved species to avoid pure chir pine stands.	**a. Mechanical** -Collection of caterpillars and cocoons is the simplest remedy in case of small plantation. -Trapping of the moths at night. (Above control measures are not practical in case of its outbreak in natural chir stand). **b. Natural control** -The caterpillars are attacked by Nucleopolyhedrosis virus and their population is reduced to a great extent. -The caterpillars are voracious feeder and many suffer and die due to lack of sufficient food at the time of mass outbreak.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			-Eggs can be noticed in the needles during cold periods.		
6	***Calopepla leayana*** **(**Gamhar defoliator**)**	*Gmelina arborea*	-Defoliation is first noticed on the onset of rainy season. -Large circular holes are present on the leaves resulting from feeding by larva. -Damage of young buds and shoots due to feeding by larva. -Complete skeletonisation of leaf leaving only midribs and main veins by 4th and 5th instar larvae. -Heavy attack causes the leading shoots of young trees to dry up and remain leafless.		**a. Silvicultural** -*G. arborea* shall be planted only on suitable sites. -Pure plantation of *G. arborea* shall be divided into strips to provide more light. **b. Mechanical** -Beetles hibernating in shelters (e.g. underbark, cracks, and hollows) can be collected by hand and destroyed. This can be facilitated by destroying the majority of natural shelters in order to force the beetles to congregate on the few remaining shelters. -The beetles can be trapped by white surfaces: using a large sheet of white cloth or metal having a central funnel. **c. Chemical** -Under severe infestation the foliage along the edges of plantations are sprayed or dusted during the migration of beetles.
7.	*Lambdina sp*	*P. roxburghii* (primary host), *Quercus lanata, Coriaria nepalensis,*	-The needles of the infested trees turn reddish brown as a result of defoliation. -They are bound by a silken thread produced by looper before they fall on the ground.	-Elimination of old-growth stands reduces the damage.	The pest is always present in the nature and their population is regulated by the natural enemies like the predators, parasites and viral diseases. Nucleopolyhedral virus disease and *Tachinidae* parasites play a vital role in controlling the population of larva and pupae

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
		Emblica officianalis, Rhus paniculata, Artemisia vulgaris, Cupressus.	-Presence of feeding scar on the upper surface of leaves.		of *Lymantridae*. The epidemic outbreak is followed by sudden disappearance of the pest.
8	***Plecoptera reflexa*** (Shisham defoliator)	*Dalbergia sissoo, D. latifolia* and *Pterocarpus marsupium.*	-The close inspection of the defoliated leaves shall reveal one egg per leaf. -When the caterpillars are disturbed they drop at the end of silken thread. -When foliage is completely destroyed, large armies of caterpillars may be seen moving over the ground in search of fresh hosts. -Growth of plant is hampered to a large extent due to defoliation. -Repeated or persistent attack may lead to the death of the tree.		Combined silvicultural and biological practice provides the most effective control of the pest. a. ***Silvicultural measures*** -Shisham shall be only raised where soil condition is good with sufficient moisture. -Raising methods shall be adopted that trees produce flush of young leaves before the caterpillars are hatched, as caterpillars feed on young and succulent leaves. -Early thinning operations in plantations are desirable. ***b. Biological measures*** -The insect pest has many enemy parasites. The pest population can be controlled by release of *Disophrys sissoo* and *Microgaster plecopterae*.
Important Forest Diseases					
1.	***Armillaria mellea***	Hardwoods species and conifers (blue pine)	-The trees loose their needles beginning with the oldest and progressing to the youngest. -The colour of the tree crown uniformly changes to yellow or red.	-Choose resistant or resilient varieties. -Good drainage and avoid water stagnation near the trunk.	-All stumps shall be removed in plantation site that has risk of *A. mellea* attack. -Since the fungus is prevalent in moist and damp site, proper choice of sites can minimize the fungus outbreak.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			-The most distinctive feature is the thick, fan-shaped mat of white mycelium in the root region. -Presence of diagnostic black strands of the fungus called rhizomorphs (shoestrings). -Presence of white fans of fungal growth with "mushroomy" odors under the bark and the occasional growth of honey mushrooms at the base of infected trees in autumn. -In advanced attack the wood becomes soft and spongy with dense mycelium threads. -The fungus finally decays root and kills cambium in roots and root collar. -The infected trees are susceptible to bark beetle attack.	-Prune diseased branches and burn it.	-The attack can be reduced by raising mixed plantation and introduction of disease resistant species, as the parasite is often specific in its attack. -Spread of root disease under the soil is prevented by making isolation trenches in between rows of trees. -Wider spacing and regular thinning may minimize the incidence of the fungus infestation. -The outbreak of the fungus can be controlled by timely removal of killed trees and bushes.
2.	*Fomes annosum*		-The fungi colonize the cambium at the root collar and gridles the tree. -Display typical root disease crown symptoms. -Incipient decay appears as yellow-brown to red-brown stain. - The trees loose their needles beginning with the oldest and progressing to the young.	-	***a. Silvicultural control*** -As the fungus is present on dead roots, complete removal of stumps and residual roots to elimate the fungus is essential. Even a small infected root is left behind on the site may initiate new infection. -The attack can be reduced by raising mixed plantation and introduction of root disease resistant species.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			-The colour of the tree crown uniformly changes to yellow or red. -Presence of fungus fruit bodies at the base of infected trees. -Fungus produces white pocket rot in the wood. -Butt rots result loss of most valuable portion of the tree due to decay in the heartwood and reduction in growth due to death of roots. -Decay in roots result in wind-throw of trees.		-Since the fungus is prevalent in moist and damp site, proper choice of suitable sites can minimize the fungus outbreak. -The spread of the root disease under the soil can be prevented by making isolation trenches in between lines/rows of trees. -Wider spacing and regular thinning may minimize the incidence of the fungus infestation. ***b. Biological control*** It includes introduction of non-pathogenic competitors like *Peniophora gigantea*. This can be done by inoculation of pine stumps with *P. gigantea* soon after felling, as it is a vigorous competitor with *F. annosus*. ***c. Chemical control*** The root rot in freshly cut stumps can be minimized by surface application of chemical (creosote, ammonium fluoride, sodium nitrite, urea and ammonium sulphamate) in order to prevent stump colonization by the fungus.
3.	*Ceratocystis bhutanensis* (Blue stain fungi)	*P. spinulosa, P. wallichi-ana, Larix grif-fithiana*	Cause blue, grey or black discoloration in the sapwood of living trees, logs and lumber, mostly on conifers. This fungi is associated with the spruce bark beetle in Bhutan. -Display typical wilt symptoms in crown, foliage becomes thin and chlorotic, needles drop prematurely.		Where the disease is known to occur, less affected species shall be favoured.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			-Extensive resinosis is usually present around the stained woods.		
4	*Cronartium ribicola* (White pine blister)	Blue pine	-Blister rust is fatal to seedling, sapling and pole sized trees. -Spindle shaped swellings on branches and cankers on main stem with heavy pitch flow, flagging of infected branches, thinning crowns, top kill and death of infected trees.		-Eradication of ribes by digging or pulling the bushes by hand or spraying with herbicides.
4.	***Taxillus kaempferi*** (True mistletoes/ leafy mistletoes)	*P. wallichiana*, *Tsuga dumosa* and occasionally also on *P. spinulosa*	-In comparison to *Arceuthobium*, diagnosis of this mistletoe is easier, because it is a bigger and much more conspicuous plant. *T. kaempferi* which grows up 1.5 m high and appears as green, bushy growths hanging from infected branches. -They are attached are attached to their hosts by modified roots called haustoria or sinkers. Branches may become swollen at the sight of infection -Attractive red flowers are seen in May to July and its orange fruits. -Parts of branches distal to and tree tops above *T. kaempferi* infestations show die-back several years after infection,		-The damage can be minimized by maintaining sanitation during silvicultural operations. -Infested trees, especially heavily infested ones shall be removed during stand entries. -Minimized by manipulating the light regimes of stands by thinning intervals and thinning intensities. -The use and admixture of non-host species, especially hardwood trees is another option for disease management.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			especially when trees are infested by several mistletoe plants.		
5.	***Arceuthobium minutiissimum*** (Dwarf mistletoes**)**	*P. wallichiana.*	-Bushy growth, thick branching habit and big bushy structures hanging on the trees. -Witches broom formations on the infected branches are characteristics of this disease. -Swellings, cankers, swelling trunk abnormalities are observed on twigs and branches. -Presence of male and female plants on infested shoots of host plant. -Tree form, health, size, height and diameter growth may be affected. -Attack by bark beetles on infested and weakened trees.	-Setting up natural and manmade barriers like roads, streams, meadow etc. -Clear cutting the area before reforestation. -Leave uninfected seed trees or shelterwood when possible. -Removal of infested trees as far as possible. -Monitoring of forest stands -Promote resistant host trees plantation	-Sanitation felling of infested trees. -Complete removal and disposal of infected trees/stands is the best solution. -Pruning of infected branches and disposing them.
6.	**Drought injury**	All conifers and hard woods	Drought injuries occur on extremely dry sites which is caused by periods of subnormal rainfall. Severity of damage may vary from slight injury to the foliage to complete tree death. -Trees die from the top down. -Discolouration of the foliage, which maybe proceeded by wilting.		Salvage of drought injured trees and reforestation with more site suited species are suggestions for management.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			-In conifers, the needles turn reddish-brown in the beginning with the youngest, and the dicolouration takes place in late summer, autumn or early winter. In hardwoods, the leaves turn yellowish to reddish, beginning usually at the tip or margins, but occasionally midway between the veins, until the entire leaf is involved. Premature leaf fall commonly season is effectively shortened.		
Nursery Pests and Diseases					
1	**Cockchafers** (white grubs)		Cockchafer grubs are mainly root feeders. They kill seedlings by destruction of rootlets or removal of bark of tap root. Adults feed on tender leaves. -An attacked plant becomes pale, gives wilted appearance and finally dries which can easily be pulled out. -In heavy infestation, fields show patchy appearance due to withering of plants	-Seedbeds shall not be prepared in hot weather or beginning monsoon to prevent oviposition. -Sowing shall be done in autumn, winter or spring when the beetles are not on wings and cannot lay eggs. -If soil working is done during oviposition period, the soil shall be covered with a layer of charcoal, sand or sulphur. Sowing shall be done by removing the covering in line and	-The white grubs are big and easily picked up by hand and destroyed. -Some of chafer grub travel at night and they can be trapped by sinking tins or earthen pots beside the nursery beds. -When presence of grub is noticed, the nursery bed if flooded with water the grubs shall come to the surface due to suffocation. At this time hand picking is suggested. -Some chemicals such as carbon disulphide, CaCN, Nepthaline, Acetic acid, Aldrin dust, B.H.C can be used in small areas. • CaCN may be applied in 10 cm deep furrows between rows of seedlings at the rate of 70 gm per sq. m. • Grubs are killed by spreading Nepthaline crystals on moist soil at the

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
				putting it back after sowing. Cover shall be removed after the danger period is over or the soil has compacted. -Transplant bed that is not immediately used shall be watered with crude oil or kerosene emulsion. Rigorous watering must be done for the chemical to penetrate deep into the soil. -Avoid weeding during the flight period of beetle, as it facilitates oviposition. -To prevent wandering of grub from neighboring bed, the bed shall be edged with planks as deep as possible and covered with 5 to 6 mm wire mesh. -Grubs can be prevented by treating soil with 0.8 % acetic acid at the rate of 9 litres. per sq. m. This shall also check damping off.	rate of 2.7 kg per sq. m. • Aldrin dust and B.H.C can control the grub by applying 32 gm per sq. m. mixed with soil at the time of seedbed preparation.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
2	Cutworms (surface caterpillars)		The most obvious damage resulting form cutworm is clipping the seedlings at the ground level retarding the growth of plant.	-Keep the nursery beds clean through constant weeding. This is to prevent oviposition and food sources of larvae. -Loose soil shall be compacted to prevent oviposition. -Avoid soil working during flight and oviposition period.	-The larvae can be collected by hand and destroyed. -Leaves and weeds can be heaped for attraction of cutworms and destroyed next day. -Cutworms can be killed by baiting with a mixture prepared of bran 2.5 parts, sodium fluoride 1/6 part dry and then in a mixture of molasses 1/4 part and water 4 parts by weight. The mixture spread at the rate of 2.25 kg per 100 sq. m. in the affected area after sunset. -Flooding of nursery bed and hand collection is also effective control measure. -In the absence of poison, seed beds may be dusted thickly with wood ash or a mixture of quick lime and ash as a repellent.
3	Cricket and grasshoppers		Crickets and grasshoppers are other injurious pests of nursery. They feed on young seedlings and shoots cutting them at night. The cut materials are dragged into the tunnel for feeding.		-The freshly made tunnels are flooded with water or water mixed with kerosene. This shall force the crickets to come out and be killed. -Crickets can be trapped by sinking earthen pots or tins filled with water or water mixed with some kerosene. -Half cut pumpkins are set as bait and covered with weeds in the evening, where crickets take shelter and they can be killed next morning. -Grasshoppers are killed by handpicking or setting baits. Young foliage can be controlled by spraying with 0.5 % Aldrin, malathion.
4	**Damping-Off**		Mortality of seedlings occurs at 3 stages during their growth 1. The seedlings maybe killed before they emerge above ground level due to pre-	As damping-off is heavy in wet soil, watering must be kept at a minimum during early	-Locate the nursery in a well drained site with light-textured soil and with no shade. If the nursery is raised in heavy-textured soil, sand shall be mixed to increase porosity and drainage.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
			emergence blight. The emerging crop is sparse. The losses due to such disease can be estimated by locating the killed seedling in the soil while germination is still in progress. 2. The seedling may be killed after emergence from ground level, as a result of rotting tissues at the base. 3. The older seedlings may die due to root rot underground. This is not too serious as the seedlings develop new roots if soil moisture conditions are favorable. But under severe drought condition, the seedlings may die altogether.	stages of seedling development. -The disease can be prevented by partial sterilization of the soil by steam or fumigants -The soil can be sterilized with chemicals like formalin and methyl bromide. The chemicals must be applied to the beds 10-15 days in advance of sowing by which time the toxic effects of chemicals are removed through volatilization. -When methyl bromide is to be used, the seedbed is first covered with thick polythene sheets with edges buried in the soil. The methyl bromide diffuses into the soil. The chemicals useful side effects are to control weeds, nematodes and insects. -250ml of commercial grade formalin is diluted with 4 litres water for 1 sq. m. of bed. -Use of proprietary chemicals such as	-The seed and soil can be treated with fungicides before and sowing. This give effective control of damping-off and other seed borne diseases.

Sl. No	Pests	Host	Symptoms	Preventative measures	Control measures
				Captan (24.5g per sq. m); Thiride (26.9g per sq. m) and Cuman (26.9g per sq. m) can sometimes effectively control the disease. Such chemicals are broadcasted and forked into top 15cm of soil one day prior to sowing. *pH ranges between 4.5 to 5.5 is considered to prevent serious damping off disease and maintain nutrient balance. Therefore, application of calcium containing fertilizers or liming is not necessary.* *-Soil treatment with chemicals is most effective control measure to ptotect conifer seedlings against damping-off.*	

5.1.6 Rehabilitation

Forests infested by pests and disease need to be restored and rehabilitated for multiple combined objectives, such as to enhance land productivity, produce wood and non-wood products, support livelihoods, contribute to poverty alleviation, provide environmental services etc. Therefore, if the extent of mortality of tree resulting from pest are large, the area needs to be restored and rehabilitated. Plantation shall be carried as per the plantation norms and standards described in Chapter Plantation and Nursery Management.

5.2. Wildlife Pest and Disease Management

5.2.1 Management Context

5.2.1.1 Background

The relationship between wildlife, domestic animals and humans in a shared environment is interlinked and complex. Drivers, in the form of an increasing human population, loss of habitat, biodiversity, climate change, and global trade and travel, to name a few, have resulted in spread of and an increase in emerging infectious and zoonotic diseases that threaten conservation, economy, public health and livestock.

Emerging infectious diseases consist of two major categories namely newly emerging and reemerging infectious diseases defined, respectively, as diseases that are recognized in the human host for the first time; and diseases that historically have infected humans, but continue to appear in new locations or in drug-resistant forms, or that reappear after apparent control or elimination

Zoonotic diseases are primarily of vertebrate animals that can be naturally transmitted to humans (in some instances, by a vector) and vice versa. Healthy wild animals are essential contributors to and excellent indicators of the health of the environment upon which we depend. A multi-disciplinary approach to wildlife health in Bhutan through a 'One health' approach involving human medicine, veterinary medicine and wildlife medicine is required to effectively address these threats.

5.2.1.2 Objectives

- Enhance care and wellbeing of wild animals.
- Prevent and manage the spread of diseases amongst themselves and transmission to human.
- Safeguard/ maintain a healthy wildlife population.

5.2.2 Roles and Responsibilities

The Nature Conservation Division (NCD) shall be responsible for conducting the risk analysis, developing the contingency plan for high risk wildlife pest and diseases, coordination and facilitation during outbreak management while the field offices would be responsible for reporting and assisting as per the ToRs highlighted in the Bhutan One Health Strategy and Wildlife Rescue SoP.

Table 5.4 Roles and responsibilities

Office	Roles and responsibilities
NCD	• Conduct the risk analysis and identify high risk/high priority diseases. • Develop contingency plan for high risk wildlife pest and diseases and harmonic with other existing plans. • Strengthen linkages at national, regional and international level. • Establish national and regional wildlife health centres and mobilise resource for wildlife health program. • Establish wildlife disease surveillance system and enhance capacity on wildlife health and disease. • Coordinate and facilitate during disease outbreak.
Field Offices	• Implement relevant documents/strategies related to Wildlife disease in the field level.

	• Report suspected or confirmed wildlife pest or disease incidents to relevant staff and agencies. • Assist with field investigation of wildlife pest or disease incidents which are suspected or confirmed to have a significant biosecurity impact. • Participate in informing local stakeholders regarding significant/relevant wildlife health incidents.
One health secretariat	• Share information to all relevant agencies. • Conduct collaborative research on zoonotic diseases. • Share and mobilise resources.
Department of Public Health, MoH	• Share information on disease that may spread at human and animals' interface. • Collaborative response during outbreak of diseases • Implement all strategies related to human health
Department of Livestock (AHD, NCAH, NVH, RLDCs, DVH)	• Implement all strategies related to animal health and collaboration, analysis and diagnosis of disease. • Provide support function in wildlife health incident responses, which may include biosecurity management, surveillance and infectious disease investigation • Provide general pathology and specialist laboratory services through NCAH Laboratory Service for diagnosis of notifiable or new and emerging infectious pests or diseases of wildlife • Provide technical support to setup lab, collaborate on research on wildlife diseases and resource mobilization
Bhutan Agriculture and Food Regulatory Authority	• Implement all strategies related to foodborne diseases and relevant animal health activities that are implemented jointly with the Department of Livestock. • Strengthen disease prevention at entry and exit points in the country • Biosecurity management • Provide support during disease outbreak investigation, RRT, Quarantine

5.2.3 Prevention and Control of Wildlife Diseases

5.2.3.1 Risk Analysis/Identification of Specific High-risk Diseases

Risk Analysis is a tool for the identification of potential problems and/or hazards, evaluation of their likelihood and probable magnitude. Risk analysis provide data to permit the effective management of risks. Risk analysis shall be based on the best available data, which may be quantitative or qualitative.

Quantitative assessment of risks associated with wildlife diseases is often difficult due to complex disease dynamics and absence of robust biological data. Qualitative assessments of risk are more common, within which, risks may be described as "extreme", "high", "medium" or "low" or a simple scoring system may be employed. Risk assessments shall be revised in the light of new data or changing circumstances.

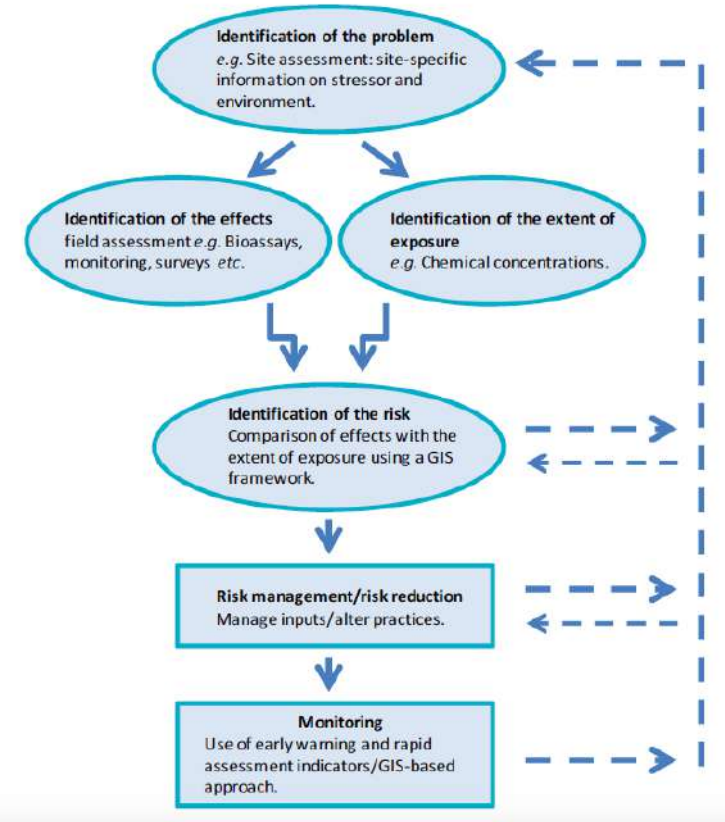

Figure 5.3 Risk analysis model/framework

5.2.3.2 Contingency Plan

It is advisable to develop contingency plans for specific high-risk diseases which incorporate generic standard operating procedures that may be common to several different specific plans. These shall be supported by additional financial and resource plans and supportive legislation to ensure enforcement of contingency plans when needed. Ethical issues shall also be considered when creating a plan.

Contingency plans shall be working documents that are subject to periodic review. Changing circumstances may require that a contingency plan be updated to retain its effectiveness in preventing and controlling disease. The effectiveness of a contingency plan in preventing and/or controlling a disease in a wetland shall be thoroughly evaluated after a disease outbreak response has ended, and recommendations for improvement shall be incorporated where necessary.

5.2.4 Management of Wildlife Health Incidents

5.2.4.1 Wildlife Diseases

Initial reporting and notification of wild animal health incidents

Initial reports on wildlife health incidents should be made to NCD through field officials, public, livestock vets, public health, media, etc. Collection of the following preliminary information is critical.

- species and numbers involved
- species and numbers of moribund vs dead animals
- age of affected animals (e.g. juvenile vs adult)
- clinical signs of affected animals
- date of observations and date of notification
- location and distribution (including if multiple locations are involved)
- any unusual environmental conditions (e.g. poor water quality, drought, construction)
- access of affected wildlife to domestic animals / livestock / captive populations.

Triage/confirmation of outbreak

Confirmation of outbreak of disease incidents needs to be verified based on the preliminary information, clinical inspection of animals, epidemiological status, etc., by the Incident Command Center (ICC) formed by the multi-disciplinary group consisting of experts from DoFPS, Department of Livestock (DoL) and other relevant agencies (e.g. epidemiologists, ecologists, Bhutan Agriculture and Food Regulatory Authority (BAFRA) officials).

Investigation

Diagnosis of disease and surveillance: Field and laboratory diagnostic strategies, linkages with national and international reference laboratories and surveillance strategies during different phases of a disease management programme shall be established.

Response

Principles and standard operating procedures for control and elimination to be followed**:**

- Methods for preventing and controlling disease spread and eliminating disease from the target area with detailed instructions for disease control activities shall be included where possible.
- Factors that may affect control and elimination.
- Feasibility of control and elimination in the target area

Appendixes for the Response plan;

- Full contact details of personnel needed before, during and after a disease outbreak.
- Full contact details of relevant bodies involved in outbreak responses national veterinary authorities and diagnostic laboratories
- Full contact details of relevant stakeholders.
- Criteria for defining infected areas and disease control zones.
- Justification for chosen methods through assessments of their cost and benefits.
- Summary of disease control actions in infected areas and other zones.
- Relevant national and international legislations and regulations for the disease if applicable (e.g. OIE International Animal Health Code).

5.2.4.2 Wildlife Pest/Conflict Management

Reporting and response shall be done as per the Bhutan One Health Strategy and Wildlife Rescue SoP or any other update hereafter.

Surveillance/ Reducing risk of Disease Emergence

Conducting frequent wildlife disease surveillance increases the likelihood of detecting new infectious and zoonotic diseases early, so that rapid response can be initiated, thereby reducing disease impact on livestock, human and wildlife populations. Wildlife disease surveillance can also be used to detect existing disease and reservoir hosts, and inform the management to mitigate the impact of disease. Wildlife disease surveillance programs can be integrated within existing national animal health surveillance systems within the Ministry of Agriculture and Forests (MoAF) resulting in a holistic comprehensive approach to animal disease surveillance in Bhutan.

A combination of passive and active surveillance shall provide most information. Types of surveillance are discussed below, along with sampling methods. Wildlife disease surveillance presents inherent challenges, and generally increased cost, compared to livestock and humans disease surveillance programs.

5.2.5 Standard Operating Procedure

The following Standard Operating Procedure/Wildlife Rescue Command System provides the basic steps in dealing with incidents of wild animals straying into human dominated landscapes and crop fields (Trapped/snared, orphaned, injured or diseased).

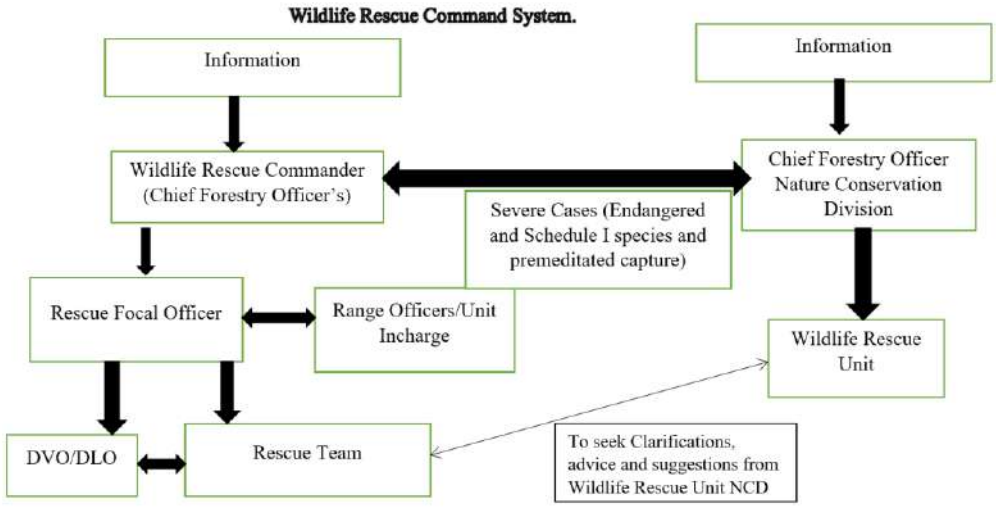

Figure 5.4 Wildlife Rescue Command System

5.2.5.1 Information Collection

- Upon receipt of information on wildlife casualties, the wildlife rescue team shall gather all the detail information (animal species, condition of the animal, location, road accessibility, trapped /snared/orphaned, etc.) of the field situation through telephonic conversation with the concerned field official.
- The Wildlife Rescue Commander shall arrange the necessary mobility facility.

5.2.5.2 Preparatory Phase

- Check all the wildlife rescue equipment's (Box 5.2) and drugs for chemical immobilization (for chemical restraint) and human anti-dote in case of accidental human exposure to narcotic drugs.
- Appropriate crates for different animal species.
- Other necessary equipment's and items as per the information received.

Box 5.2 Check List of Equipment's for Wildlife Rescue

1. Projectiles.
2. Spare CO_2 cartridge.
3. Medicine Kit (Ensure that all the required drugs (Agonist/Antagonist) and dan-inject projectiles accessories are in place.
4. Different sizes of disposable syringes and needles.
5. Sterile water (for topping off darts).
6. Blood, Fecal and Hair Sample collection kits.
7. Different crates for animal transportation.
8. Animal carrying rug.
9. Heavy duty wire cutter.
10. Pulley and Rope.
11. Pliers/Multi-tool (Knife blade, screwdrivers etc).
12. Animal Restraint Record Form.
13. GPS/Camera/Notebook/Pencil/Binoculars/Rage Finder
14. Gloves (Leather/Plastic).

15. Flash light.
16. Blind Fold Cloth.
17. Hobbles
18. *Patang*

5.2.5.3 At the site (Concerned Field Officials)

- Avoid crowding of people around the animal.
- Physically confirm the animal species, condition, status of traps, etc.
- Never approach the animal very closely.
- Talk in soothing tones and avoid high-pitched and excited voice.
- Avoid direct eye contact with the animal but maintain safe visual contact.
- Do not rely on third party information and never provide incorrect information.

5.2.5.4 Restraint Methods

- Rescue team shall decide whether the animal shall be restrained physically or chemically (depending upon animal species, situation, condition of animal and safety)
- Physical restraints is preferred over chemical immobilization in most of the situation
- Both physical and chemical restraint methods can be combined in certain situation.
- Follow the general safety precautions (Know the defense mechanism of the animals, potential threat of accidents/injuries, zoonosis, etc.)

5.2.5.5 Drug Dose calculation and Dart Preparation (For Chemical Immobilization)

- Estimate the weight of the animal.
- Prepare the drug volume as per estimated body weight.
- *Calculate the total volume / dose:*

$$\text{Total volume (ml)} = \frac{\text{Dose rate (mg/kg) x Body weight (kg)}}{\text{Drug concentration (mg/ml)}} \quad (4)$$

- Ensure to use Personal Protective Equipment's (PPE) during drug preparation.
- Other members to keep safe distance from the person who is preparing the drug.
- Narcotic drugs are ***contraindicated*** for felids.

Box 5.3 Drug dose chart

Drug Dose Chart

Animal Species	**Approximate Body Weight**	**Agonist**	**Recommended Dose Rate**	**Antagonist**
Asiatic Black Bear	80-175kg	***Zoletil 100mg/ml*** (Zolazepam-Tiletamine 100mg/ml) ***Captivon98*** (Etorphine Hcl 9.8 mg/ml) **Ketamine 100mg/ml** Medetomidine 1mg/ml	3-5 mg/kg 0.098mg/kg **(i.e 1ml/upto 150 kg)** 1.5mg/kg 0.04mg/kg	None ***Activon*** (Diprenorphine Hcl 12 mg/ml) Atipamezole Hcl 5mg/ml(0.2mg/kg)

Asiatic Water Buffalo	800-1200kg	***Captivon98*** (Etorphine Hcl 9.8 mg/ml)	0.030mg/kg	***Activon*** (Diprenorphine Hcl 12 mg/ml)
Asiatic Elephant	5000kg Males 4000kg Female Average = 2720kg	***Captivon 98*** (Etorphine Hcl 9.8 mg/ml)	0.003-0.006mg/kg	***Activon*** (Diprenorphine Hcl 12 mg/ml)
Assamese Macaque	7.9 to 16.5kg Male 4.9-8.8kg Female	***Zoletil 100mg/ml*** (Zolazepam-Tiletamine) Ketamine 100mg/ml Medetomidine 1mg/ml	3-6 mg/kg 5mg/kg 0.1mg/kg	None Atipamezole Hcl 5mg/ml
Barking Deer	20-25kg	Ketamine 100mg/ml Medetomidine 1mg/ml Ketamine 100mg/ml Xylazine 100mg/ml Ketamine 100 mg/ml Xylazine 100mg/ml Diazepam	3-4mg/kg 0.05 -0.10mg/kg 2-3mg/kg 2-3 mg/kg 2-3mg/kg 1.5-2mg/kg 1mg/kg	Atipamezole Hcl 5mg/ml Yohimbine Hcl 10mg/ml Yohimbine Hcl 10mg/ml
Common Leopard	Male 37-90kg Female 28-60kg	***Zoletil 100mg/ml*** (Zolezapam-Tiletamine)	4-6 mg/kg	None
Gaur	800-1200kg	Ketamine 100mg/ml Xylazine 100mg/ml	0.14mg/kg 0.2mg/kg	Yohimbine Hcl 10mg/ml
Small Felids		Ketamine 100mg/ml Medetomidine 1mg/ml	3-4mg/kg 0.05 -0.10mg/kg	Atipamezole Hcl 5mg/ml
		Zoletil 100mg/ml (Zolazepam-Teletamine)	4-6 mg/kg	None
Sambar Deer	225 to 320kg Male 135 to 225kg Female	Ketamine 100mg/ml Medetomidine 1mg/ml Ketamine 100mg/ml Xylazine 100mg/ml ***Zoletil 100mg/ml*** (Zolazepam-Teletamine) ***Captivon98*** (Etorphine Hcl 9.8 mg/ml)	3-4mg/kg 0.05 -0.10mg/kg 2-3mg/kg 1-2mg/kg 5-9mg/kg 0.098mg/kg	Atipamezole Hcl 5mg/ml Yohimbine Hcl 10mg/ml None
Snow Leopard	Male 45-55 Female 35-40	***Zoletil 100mg/ml*** (Zolazepam-Teletamine)	4-6 mg/kg	None

Tiger	180 to 258 kg (Male) 100 to 160 kg (Female)	***Zoletil 100mg/ml*** (Zolazepam-Tiletamine)	4-6 mg/kg	None
Takin	Male 400-1000kg Female 200-500kg	Ketamine 100mg/ml Xylazine 100 mg/ml **Zoletil 100mg/ml** (Zolazepam-Tiletamine) ***Captivon98*** (Etorphine Hcl 9.8 mg/ml)	0.35mg/kg 0.15mg/kg 4mg/kg 0.020-0.030mg/kg	Yohimbine Hcl 10mg/ml None ***Activon*** (Diprenorphine Hcl 12 mg/ml)
Wild pig	90-225 kg	Ketamine 100mg/ml Xylazine 100mg/ml Diazepam **Zoletil 100mg/ml** (Zolazepam-Tiletamine) Ketamine 100mg/ml Medetomidine 1mg/ml	10 mg/kg 2-3 mg/kg 0.5mg/kg 3-5mg/kg 5mg/kg 0.2mg/kg	Yohimbine Hcl 10mg/ml None Atipamezole Hcl 5mg/ml
Wild Canids		**Zoletil 100mg/ml** (Zolazepam-Tiletamine	8-10mg/kg	

- Reversal for Xylazine and Medetomidine is given at 2-3 times or simply we can give at the ratio of 1:2 (agonist: antagonist)
- Similarly, for opioid drugs the reversal dose ratio is 1:2

5.2.5.6 Drug Delivery (Chemical Immobilization).

- Load the dart.
- Look for what is behind the target since here are chances of dart deflecting and injuring.
- Never point the muzzle at any one.
- Consider the effective range of projectiles.
- Aim the dart on the thick muscle mass (Hindquarters and Forelimb region).
- Ascertain whether the dart has beenproperly delivered or not.
- After darting, do not disturb the animal for a minimum of 15-20 minutes.
- Check the animal whether it has been adequately immobilized or not (with the help of a long pole, check inside the ear of the animal and if the ear doesn't move or tickle, it is confirmed that the animal is fully immobilized).
- Always approach potentially dangerous animal from its rear side.
- If reflexes still persist, leave the animal for few more minutes and check the reflexes again. Top up/supplement the drug if required.

Box 5.4 Distance Coverage with Loaded Dart

Distance Coverage with Loaded Dart

Dan Inject Model IM Zeroed with 1.5ml dart filled with 1.5ml.	5 meters	2 bars
	10 meters	3 bars
	15 meters	4 bars
	20 meters	5-5 ½ bars
	25 meters	6-6 ½ bars
	30 meters	8 bars
	40 meters	10 bars
Dan Inject Model IM Zeroed with 3.0 ml dart filled with 3.0 ml.	5 meters	2 bars
	10 meters	3 bars
	15 meters	5 bars
	20 meters	6 bars
	25 meters	7 bars
	30 meters	9 bars
	40 meters	12 bars
Dan Inject Model IM Zeroed with 5.0 ml dart filled with 5.0 ml.	5 meters	3 bars
	10 meters	4 bars
	15 meters	5 bars
	20 meters	7 bars
Dan Inject Model IM Zeroed with 10.0 ml dart filled with 10.0 ml.	5 meters	3 bars
	10 meters	4 bars
	15 meters	6 bars
	20 meters	8 bars

Air Pressure for Dart Syringes

Dart Syringe	Air Pressure
10 ml dart syringe	20 ccl air
5 ml dart syringe	15 cc air
3 ml syringe	12-14 cc air
1.5 ml syringe	10-12 cc air

5.2.6 Animal Safety

- Treat the animal as humanely as possible.
- Approach the animal very gently and avoid high pitch tone at all times.
- Assess the condition of the animal and subsequently monitor it (heart rate, pulse and temperature).
- Apply eye ointment.
- Cover the eyes of the animal with a towel or cloth piece (blind fold) to reduce the stress.
- Maintain the animal body position in correct recumbency (Sternal for Ruminants and Lateral for elephants and other species).
- Ensure patent airway, breathing and circulation (ABC).

- An immobilized animal shall never be left unattended.

5.2.6.1 Data Collection

- Take all the morphometric measurements as per restraint record form.
- Respective Wildlife Rescue Focal shall maintain the data of the animals rescued.
- Wherever possible, take the opportunity to collect various biological samples.

5.2.6.2 Revival of Immobilized Wild Animal

- Administer recommended antagonist (reversal) if available.
- Unless the animal requires major treatment or rehabilitation, the rescue team shall release the animal at the site with necessary first aid medication.
- If the team concludes that the animal is severely injured and need further treatment, the rescue team shall bring the animal to the nearest livestock centers, Dzongkhag Veterinary Hospital (DVH) or Wildlife Rescue and Rehabilitation Center for treatment.
- Maintain calm and dark environment while transporting, always make use of appropriate crates with sufficient ventilation and bedding materials.

5.2.6.3 Carcass Disposal

- In case the animal dies during the rescue operation or during the treatment procedure, the rescue team shall dispose the carcass accordingly at DVH/BAFRA biological pit/ or any other designated area. However, for list of scheduled animals as per FNCRR2017, parts and trophies shall be submitted to the Department.
- The concerned field divisions shall be responsible for disposing the carcass of the animal.

5.2.6.4 Safety Precautions for the Wildlife Rescue Team

- There are risks involved in handling wild animals and especially while using drugs for chemical capture, therefore, always work in pairs.
- Consider what to do in the event of an accident or emergency human drug exposure.
- Teach members of the team of the risks of human drug exposure and procedures for addressing drug exposure.
- Ensure you have access to antagonist when appropriate, and knowledge of how to administer to a human.
- Update emergency kit and ensure all drugs are not out of date.
- The projectiles shall be cleaned after every rescue operation.
- Dart needles and syringes shall be cleaned in warm water or detergent and dart syringe oiled with silicone oil.

Take the time to practice before chemical immobilization so you are confident you know what to do in event of an injury or accidental drug exposure

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6. Forest Fire Management

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6. Forest Fire Management

6.1. Management Context

6.1.1 Background

Forest fire is identified as one of the major drivers of forest degradation and deforestation (WMD, 2016). Forest fire directly impacts the environment, damage resources, wildlife habitats and population, including public property and human lives. The rugged topographic conditions combined with high ground fuel loads i.e. undergrowth vegetation of perennial grasses/shrubs, erratic wind conditions and prolonged dry winter season makes Bhutan vulnerable to increased forest fire incidences specially in the conifer zones.

Forest fires are a common feature during the dry season throughout the country. Annually, large areas of State Reserved Forest (SRF) land are damaged by forest fires and are mostly anthropogenic in nature. Nearly 60% of the population reside in rural areas who depend on agriculture and small-scale livestock farming wherein people use fire as a common tool for land management. The most common causes of forest fires in Bhutan are from burning of agricultural debris, camp fires, smoking, deliberate burning of grasslands and electric short circuits. Fires are also caused due to natural causes like lightning strikes and fire sparks from rolling boulders.

6.1.2 Objectives

The objective of forest fire management is to;

- reduce the number of forest fire incidences;
- reduce the severe negative impacts on forest and biodiversity resources;
- promote fuel load management practices (prescribed burning) and silviculture measures;
- reduce the emission levels from forest fires; and
- reduce damage to public property, livelihoods and heritage sites.

6.2. Roles and Responsibilities

Forest Protection and Enforcement Division (FPED) is the focal office for forest fire management and implementation of effective fire management activities in coordination with field office (Divisional Forest Offices and Protected Area Offices), forest fire management groups and other fire volunteers.

Table 6.1 describes the roles and responsibilities of different stakeholder in the management of forest fire incidences in Bhutan.

Table 6.1 Roles and responsibilities

Office	**Roles and Responsibilities**
FPED	• Develop policies, strategies and standards for forest fire management • Impart trainings to field staff on forest fire prevention and management techniques • Provide technical guidance to field offices regarding the use of prescribed burning and fuel load management • Coordinate and monitor forest fire management activities • Conduct National level awareness programmes • Mapping of forest fire hazard areas at the national /dzongkhag level. • Prepare a forest fire disaster contingency plan of the Department.
Field Offices	• Coordinate forest fire management within the respective jurisdiction • Liaise with IFFCG for fire management • Facilitate formation of CBFFMG and FFV • Organise Forest Fire Management awareness and trainings at community levels

Interagency Forest Fire Coordination Group (IFFCG)	• Coordinate preparations, including planning, training, awareness, identification of fire prone zones and conduct of prescribed burns wherever required before the onset of the fire season. • Discuss issues related to forest fire management and suppression activities, as and when required. • Participate in all necessary training before the onset of the fire season.
Community Based Forest Fire Management Groups (CBFFMG)	• Participate in local forest fire management activities within the community • Collaborate with the field offices in developing the forest fire management plan. • Ensure that the strategies and actions in the forest fire management plan are implemented, and to review the plan on a bi- annual basis to ensure frequency and relevance. • Liaise regularly with relevant Government Departments, agencies and Forestry staff for advice, technical help and support, to raise any issues, and develop solutions. • Report on group activities and implementation of plan and to maintain records of community activities.
Forest Fire Volunteers (FFV)	• Offer voluntary services for fire prevention and management • Coordinate with the Department in imparting education and awareness program on fire management

6.3. Standard Operation Procedure

Fire management includes three major aspects, viz., *fire prevention, fire suppression and post-fire management.*

6.3.1 Fire Prevention

Fire prevention can consist of both short-term and long-term measures. Short-term fire prevention is associated with periodic fire risk assessment, dissemination of a daily fire risk bulletin, regular awareness and related fire restrictions, law enforcement and patrolling during peak fire seasons.

Long term measures include scientific research on fire dynamics, improvement of forest management planning, mapping of forest fire risk zones/areas, fuel load management (prescribed burning, leaf litter collection, etc.) and silviculture treatments options, which are key strategies to prevent devastating fires in the future.

Prescribed/controlled burning and silviculture treatments are important measures recommended for fire prevention in Bhutan.

6.3.1.1 Prescribed/controlled burning

Prescribed burning is the "*controlled application of fire to vegetation in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives"* (FAO, 2002). Prescribed burning is recommended during spring and autumn and aimed to reduce high fuel load and decrease probability of forest fire.

6.3.1.2 Silviculture treatments

Silvicultural measures can help to prevent the spread of fires in high fire risk forest areas. The following silvicultural options can be adopted:

Conversion to mixed species /Manipulation of pure monoculture species

The risk of forest fire decreases as the proportion of evergreen trees increases and with the conversion of pine forests into a mixed broadleaved stand. Broadleaved trees species that are fire resistant could be introduced in plantations and natural forests to reduce the intensity of fire.

Salvage operation of dead trees and poles

When dead trees and poles catch fire, they can burn for several days even after the main fire has been extinguished. When they fall down, they become a source of fresh forest fires by scattering fire ambers. Their removal prevents future forest fires.

Thinning and Pruning

Thinning and pruning alter the way fire interacts with the forest. By reducing the number of small-diameter trees/pruning, fuel ladders can be broken from the forest floor into the canopy of trees, preventing crown fires which causes major damage to trees. Thinned and pruned material should also be removed from the site to reduce ground fuel load.

Weeding and Cleaning

Removing competing vegetation (usually grasses and shrubs) and fuel reduction through leaf litter collection can also reduce fuel load and reduce the intensity of future forest fires.

6.3.2 Fire Suppression

Fire suppression includes three critical stages viz. pre-suppression, detection, and suppressions of forest fires.

6.3.2.1 Pre-suppression of fires

Pre-suppression of fires includes the preparedness actions for fire prevention and management consisting of planning, recruitment & training, procurement & maintenance of firefighting tools/equipment and the creation & maintenance of fire line/fuel breaks.

Pre-incident Planning and Preparedness

a. Formation of IFFCG

The IFFCG shall be formed by the Department, with members from concerned agencies involved in firefighting. The members shall be from the Department, Royal Bhutan Army (RBA), Royal Bhutan Police (RBP), Dzongkhag Adminstration and De-suung. During the formation phase, the roles and responsibilities of the different agencies shall also be defined.

Table 6.2 IFFCG Members

Sl. No.	***Agency***	***Focal (by Position)***
1.	Royal Bhutan Army (RBA); *Wherever available*	Officer Commanding (OC)
2.	Royal Bhutan Police (RBP)	Superintendent of Police (SP) /OC
3.	Dept. of Forest and Park Services (DoFPS)	Chief Forestry Officer (CFO)
4.	Dzongkhag Administration	DDMC Chairperson, Dzongkhag Disaster Management Officer (DDMO)
5.	De-suung	Dzongkhag De-suung Coordinator

Training and Capacity Building

All fire fighters shall be adequately trained in various firefighting techniques, fire safety, coordination and communication protocol. The Department shall conduct basic firefighting training of trainers (TOTs) for all the agency focal, who in turn shall train their respective Rapid Response Team (RRT) and fire fighters. The fire experts of the Department shall train all focal officers on incident management systems and coordination.

Equipment handling training (Drone) and power chainsaw (felling technique) shall also be conducted for focal officers. Selected officials shall be nominated and shall be trained, who shall use this equipment during firefighting incidents.

Effective communication is key to smooth coordination and deployment of fire fighters. All focal shall be assigned a call code on a radio frequency and trained in use of handsets & a common communication protocol by RBP. The focal shall then train their respective fire fighters on their own communication as per Radio Telephony procedures in practice. Interoperable/common frequency carrier for interagency communication link is recommended.

The Department shall train members from stakeholder agencies and communities to carry out prescribed burning techniques in identified fire prone areas. Helicopter services have proven to be crucial during fire incidents in difficult terrain and inaccessible locations, where firefighters have limited access. A joint team of smokejumpers is proposed to be trained in coordination with DDM and Royal Bhutan Helicopter Services Ltd. (RBHSL) for deployment during such occasions to effectively deliver first response and suppression.

Rapid Response Team

Rapid Response Teams (RRT) shall be formed from representatives from RBA, RBP, De-suung and the Department to coordinate quick and effective first response to forest fire incidents. The RRT shall consist of 20-30 member teams and may be further deployed as crews of 5 members each led by a crew leader.

- Each RRT shall be led by an officer of adequate command and decision-making authority, who shall coordinate with respective focal officers during fire incidents.
- The RRTs shall be fully trained and equipped with Personal Protective Equipment (PPE) and other firefighting tools and accessories.
- Each officer in-charge of RRT shall use a walkie talkie handset to communicate with IFFCG and fire fighters in his team.
- Each RRT shall have one power chainsaw to be used for fire suppression activities.
- Adequate transportation facilities shall be maintained with the Department RRT to quickly drop the RRT's to the forest fire incident site for fast response.
- A Drone shall be used by the RRT to monitor the fire, assess spread & potential threats and accordingly facilitate deployment of fire fighters.

Equipment

It is absolutely essential that any individual on forest fire incidents be adequately and appropriately equipped to effectively suppress the fires while at the same time ensuring personal and team safety. The procurement and distribution of all equipment shall be coordinated by the Department and approved through the IFFCG. Equipment shall be of acceptable international standards. The following list of firefighting equipment (Table 6.3) are required for effective fire suppression.

Table 6.3 Equipment set required for fire fighting

Sl. No	Equipment	Sl.no	Equipment
1	Collapsible Tank	12	Pulaski
2	Communication handset	13	Rake
3	Drip torch and fuel	14	Safety Goggles
4	Drone (UAV)	15	Safety Helmet
5	Fire Gloves	16	Safety Rope (4, 100 and 500m)
6	Fire mask	17	Shovel
7	Flappers	18	Small backpack
8	Machete (*Patang*)	19	Spade
9	Mcleod	20	Torch
10	Whistle	21	Water bottle
11	Power chain saw	22	Portable water pump

Box 6.1 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE)

This SOP details the PPE to be used while operating on or near the fire area. Persons undertaking forest fire activities shall be appropriately attired to protect themselves from the dangerous effects of fire.

Ideally, clothing made from natural fibre shall be worn that covers all major parts of the body to give protection from radiant heat. Garments made from synthetic materials, (nylon, rayon, etc.) shall not be worn.

Helmet to protect the head from falling, low or over-hanging objects shall be worn at all times during firefighting.

Foot-wear shall be sturdy to prevent ankle injury while traversing rugged, loose and uneven terrain.

Goggles and smoke masks shall be worn to protect the eyes and respiratory system from smoke and embers.

Soft leather gloves with gauntlets shall be worn to protect exposed areas of skin extending from shirt/coat sleeves (e.g. wrists, hands and fingers) to provide protection against radiant heat, embers and sharp objects or splinters. Gloves would also minimise blistering from excessive use of hand tools.

Fire Line Creation

Fireline creation is one of the tools for prevention of forest fire from spreading to unburnt areas. It is recommended to create fireline of minimum 5 metres width around important structures and properties at risk. Such areas shall be identified by the Department in consultation with the Dzongkhag administration. Fireline construction shall be coordinated by the IFFCG.

b. Community Based Forest Fire Management Groups (CBFFMG)

Community Based Fire Management is a management approach based on the strategy to include local communities in the proper application of land-use fires, forest fire prevention, and in preparedness and suppression of forest fires (FAO, 2006).

A Community Forest Fire Management Group (CFMG) shall work closely with the concerned field office for planning and supervision of activities, joint action for prescribed burn and fire monitoring & response.

c. Forest Fire Volunteer Program (FFVP)

A group or individual citizens, wishing to assist the Department in forest fire management, can provide support during surveillance of forest fire, fire prevention education/awareness program and fire fighting.

6.3.2.2 Fire Suppression Operations

The (early) detection of fires is crucial for effective firefighting. It can be achieved by automated smoke detection systems, surveillance flights (UAV), video control systems (a video surveillance system), monitoring service or by depending on the reports by the *me-soops*, local communities or general public. During the suppression of forest fires, all relevant stakeholders such as RRT, firefighters, local communities, volunteers and the general public actively fight forest fires. However, during such events, safety of fire fighters is always considered as a top priority.

Box 6.2 Fire Fighter Safety (SAFETY FIRST)

Fire Fighter Safety (SAFETY FIRST)
The Officer-in Charge is accountable for safety at the forest fire. However, all firefighters are also individually responsible for their own safety.
All fire fighters shall work collectively at the incident site to ensure safety of other firefighters and other people in the area.
On the incident site, everyone shall be aware of possible hazards and identify methods to eliminate, reduce or avoid them.
The first concern shall be: "Is anyone in danger? If so, what can we safely do to protect them.
The second concern shall be, "Is there anything of value in danger? If so, can we safely protect it?"
The third concern shall be, "Is there anything we can safely do to help restore normality to the affected area?"

Forest Fire Incident Management

On receipt of the first incident report by any members of the IFFCG, respective agencies shall immediately deploy their RRT to the incident site. The RRT shall size up the incident and initiate first response to suppress and contain the fire. Based on the outcome, the RRT shall jointly submit the incident report to the IFFCG stating whether the fire is contained or if additional backup is required. The IFFCG shall then deploy additional backup teams in case of larger fires, which could not be contained by the RRTs. The IFFCG shall be fully responsible for coordination and fire suppression till the fire is suppressed and contained. A diagrammatic illustration of the flow of decision making, on-ground suppression action and communication process is provided in Figure 6.1 Incident Coordination system during forest fires.

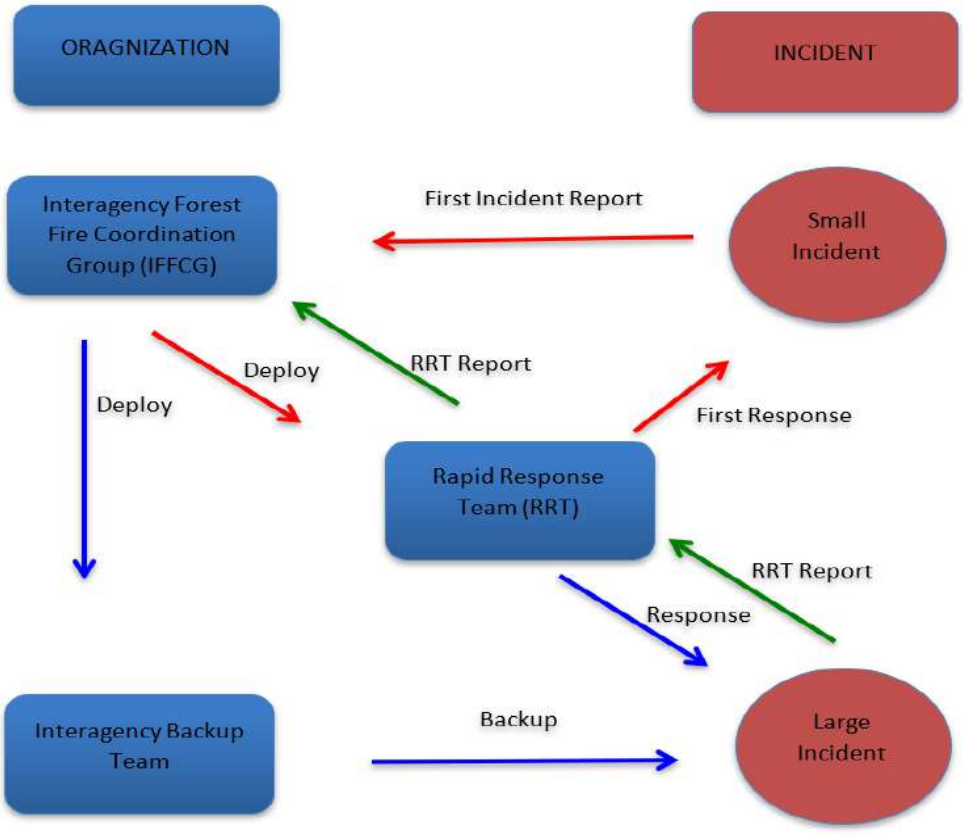


Figure 6.1 Incident Coordination system during forest fires

The roles and responsibilities of different agency in the ICS is deailed out in Table 6.4

Table 6.4 Roles and responsibilities of difference agency (ICS)

Offices	**Roles and responsibilities**
IFFCG	• As soon as the fire incident is reported, the IFFCG shall coordinate and plan response with other focals. • As a first response, the IFFCG shall dispatch the RRT to the forest fire incident site to investigate, suppress and contain the fire. • The IFFCG shall start mobilizing backup teams and keep them ready for deployment depending on first incident report from the RRT. • The IFFCG members from Department shall coordinate medical support from hospital. • Arrangement for transportation of the fire fighters and deployment shall be done by IFFCG from their respective agencies. • The Department RRT shall investigate and determine the main cause of forest fire and report back to the IFFCG. • On large incidents the IFFCG from Department shall take the lead role in planning and coordinating the next steps for fire suppression.
RRT	• The RRT shall be fully equipped and shall always be on standby for immediate deployment during the forest fire season (Oct-March). • They shall provide the first incident response and combat all forest fires at the initial stage. • The RRT shall conduct assessment of the incident and report to the IFFCG, who shall then take further decisions for suppression and containment of the fire. • The RRT shall try to suppress the fire and call for backup based on the situation and status of the incident.
Backup Teams	• The backup teams shall get ready as soon as the RRT is dispatched to the forest fire incident site • The backup teams shall be deployed on instruction from their respective IFFCG members, who shall coordinate deployment of the backup teams based on RRT's initial incident report. • The size of backup teams and timing of deployment shall be decided by the respective IFFCG members based on the size and situation of the incident. • The backup teams shall be adequately equipped with PPE and firefighting equipment.

COORDINATION AND COMMUNICATION

In order to provide fast and efficient suppression response and to ensure fire fighter safety during forest fire incidents, interagency coordination and communication flow are crucial.

Coordination Protocol

- For any reported forest fire incident, one representative from each agency on the IFFCG shall immediately meet together to plan and deploy fire fighters at an agreed vantage point.
- All IFFCG members shall use the common call sign as per Table 6.5 and frequency and also commonly used social media platforms/forums (eg. Wechat, Telegram).
- All IFFCG members shall be responsible for coordinating all communication requirements for their respective agencies.

Communication Protocol

To ensure timely and effective communication amongst IFFCG members and with the RRT and firefighters on the forest fire incident, the call signs shall be assigned and used for communication on radio handsets by the members during forest fire incidences.

Table 6.5 Name List and Call Sign of IFFCG Members

Sl.No.	Agency	Focal (by Position)	Handset Call Sign (Assign)
1	RBA; wherever available	OC	
2	RBP	SP/OC	
3	DoFPS	CFO	
4	DDMC	DDMO	
5	De-suung	Dzongkhag De-suung Coordinator	

- All IFFCG Members must use radio handsets and be available on the designated frequency during fire incidents.
- The Department shall process with BICMA for availing a designated radio frequency for use of the IFFCG Members.
- IFFCG Members shall use their current agency communication protocols for communication with RRTs and other firefighters.
- In areas where radio hand-sets do not have reach, the IFFCG shall provide mobile phone recharge vouchers to support communication and flow of information.

Logistic Coordination at Incident Site

Overall coordination and logistic distribution shall be done by Department IFFCG Members in coordination with respective agency Members. Dzongkhag Administration, DDMC shall mobilize funds for food and refreshments.

Suppression Coordination on Large Fires

The IFFCG shall initiate incident suppression planning including: roster of rotation of fire fighters, calling-off of firefighters during the night, additional logistic team organization, gathering weather forecast from National Center for Hydrology and Meteorology (by DDM), etc.

When the use of helicopter services is considered necessary by the IFFCG, Dzongkhag shall coordinate with DDM for availing and approval of the helicopter service. The Department designated team leaders shall use GPS and provide coordinates/directions to the helicopter pilot for dropping water on the incident site.

When fire incidents are in inaccessible areas, helicopter services shall be availed to airlift and deploy firefighters to the incident site based on the decision taken by the IFFCG.

Water Tankers

It is necessary to arrange water tankers when fire incident sites have road access. Water tankers shall be deployed to the road-head nearest to the incident site to suppress fire, which is accessible from the road for water supply, and to protect adjoining infrastructure. The fire brigade shall be dispatched by the RBP (IFFCG Members) based on decisions taken by the IFFCG.

6.3.3 Post Fire Assessment and Rehabilitation

Post fire Assessment is a critical aspect in fire management. This shall enable to get an insight into the extent of damage caused by the fire and related economic loss besides the impacts on the biodiversity

and environment. This shall also give an idea of the rehabilitation activities and the costs associated with the restoration activities.

The following post fire interventions are recommended:

6.3.3.1 Mopping

It is recommended to carryup mopping with the fire burnt area and leftovers fire in the tree trunks, dead, fallen logs and branches

6.3.3.2 Investigation of causes of fires

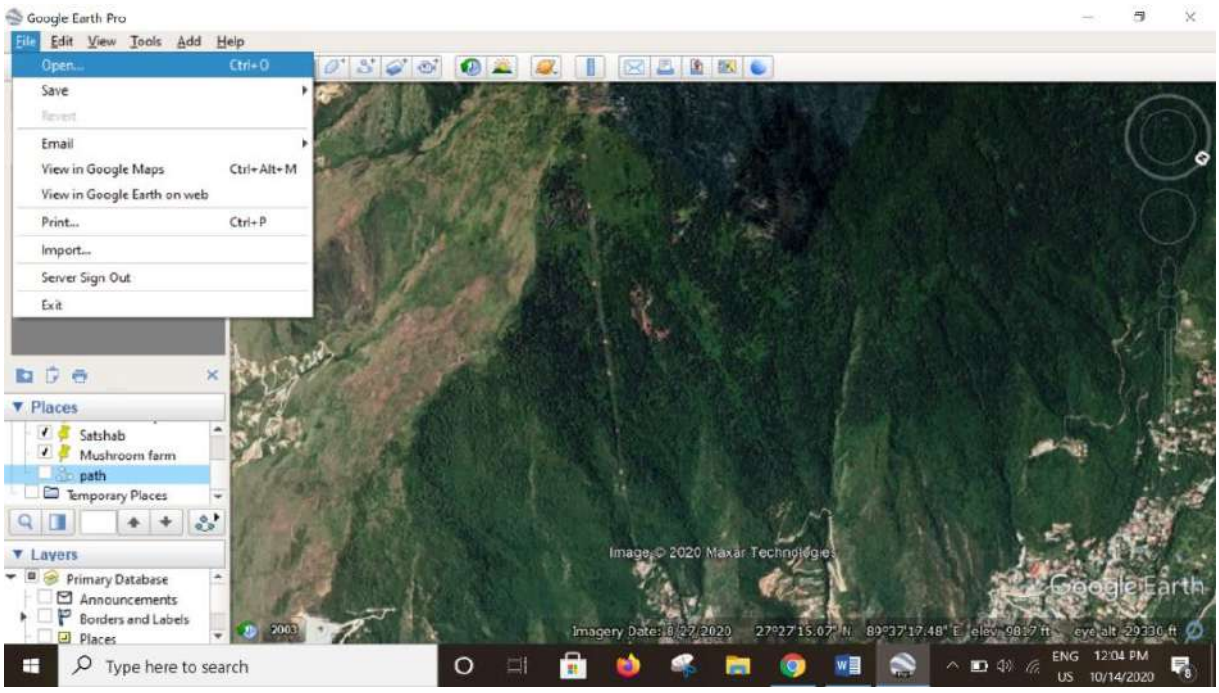
The concerned field office shall investigate about the fire incidences as per Form 6.1 and Form 6.2.

6.3.3.3 Mapping extent of fire burnt areas, and damage assessment

Mapping

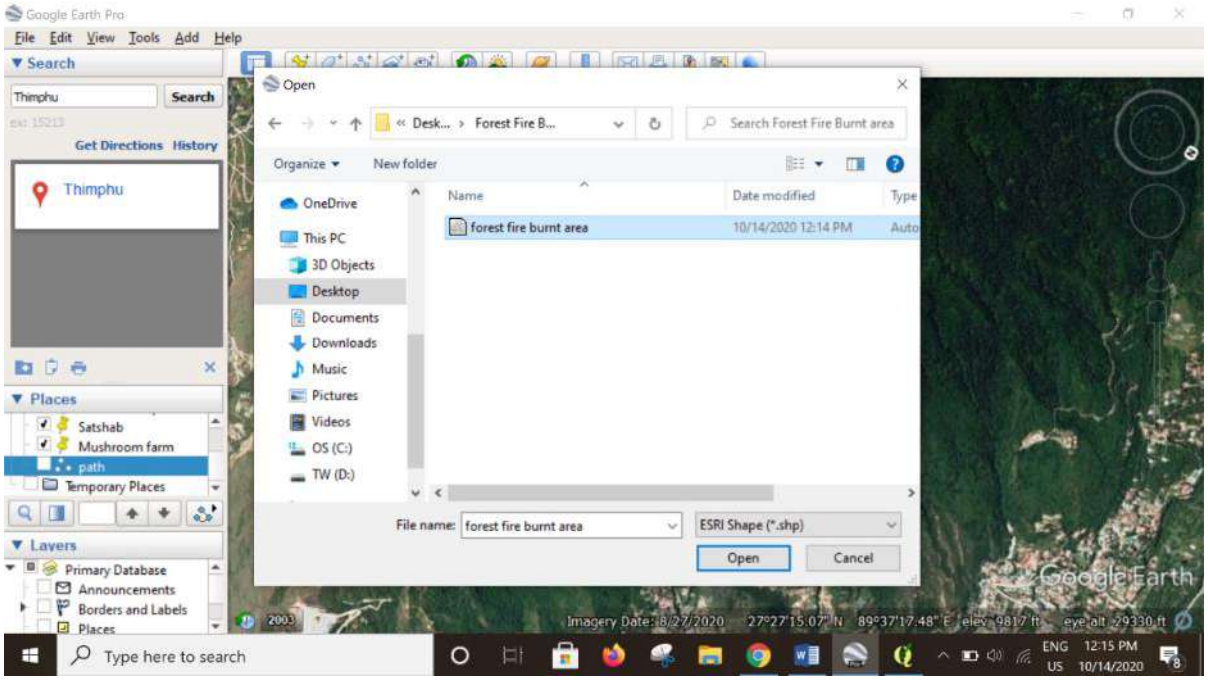
Fire burnt area after fire incidences shall be mapped using Global Positioning System (GPS) or Google Earth to determine shape, area and perimeter. The stepwise procedure of mapping using Google Earth is described below:

Step 1: Demarcate the fire burnt area using GPS and save the file in your Desktop/Laptop in a folder "Forest Fire Burnt Area".

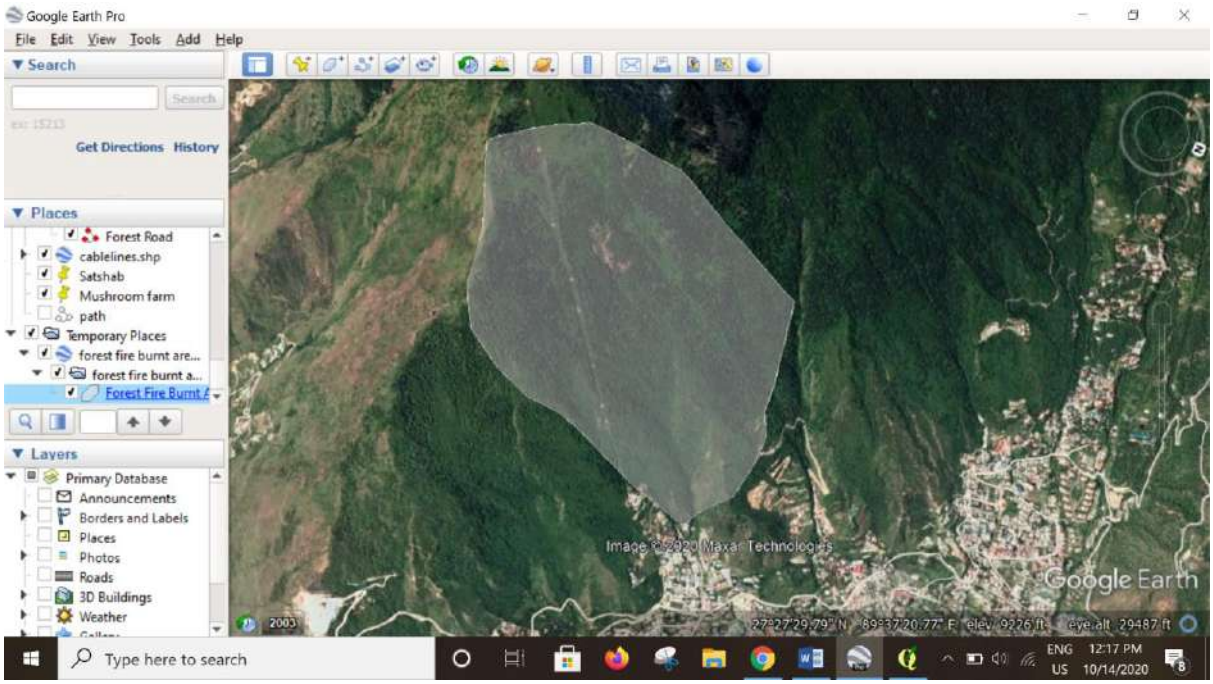


Step 2: Upload the shape file of the burnt area in Google Earth, preferably the latest version (Google Earth Pro).

1. Open the Google earth >>>Go to file> open

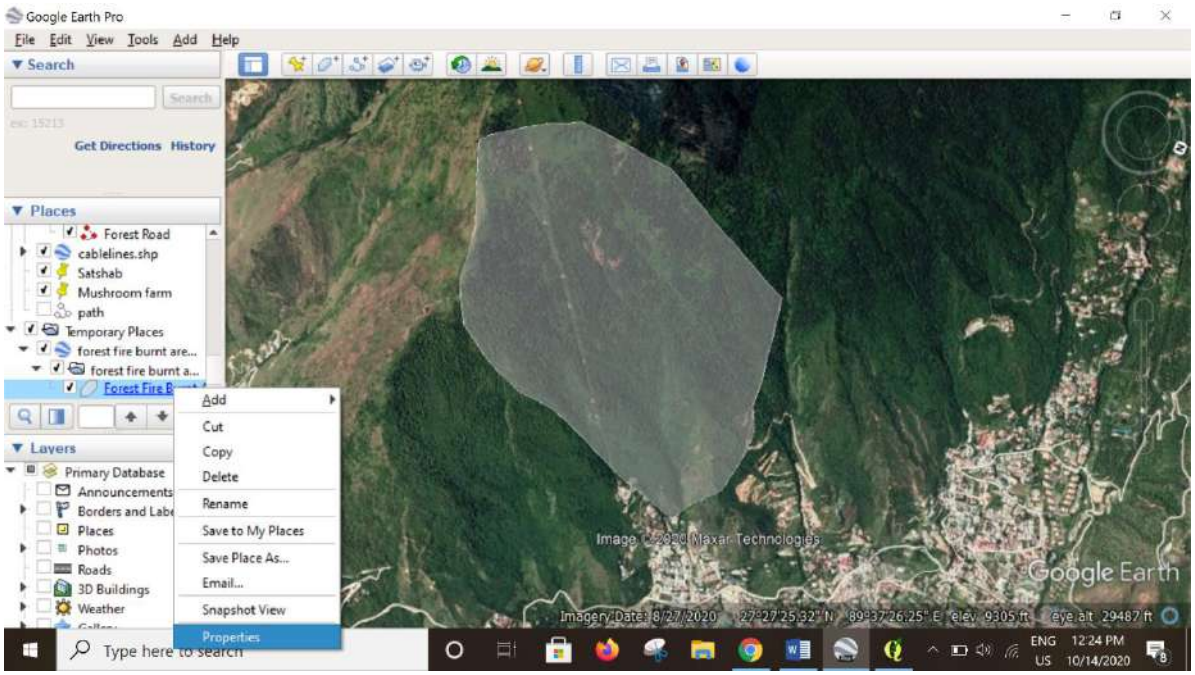


2. Open the folder “Forest Fire Burnt Area” and open the GIS file “ Forest Fire Burnt Area” in the folder.

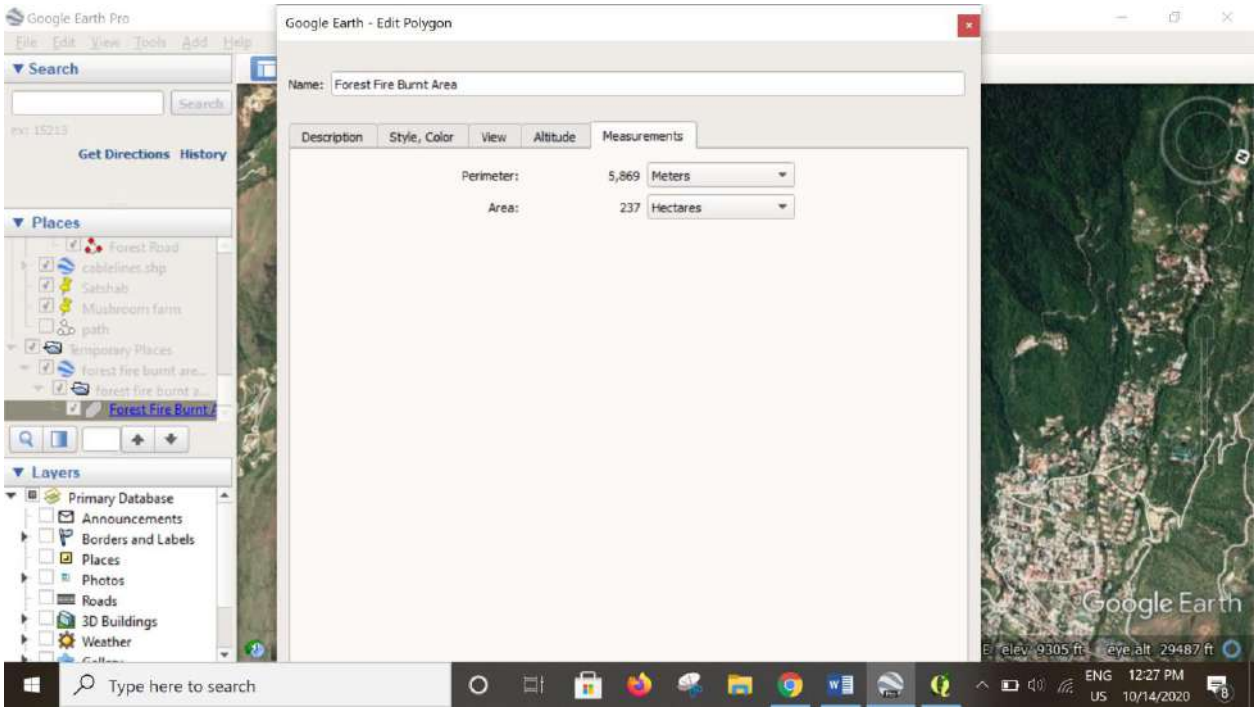


***Step 3*:** Calculate the Forest Fire Burnt area in hectares

1. Right click on the Layer "Forest Fire Burnt area" and go to Properties.



2. After Opening Properties, a "Edit Ploygon window shall Pop up > go to "Measurements"> Change the unit to of Perimeter and Area to "meters" and " hectares" respectively.



3. Read the value for Perimeter and Area.

Damage assessment

Once the fire is out, the first step is to assess the damage (Form 6.2). Fire can be very destructive and the damage depends on the intensity of burn which is usually low, moderate and high intensity.

The report must contain the following:

- General decription: Size, gradient of slope, aspect and location of the burn area
- Vulnerability to secondary damage such as land slide and soil erosion for restoration
- Damage to trees, soil, water, regeneration prospects and vegetation type for magnitude of severity
- Economic losses: house, cash crops, cereals, livestock, etc.

Form 6.1 FIRE INCIDENT FORM A

FIRE INCIDENT FORM A
INITIAL FIRE REPORT

- First Hand Information – Phone in / fax / email.

FIRE START	DATE:	TIME:
DIVISION :		
DZONGKHAG :		
GEOG		
VILLAGE :		
LOCALITY:		

Forest Type: tick the box. ✔

Broad leaf	?		Mixed Conifer	?		Chir Pine	?
Blue Pine	?		Grassland	?		Others	?

Cause of fire (if known) Tick 1 box only ✔

Cause of fire (if known)	Arson	Agriculture-debris burning	Campfire/ Picnickers	Children	Construction/ Labour camp	Electric Short circuit	Natural
	Cattle herders	Prescribe burning	Smokers	Trans-boundary	Unknown	Others	

Possible risks:

Human Settlement	
Lhakhangs / Monasteries	
Schools & other institutions	

Remarks: Description/other information

Fire status (topography, distance, accessibility)

Note: First hand information to be conveyed by CFO/PM

Submitted By	**Name & designation:**	**TIME:**

Fax: 322836/322395 - Phone:

Forest Fire Management Program **OFFICE USE ONLY**

Fire Case number allocated: Dzongkhag code/ **000 / dd/mm/yyyy**

Form 6.2 FIRE INCIDENT FORM B

FIRE INCIDENT FORM B

FOREST FIRE REPORT- To be submitted within one month.

1. Fire Location

DIVISION :		
DZONGKHAG :		
GEOG		
VILLAGE :		
LOCALITY:		
GPS Reading	E:	N:
ATTACH GIS MAP OF FIRE AREA		

2. Fire time

FIRE START	DATE:	TIME:
FIRE FIGHTING	START:	FINISH:
FIRE SUPPRESED	DATE:	TIME:

3. Cause of fire: Tick 1 box only ✔

Cause of fire (if known)	Arson	Agriculture-debris burning	Campfire/ Picnickers	Children	Construction/ Labour camp	Electric Short circuit	Natural
	Cattle herders	Prescribe burning	Smokers	Trans-boundary	Unknown	Others	

Details of offender (if known)	
Name/CID No:	
Address	
Age	
Sex	
Occupation	

4. **Fire Characteristic** – tick. ✔

Ground Fire	☐	Surface Fire	☐	Crown Fire	☐

5. Personnel involved in fire fight

Personnel	Number		Personnel	Number
Forestry Officials			Public/community	
RBA			Labour force	
RBP			Fire volunteers	
De-Suups			Fire brigade	
RBG			TOTAL NUMBER PERSONS INVOLVED IN FIRE FIGHTING	
Others				
Fire trucks involved			Other resources involved	

6. Forest Type: tick the box. ✔

Broad leaf	☐		Mixed Conifer	☐		Chir Pine	☐
Blue Pine	☐		Grassland	☐		Others	☐

7. Classification of Forest burnt

Particular	Number of Acres	Particular	Number of Acres	Particular	Number of Acres
SRF Land		Private forest		Others	
Community Forest		Plantation			
Total burnt area:					

8. Damage Report

A) TREE CROP				
Damage	**Girth Class**	**Total**	**Rate (Nu)**	**Estimated amount**
Trees	8 – 9’			
	7 – 8’			
	6 – 7’			
	5 – 6’			
	4 – 3’			
Poles	3 – 2’			
	2 – 1’			
	1 – 0’			
Small poles	0.6 Below			
Saplings				
Seedlings				
Any other				
TOTAL ESTIMATED VALUE OF DAMAGED FOREST CROPS				
B) OTHER ECOMONIC DAMAGE				
Type	**Details**		**Quantity**	**Estimated value**
Understory/scrubs	(eg: species / habitat)			
Agricultural Crop	(eg: maize, lemon grass, orchard, etc)			
Livestock	(eg: cows, horses, etc)			
Other forest product	(eg: bees, medicinal plants)			
TOTAL ESTIMATED VALUE OF OTHER ECOMONIC DAMAGE				

9. Impact & Loss

A) HUMAN & LIVESTOCK		
	Yes/No	**Number / Detail if known**
People injured		
Loss of life		
Livestock injured/loss		
Loss of wildlife		

B) INFRASTRUCTURE			
Loss / damage	**Number / Detail**	**Loss/ damage**	**Number / Detail**
Houses	Click here to enter text.	Religious building. Lhakhangs, Monastery, Chorten, etc	Click here to enter text.
School buildings / other institutions	Click here to enter text.	Farm fences	Click here to enter text.
Electricity infrastructure	Click here to enter text.	Water infrastructure	Click here to enter text.

C) ENVIRONMENTAL IMPACTS		
Type	**Risk (H/M/L)**	**Remarks**
Erosion		
Landslip		
Water Quality		
Water Catchment area		
Habitat		

10. TOTAL DAMAGE & COST OF FIRE

ITEM	**Amount Nu**
Total Fire Suppression Cost	
Total direct losses – timber, structural, agricultural, livestock, etc	
Others	
TOTAL	

11. **General comments/recommendations for recovery activities** *(describe briefly on the extent of damage and possible interventions required (eg., plantation, land management, etc.)*

General comments:

12. Assessment

Position	**Date**	**Name / signature**
GFEO / FOREST GUARD		
BEAT OFFICER / RANGE OFFICER		

REPORT FORWARDED TO DFO / PM - Date:

DIV. FOREST OFFICER/ PARK MANAGER		

REPORT FORWARDED TO FOREST FIRE MANAGEMENT PROGRAM - Date:

FOREST FIRE MANAGEMENT PROGRAM - *OFFICE USE ONLY.*
Received Forest Fire Program – Date:
Fire Case Number: (Dzongkhag code/ 000/dd.mm.yyyy)

6.3.3.4 Estimating the quantity of timber that could be salvaged

Sampling intensity and samling design

Total enumeration of trees damaged shall be done for burnt areas which is less than 2 ha. However, for larger areas, a stratified random sampling shall be adopted to determine the quantity of timber for harvest.

For burnt area between 2 to 20 ha, 5% of the burnt area shall be sampled while a minimum of 1% of the burnt area shall be sampled if burnt area exceeds 20 ha.

Sampling Plot and Inventory design

Each Inventory plot shall consist of two circular plots viz, major plot and minor plot of 12.62 m and 5.64 m radius respectively. The inventory design shall be prepared in Arc GiS/QGiS to generate random points. The point coordinates of random sampling plots shall be then transferred into GPS for location and navigation to the sampling points.

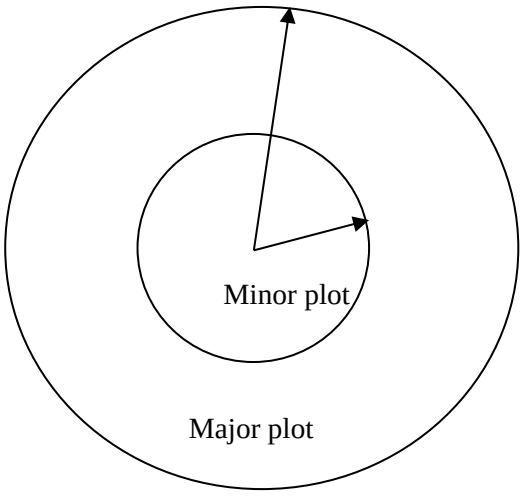


Figure Inventory Plot

Plots	**radius (m)**	**area (m^2)**	**area (ha)**	**dbh**
Minor	5.64	40	0.004	10-29 cm
Major	12.62	500	0.05	≥30 cm dbh

Data Collection and Analysis

The major plot of 12.62 m radius with an area of approximately 0.05 ha shall be used for collecting tree data with dbh ≥30cm. The minor plot of 5.64m radius shall be used for collecting tree data with dbh10-29 cm. Dbh of all fire burnt trees/poles, likely to die, falling within the sampling plot (major and minor) shall be measured and collected using the tally sheet (Form 6.3). The data thus collected shall be transferred to compilation sheet (Form 6.5). The results of the compilation sheet shall then be transferred to stand and stock table (Form 6.4, Form 6.6 and Form 6.7) for calculation of number of trees/ha, basal area/ha and volume/ha. General volume table or Local Volume Tables shall be used for the purpose of volume calculation.

Form 6.3 Tally sheet

INVENTORY: TALLY SHEET

	Plot identification		
1	Inventory Unit:	5	Date:
2	Plot Number:	6	Altitude:
3	Sheet Number:	7	Forest Type:
4	Name of the Enumerator:	8	Accessiblility: Yor N

If plot not accessible: stop recording here

Measure all Trees above 10 cm dbh

(dbh 30+ cm on major plot, r < 12.62 m; dbh 10-29 cm on minor plot, r < 5.64 m)

	Species	***dbh****(cm)*	***height****(m)*
1	…….		
2	…….		
3	…….		
4	…….		
5	…….		
6	…….		

General remarks :

Form 6.5 Compilation sheet

Compilation sheet								
1. inventory area	:			4. species group				
2.stratum	:			5. volume table				
3. nr of plots	:							
col1	***col2***	***col3***	***col4***	***col5***	***col6***	***col7***	***col8***	***col9***
		(3 decimals)	(3 decimals)	(3 decimals)	(0 decimals)	(2 decimals)	(2 decimals)	(2 decimals)
dbh class (cm)	class basal area (m2)	class volume (m3)	plot size (ha)	expansion factor	tally	nrha (stems/ha)	basha (m2/ha)	volha (m3/ha)
10 --19	0.017							
20-29	0.047							
30-39	0.093							
40-49	0.156							
					sum for all dbh classes			

Explanation:

col3	: look up in volume table, for given species group and dbh class	***col6***	: count, and fill in
		col7	: col5 * col6
col4	: plot size for given dbh class	***col8***	: col7 * col2
col5	: (1 / col4) / (nr. of plots)	***col9***	: col7 * col3

(when rounding: round to the nearest EVEN digit; e.g. 0.635 to 0.64 but 0.665 to 0.66)

Form 6.4 Stand and stock table (No. of trees/ha)

STAND & STOCK TABLE SHEET 1 - NUMBER OF TREES

1. inventory area

2. stratum

3. nr. of sampling units

4. estimated parameter : **Average Number of Trees per Ha** *(report all values to 2 decimals)*

	Dbh class (cm)													
Species group	**10-19**	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**70-79**	**80-89**	**90-99**	**100-109**	**110-119**	**120+**	**total**	**%**
Hemlock														
Fir														
Spruce														
Juniper														
total conifer														
Acer														
Betula														
Others														
total broadleaf														
total all species														
%														

Form 6.6 Stand and stock table (Basal area /ha)

STAND & STOCK TABLE SHEET 2 - BASAL AREA

1. inventory area

2. stratum

3. nr. of sampling units

4. estimated parameter : Average Basal Area per Ha (m2/ha) *(report all values to 2 decimals)*

	Dbh class (cm)													
Species group	**10-19**	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**70-79**	**80-89**	**90-99**	**100-109**	**110-119**	**120+**	**total**	**%**
Hemlock														
Fir														
Spruce														
Juniper														
total conifer														
Acer														
Betula														
Others														
total broadleaf														
total all species														
%														

Form 6.7 Stand and stock table (Volume/ha)

STAND & STOCK TABLE SHEET 3 - VOLUME

1. inventory area

2. stratum

3. nr. of sampling units

4. estimated parameter : Average Volume per Ha (m3/ha) *(report all values to 2 decimals)*

	Dbh class (cm)													
Species group	**10-19**	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**70-79**	**80-89**	**90-99**	**100-109**	**110-119**	**120+**	**total**	**%**
Hemlock														
Fir														
Spruce														
Juniper														
total conifer														
Acer														
Betula														
Others														
total broadleaf														
total all species														
%														

Estimation of quantity of timber for salvage operation.

The estimate for the quantity of the timber for salvage operation shall be calculated using the equation 5.

$$Timber\ quantity\ for\ salvage\ operation\ =\ Vol/ha\ x\ total\ fire\ burnt\ area \quad (5)$$

Where the Volume/ha can be derived from Stand and Stock table and the total fire burnt area is determined and mapped under 6.3.3.3.

6.3.3.5 Develop and implement reforestation plans

Wherever feasible, allot dead trees to NRDCL and local people as per the existing rules. Reforestation shall be done following the guidelines prescribed in Chapter 8, Plantation and Nursery Management.

6.3.3.6 Regular monitoring of the plantation

Regular monitoring of plantation shall be done to ensure the success of the plantation.

6.4. Monitoring and Evaluation

FPED shall also evaluate the functionality of the IFFCG, CBFMG and Fire Volunteers in the respective field offices. The Field offices shall submit the forest fire incidents report (Form 6.1and Form 6.2) on real time basis through the Forest Information Reporting and Monitoring System.

Field Divisions shall constantly monitor the forest fire control programme in their respective jurisdiction. FPED shall also monitor the implementation of fire control programme activities in the field divisions annually.

The overall monitoring and evaluation of forest fire management program shall be part of the monitoring and evaluation of the area-based management plan and the overall progress of the field offices.

6.5. Bibliography

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7. Management of Other Conservation Areas

Ecotourism

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7. Management of Other Conservation Areas

7.1. Ecotourism Product/Sites

7.1.1 Management Context

7.1.1.1 Background

The overall goal for tourism is to promote conservation, understanding and appreciation of Bhutan's natural and cultural heritage in an environmentally and socially sustainable manner. Although the concept of ecotourism emerged only in the early 1980s, the tourism policy that Bhutan had pursued was very much in line with the principles of ecotourism. These principles bear close affinity to the vision of Gross National Happiness (GNH).

Considering the similarities on the principles of ecotourism and Bhutan's development vision of GNH, ecotourism in the Bhutan's context is defined as the *"High value low impact travel that supports the protection of cultural and natural heritage; provides positive and enriching experiences for visitors and hosts; assures tangible benefits to local people; and contributes to the pillars of Gross National Happiness." (NRED 2012)*

Therefore, in light of this principle, the promotion of ecotourism is seen as an opportunity to enhance and complement the overarching vision of GNH. Recognizing these benefits, the Royal Government of Bhutan increasingly promotes ecotourism as a pathway to balance conservation goals with the need to fulfill the socio-economic development aspirations.

Ecotourism development is identified as one of the priority programs of the Department. However, due to rapid increase in tourist visitation numbers, the development and management of ecotourism is becoming ever more challenging. Tourism, as a multidisciplinary sector, requires the partnership and concerted efforts of all its stakeholders to contribute to sound planning and management which is critical for the success of ecotourism.

7.1.1.2 Objective

The objectives of ecotourism development are to;

- enhance long-term conservation of the natural area and to optimize social and economic benefits for local communities, both in the present and in the future, creating economic opportunities that provide an alternative income source.
- promote and support the understanding, appreciation and conservation of the environment and culture, raising awareness and inculcating a sense of appreciation for biodiversity and cultural heritage; and
- contribute economic resources to the conservation of the area's natural and cultural heritage, supporting other local efforts to this end.

7.1.2 Roles and Responsibilities

Ecotourism planning, development and management needs the involvement of multiple stakeholders and partners. The success of ecotourism shall largely depend on the concerted effort of all the relevant partners. The following are the roles and responsibilities of an important partner for ecotourism development within the State Reserve Forest (SRF) land (Table 7.1).

Table 7.1 Roles and responsibilities

Offices	**Roles and responsibilities**
Nature Conservation Division (NCD)	• Review Management Plan /Action Plan • Develop standards and ensure quality of product • Provide technical assistance to proponent in developing products if required • Develop national strategies, guideline and frameworks related to ecotourism development within SRF

	• Share information with all relevant stakeholders and proponents regarding the restricted activities and areas • Monitor and regulate product and activities
Field Offices	• Identify and assess ecotourism Product • Product development • Develop Management Plan/Action Plan for the Product • Monitor product and activities
Tourism Council of Bhutan (TCB)	• Develop safety and standard • Market and promote ecotourism product • Certify Product

7.1.3 Eco-tourism Planning and Management

The services and products offered shall have minimal or no adverse impact on the social, cultural and natural environment. It shall only be promoted to enhance the positive benefits. Therefore, to ensure that the development of ecotourism activities/products/services, the following must be considered:

7.1.3.1 Environmental Considerations

Environmental Management Plans need to be developed which shall outline the ways in which negative impacts shall be reduced and managed. The management plan shall need to consider the following.

Infrastructure development

- Ecologically and culturally sensitive sites shall be avoided;
- Import of raw materials shall be avoided as far as possible to encourage use of locally available materials including local labor;
- Local/traditional designs to be promoted;
- Less obtrusive coloring to be used.

Waste management

- Waste management plans shall be developed and implemented;
- Standards set for segregation/disposal of waste and sewerage treatment;
- Biodegradation practices to be adopted;
- Implement concept of the reduce, recycle and reuse;
- Waste disposal system to be clearly outlined.

Energy

- Promote use of Sustainable energy sources such as solar, wind energy, hydropower, biomass, etc.

Water

- Proper Water usage and Management shall be practiced
- Wastewater treatment plans shall be developed and implemented.

7.1.3.2 Green Operations

- Consider use of recycled products in daily operations of business;
- Follow environmentally friendly practices such as recycling, water, energy use etc.
- Avoid use of any environmentally harmful products; and
- Minimize disturbance to wildlife and local communities

7.1.3.3 Socio-cultural Considerations

- Protect and promote the social and cultural norms; and
- Contribute to revival of old traditions while strengthening the existing practices;

7.1.3.4 Economic Considerations

- Demonstrate benefit sharing and direct economic benefits to local residents;
- Local equity/ownership;
- Support local business enterprises; and
- Generate revenue support to protect the natural heritages.

7.1.3.5 Empowerment Considerations

- Capacity building of local communities, field officials and other government staff delivering service in the area;
- employment, business enterprises, participation, and management;
- Identify possible linkages to further enhance benefits to the local community.

7.1.3.6 Safety considerations

- Adequate provisions must be in place to ensure safety measures for guests, host communities and staff.

7.1.4 Ecotourism Implementation Modalities

In order to ensure transparency and equitable distribution of opportunities from ecotourism, any of the following methods may be implemented but not limited to;

Direct Award: This process highlights the equitable distribution of opportunities and the involvement of the local community. The communities are given the opportunity to operate the product/services developed by the Department of Forests and Park Service (DoFPS) with proper By-laws or management agreement.

Tenders: In cases where an ecotourism opportunity has been identified by the Department and there are more than one interested operator, the opportunity may be tendered via an open, transparent, and competitive process.

Consideration of unsolicited applications: In case a private sector entity presents an innovative and profitable business plan under a concessionary framework for areas where the Department has not identified an ecotourism opportunity yet, the ecotourism development proposal (Expression of interest) shall be forwarded to the Department for review. If the proposal is approved, the concessionaire may be awarded to operate the business for a fixed period. However, the applicant must follow the process described in Figure 7.1.

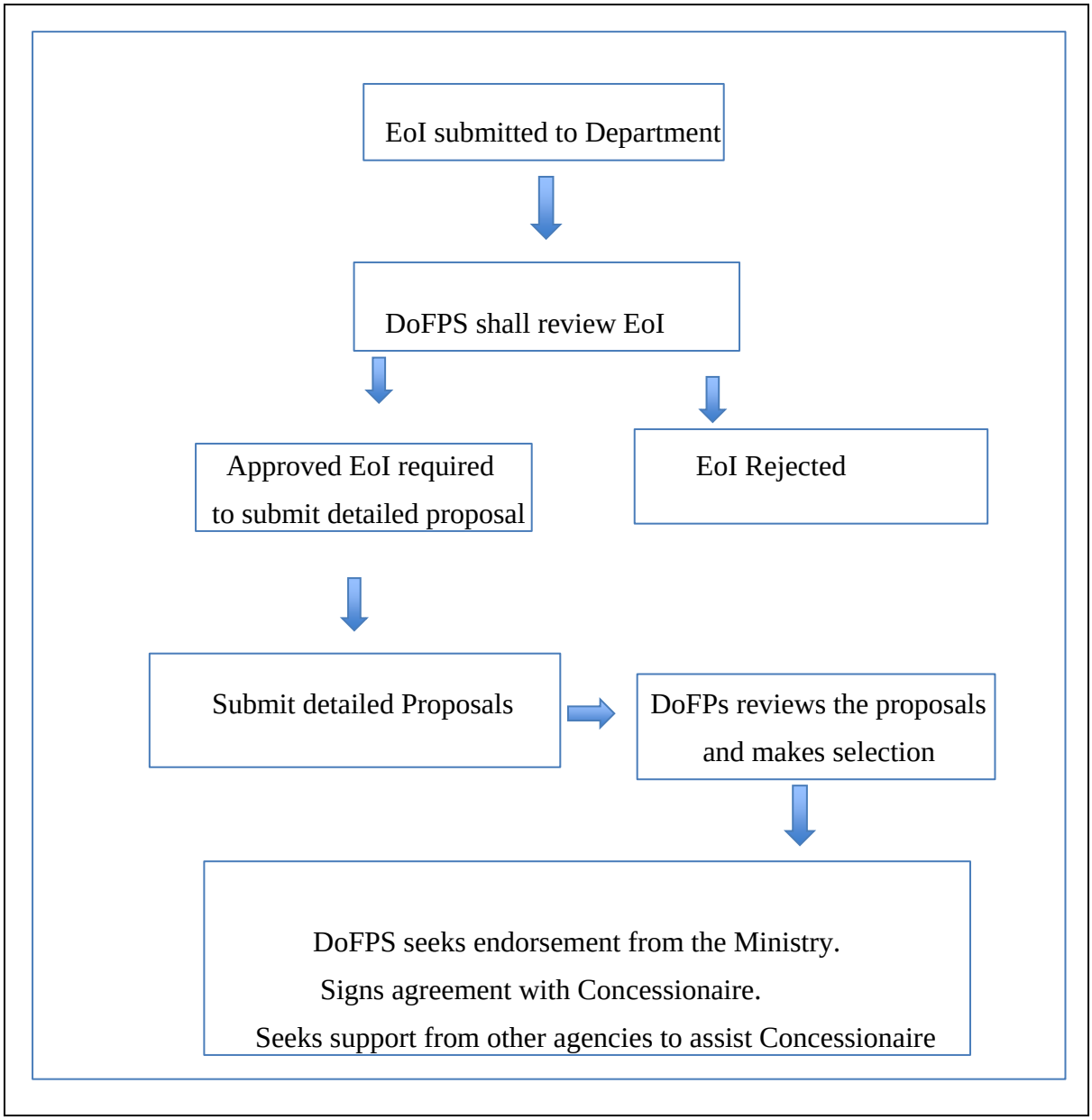


Figure 7.1 Flowchart show process for consideration of unsolicited applications

7.1.5 Monitoring and Evaluation

Monitoring and Evaluation of the ecotourism product shall be done as part of the monitoring and evaluation process of the area-based management plan as described in Volume III and IV of the *Code*.

In order to ensure effective implementation of the ecotourism program, the following parameter shall be considered.

Parameter	**Criteria**
1. Environmental Considerations	• Are the management goals, objectives, vision, mission aligned with principles of ecotourism? • Is the management/operational plan aligned with principles of ecotourism? • Is the ecotourism product/service nature/environment friendly? • Is there system in place to control access /use of natural resources at site?

	• Are there enough employees to manage and protect the environment of the area? • Are the employees/staff trained by TCB or other certified training providers to fulfill/ operate ecotourism activities? • Is there adequate budget allocated for environmental management? • Is the site practicing proper water and waste management?
2. Socio-Cultural and Economic Consideration	• Does the site contribute towards protection and promotion of the social and cultural norms? • Does the program contribute to revival of old traditions while strengthening the existing practices? • Are local labour engaged in establishing the area? • Are local people engaged/ employed in operating of the ecotourism site? • Does local leader have input in management decision making? • Does the site provide economic benefit to local communities? • Is there value addition to local products/resources? • Are local products used? • Is the system of sharing revenue in place (Contribution to community development; conservation and paying Taxes to the Government)
3. Visitor satisifaction and management	• Is there any feedback mechanism being implemented? • Based on the feedback mechanisms, are visitor satisfied in their visits and activities undertaken at the site?

7.1.5.1 Monitoring

Field Offices shall constantly monitor the Ecotourism programme in their respective jurisdiction. A monitoring form shall be used to gather information on visitor profiles, satisfaction levels and suggestions for improvement. NCD shall also monitor the implementation of ecotourism activities annually.

7.1.5.2 Evaluation

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall intervention. The ecotourism product shall be evaluated to see the impacts of the ecotourism project (economically, socially, and environmentally).

7.2. Recreational Area

7.2.1 Management Context

7.2.1.1 Background

With increasing tourism in Bhutan, the demand for recreational avenues is also growing. Bhutan places a strong emphasis on improving avenues of nature recreation and, development of recreational areas is a priority. Nature Recreational Areas are established on State Reserved Forest Lands having conservation values or natural and/or cultural attractions so that people value and appreciate the importance of nature. Nature Recreational Areas provide multipurpose functions.

From a conservation viewpoint, they offer an opportunity for public appreciation of biodiversity values through enjoyment, understanding and appreciation, thereby garnering support for conservation. This may be achieved via formal environmental education programs or in less formal and more subtle ways such as interpretation programs.

Recreational Areas, therefore, have environmental, economic and social benefits while also contributing to physical and mental wellbeing of the visitors and the people.

7.2.1.2 Objectives

The objective of recreational areas are to:

- Provide access to clean, safe, organized and beautiful recreational and community space for the general wellbeing of the people;
- Contribute towards spiritual, mental and physical wellbeing of people;
- Increase awareness on the value of nature and its services;
- Enhance the natural landscape in urban and rural areas;
- Serve as living class room for the youths; and
- Provide an appropriate and diverse range of recreational opportunities

7.2.2 Roles and Responsibility

Field office shall carry out identification, field survey, management planning and monitoring of recreational areas while the Nature Conservation Division (NCD) shall facilitate and provide technical support and capacity building. The final management plan shall be endorsed by the Department.

The recreational area can be managed by government agencies, local communities and private sectors based on the existing rules and technical regulation issued by the department.

Office	**Role and Responsibilities**
Nature Conservation Division (NCD)	• Develop national strategies, guidelines and frameworks related to recreational area development within SRFL. • Develop standards and ensure quality. • Review of Management Plan / Business Plan. • Provide technical assistance to field offices and the proponent in developing area if required.
Field Office	• Identify and assess the recreational area. • Develop recreational area. • Develop Management Plan/Business Plan. • Monitor and evaluate activities in the field.

7.2.3 Criteria for Identification of Sites for Recreational Area Development

Following factors shall be considered for identification of sites for development of recreational areas:

- Availability of suitable SRF land for establishment of recreational area
- Legal status of the area under consideration for recreational area development
- Support of Local Government
- Accessibility and utility

- Willingness of local communities' participation and support.
- Potential tourism attraction

7.2.4 Implementation of Recreational Areas

The recreational areas that are identified by the Department can be managed either by the Department or it could be handed over to local communities with clear roles and responsibilities including plough back mechanisms. In case private individuals and/or youth groups identify and propose a potential areas for operation as a recreational areas in areas not identified by the Department, the site may be operated after going through certain screening process as described in Figure 7.1 for Ecotourism Implementation Modalities.

7.2.5 Management Prescriptions Outline for Recreational Area

Table 7.2 outlines the general outline for management plan of recreation areas. This can be a standalone plan in case of private or municipal areas but shall form part of the area-based management plan in case it is established in the State Reserved Forest (SRF) land.

Table 7.2 Management Prescription outline for recreational areas

1. Background
2. Description of Area
    - 2.1 Location
    - 2.2 Climate
    - 2.3 Topography and soil
3. Objectives
4. Map
5. Values of Recreational Area
    - 5.1 Natural values
    - 5.2 Cultural values
    - 5.3 Economic values
    - 5.4 Social Values
6. Current Status of Biodiversity and livelihood
    - 6.1Biodiversity Survey
    - 6.2 Socio-Economic Survey
7. Park visitation analysis
8. Nature-based tourism potential
9. Issues
10. Management Strategy and Action
11. Monitoring and Evaluation

7.2.6 Monitoring and Evaluation

Monitoring and Evaluation shall form the principal constituent for determining the achievement of management objectives and strategic actions outlined in the management plan. The broad objectives of monitoring and evaluation are identified whether the plan is being implemented effectively and the objectives are being met, to learn from observation of the management strategy implementation and to adapt the management actions accordingly.

7.2.6.1 Monitoring

Monitoring can be supplemented through visitor records and visitor feedback registers. The field offices or the Recreational area manager shall conduct regular monitoring of activities during implementation. Reports on the status of the implementation shall be produced annually and submitted to the Department. NCD shall also monitor the implementation of programme activities annually.

7.2.6.2 Evaluation

Mid-term and Final evaluation shall be conducted to assess the overall impact and outcome of the planned activities. Monitoring and Evaluation of the recreation area can be done as a part of the monitoring and evaluation process of the area-based management plan as described in Volume III and IV of the *Code*.

7.3 Man and Biosphere Reserve

7.3.1 Management Context

7.3.1.1 Background

The Man and Biosphere (MAB) program under United Nations Environmental, Scientific and Cultural Organisation (UNESCO) is an intergovernmental Scientific Programme, launched in 1971, aiming to set a scientific basis for the improvement of the relationships between people and their environment globally.

According to UNESCO, biosphere reserve is a learning place for sustainable development. It is a place for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. They act as divers for the conservation of natural, social and cultural values and the sustainable use of these resources at the services of the welfare of local communities. They serve as places that provide local solutions to global challenges. Once it is internationally recognized after being nominated by national governments, it remains under the sovereign jurisdiction of the States where it is located.

Similar to zoning of the protected areas in Bhutan, biosphere reserves are divided into three interrelated zones such as core area, buffer zone and transition area. The core area comprises a strictly protected zone that contributes to the conservation of landscapes, ecosystems, species and genetic variation. The buffer zone surrounds or adjoins the core areas and is used for activities that are compatible with sound ecological practices that can reinforce scientific research, monitoring, training and education. The transition area is where communities foster economic and human activities that are socio-culturally and ecologically sustainable.

7.3.1.2 Objectives

The main objective of the MAB program is to:

- promote biosphere reserves as tools for innovative projects to bring added value to local socio-economic activities;
- raise awareness and capacity building among all concerned stakeholders in the area about biosphere reserves and climate change adaptation; and
- link the country with the World Network of Biosphere Reserves in order to ensure international support and exchange of experiences, especially on sustainable development and climate change adaptation.

7.3.2 Roles and Responsibilities

NCD shall act as the secretariat for MAB program and propose members for the national MAB committee to the Department for endorsement. The concerned field office shall prepare and implement the plan. The roles and responsibilities of the main offices involved in the designation of MAB site are shown in Table 7.3

Table 7.3 Roles and Responsibilities

Office	Role and Responsibilities
Nature Conservation Division (NCD)	• Facilitate and provide technical support for declaration of biosphere reserve • Review of Management Plan • Conduct Monitoring and Evaluation • Submit nomination file for approval to the Royal Government of Bhutan.
Field Office	• Identify a site • Conduct feasibility assessment • Conduct survey and demarcate boundary demarcation • Prepare and implement Management plan • Conduct Monitoring

MAB National Committee	• Provide guidance for identification of MAB site • Review nomination file • Establish and maintain cooperation with other relevant agencies • Exchange information and expertise and advice decision-makers.
Bhutan Nat Com	• Facilitate between UNESCO and DoFPS for seeking support for establishment of MAB site in Bhutan.

7.3.3 General Criteria

The general criteria for an area to qualify for designation as a biosphere reserve are listed as follow:

- It shall encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions.
- It shall be of significance for biological diversity conservation.
- It shall provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale.
- It shall have an appropriate size to serve the three functions of biosphere reserves.
- It shall include three interrelated zones such as core area; buffer zone and transition zone through appropriate zonation
- Organizational arrangements shall be provided for the involvement and participation of a suitable range of inter alia public authorities, local communities and private interests in the design and carrying out the functions of a biosphere reserve

7.3.4 Steps for Site Identification and Declaration of MAB Site

The detail process for identification and declaration of MAB site is shown in Figure 7.2.

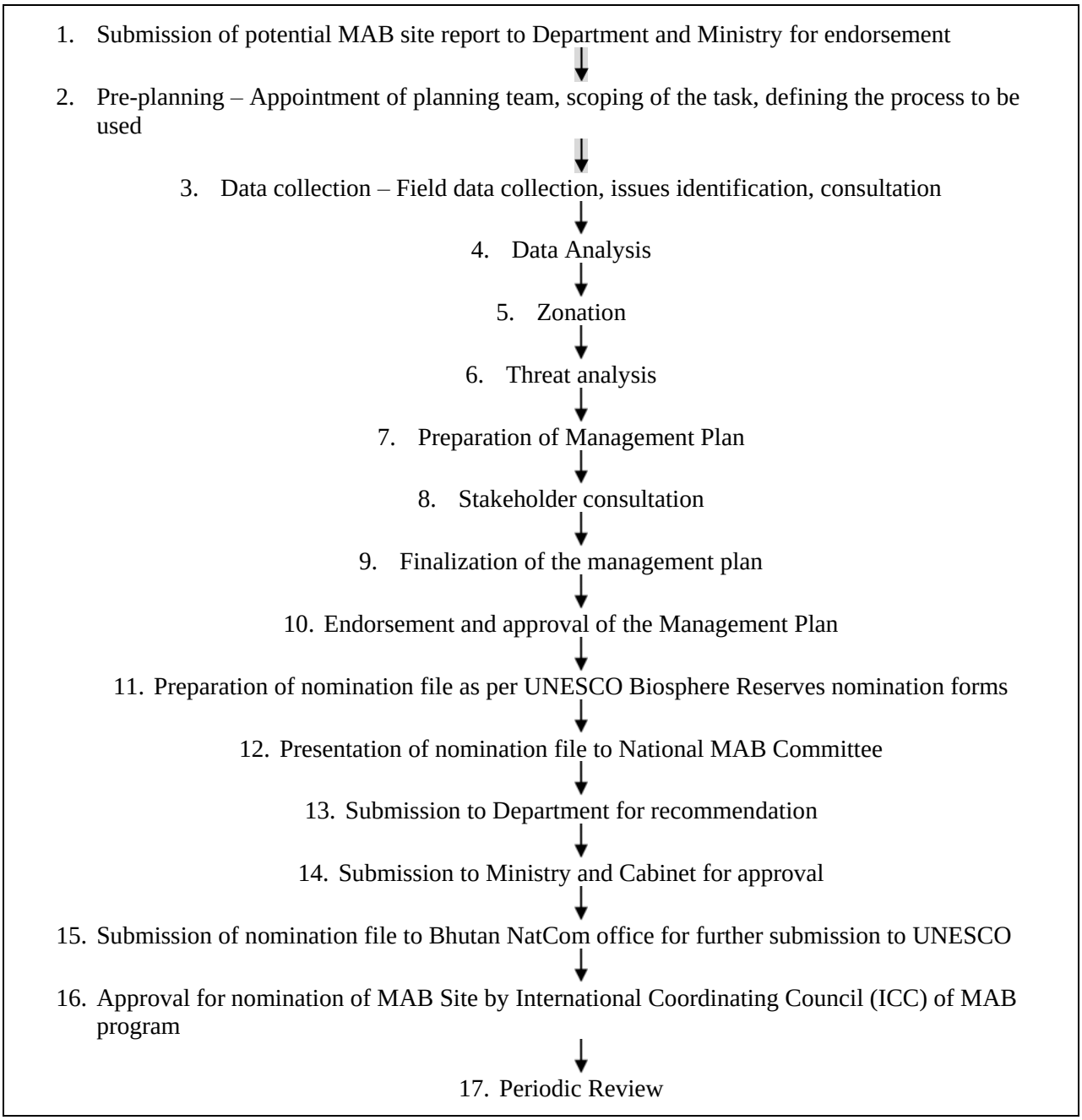


Figure 7.2 Steps for idenfication and declaration of MAB sites

7.3.4.1 *Submission of Potential MAB Site Report to Department and Ministry for Endorsement*

Based on the above criteria, concern field office shall propose MAB site to Department and Ministry for endorsement.

7.3.4.2 Pre-planning Phase

The pre-planning phase is one of the most important steps in the management planning process. This phase defines what should be achieved, how it is to be carried out, timing considerations and who is to be involved, etc. The planning phase shall include;

- identifying the purpose and management objective and ensuring that all stakeholders involved can understand them;

- identifying and forming survey team members;
- training of the survey team members;
- prepare and follow a well-laid out work schedule for the management planning process; and
- identifying planners.

7.3.4.3 Data collection and analysis

7.3.4.3.1 Large Mammals

7.3.4.3.1.1 Data collection

Transect Survey

Direct observation is often not an efficient method to detect mammal species in the forest with thick ground and canopy cover as the detection is very low. Mammals often leave behind signs of characteristic appearance that indicate their presence. Indirect evidence of presence such as tracks, hairs, scats, dung piles, scent marks, or scrapes can, instead, be more easily recorded in the course of any survey.

Trail transect survey is an inexpensive method commonly used for surveying of mammals over time to determine species distribution of most carnivore groups, including several felids and ungulates. Given the relative ease and low cost of data collection, detection/non-detection or patch occupancy methodologies have become one of the most commonly used surveying methods currently in use, and one that is increasing in popularity (Marsh and Trenham 2008). Transect survey can be a best option to survey mammals given limited financial and human resources.

Materials required

GPS device	Clinometer	Survey forms
Compass	Topographic maps	Pen/Pencils

Survey design and methods

The Biodiversity Monitoring Grids (BMG) are firstly stratified based on vegetation types after which grids (4km x 4km) are randomly sampled for conducting the Mammal transect survey. The survey form as prescribed in Table 1.2 shall be used.

Table 1.2 Mammal transect survey form

MAMMAL TRANSECT SURVEY FORM

PA/ FD:
Grid ID:
Transect ID:
Date (YYYY/MM/DD):
Weather:
Surveyors:
Start GPS (Deg Dec):
End GPS (Deg Dec):
Locality:

A: acoustic SP: scrape
C: carcass ST: scratch
D: dropping CW: clawing
T: track WL: wallow
S: sighting PL: ploughing
FR: forage BD: bedding
BP: body part HL: hole

ST: sub-tropical WB: warm broadleaf
CB: cool broadleaf B: bamboo C: Conifer (Fir/Chir/Pine/Bluepine/Hemlock)
MC: Mixed conifer WL: wetland
GL: grassland AM: Alpine meadows

GR: Grazing
P: Poaching
DA: Road/Transmission/ NRE: Timber/NWFP extraction/Fodder/Fuelwood
FR: Forest Fire
N: Erosion/landslides/
PD: Pest/Diseases/Invasive spp.

			Direct sighting												
			Count no					Latitude [N]	Longitude [E]						
Species	Time	Dist (m)	M	F	J	Unknown	Evidence	Deg Decimal	Deg Decimal	Altitude (m)	Aspect (deg)	Slope (deg)	Habitat type	Threats and Disturbance	Remarks

Note: M = male, F = female, J=juvenile under column number 4, 5 & 6 respectively

- For each selected biodiversity grid, the GPS coordinate of the centre of the grid should be recorded and marked in the GPS which would be used for calibration while surveying.
- Within each selected BMG, a trail transects measuring upto 3-5 km (natural trails or existing footpaths) depending on the accessibility of the area should be walked covering major habitat types within the grid.
- If the area is inaccessible, 3-5 shorter trail transects of at least 1 km each should be searched for mammal and mammal signs (Figure 7.3).
- Ensure that the survey team enters inside the grid to initiate the survey.
- If there are more than one trails within the grid, the trail leading towards the centre of the grid should be selected for surveying.
- Mammals sightings and mammal signs including tracks, scats, dung, scratch marks, etc., encountered on the trail transect should be recorded.

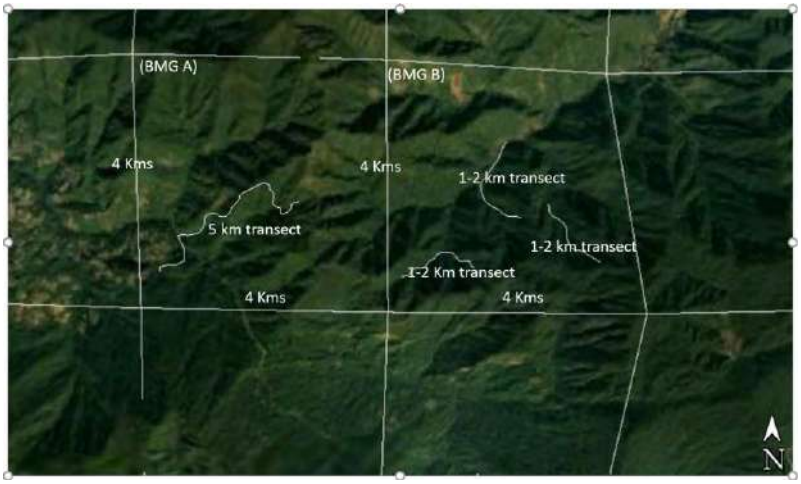


Figure 7.3 Survey grid (4x4 km) with 5 km transects (BMG A: Where a single long transect is executed; BMG B: where three shorter transects are executed)

- GPS location at every 500m distance covered should be recorded in the datasheet even if there is no animal or sign observed.
- In case of direct sighting, record the species, GPS location details of the observer, number of animals seen and sex and age of the animal in the datasheet in the Table 1.2**.**
- If animal signs are encountered, record species, sign type, GPS location details and habitat type of the areas in the the datasheet.
- In case of animal trails, each trail set is considered as one sign (not every indirect sign as a new sign). If an animal continues to walk along a trail for a long distance in the same direction, then this should be considered as one sign.
- If no sign is seen on the track for over 50 m then encountering a fresh track set is considered as a new sign.
- Photographic records with proper scale reference and GPS location should be taken if there is difficulty in sign identification.

Data compilation and storage

- After every transect survey, data gathered in the datasheet should be entered into a spreadsheet for further analysis and storage.
- Species wise data entry should be done as per the format in Table 1.3 (one spreadsheet for each species).
- One copy each of compiled data should be submitted to the Data Repository Centre of the Department for storage, and to the NCD for analysis and reporting at the national level. Analyzed data should be reported as species status updates on a regular basis through technical reports, policy briefs, scientific papers, etc.

Table 7.3 Format for tabulating transect survey data

Species Name:															
	GPS Coordinates		**Evidences recorded**												
			Transect 1			**Transect 2**			**Transect 3**						
Grid ID	**X**	**Y**	**Dropping/Scat**	**Pugmark/Hoof mark**	**Others**	**Dropping/Scat**	**Pugmark/Hoof mark**	**Others**	**Dropping/Scat**	**Pugmark/Hoof mark**	**Others**	**Habitat Type (Major)**	**Avg Elevation**	**Aspect**	**Avg Slope**

Camera Trapping

Camera-trapping is a useful and widely used non-invasive tool to study wildlife. It can gather information on a wide range of species simultaneously and continuously, over large survey areas for long duration. Camera traps can be used as a monitoring tool to document detection/non-detection of a target species or to conduct a species inventory for a given area. The use of camera traps can also advance to major researches such as deducing wildlife abundance and density through Spatially Explicit Capture Recapture Models (SECR) which is well suited for many wild felids with distinct body pattern, Random Encounter Modelling (REM), species interaction and activity pattern, etc.,

Equipment and Materials required

- Camera trap, batteries and memory card
- GPS device
- Compass
- Clinometer
- Topographic maps
- Survey forms
- Pen/Pencils

Sampling Design

Within the 4 x 4 km sampling frame/reference grids (Figure 1.2), camera traps shall be randomly placed along the trails at 2-4 metres away from the center of the trail on both sides. The camera trap installation sites shall be selected while conducting the transect survey in the same grid. Camera stations should be stratified by habitat type to address habitat use by the species. For the purpose of development of the conservation management plan, where only species distribution patterns, wildlife abundance and their presence-absence are to be estimated, a single camera trap per station can be adopted.

However, two cameras per station should be installed when the objective is to identify individuals of a species for the purpose of estimating animal abundance and density using SECR models which is suited for wild felids.

Camera Trap Installation Methods

Camera traps are particularly well-suited to survey terrestrial mammals, especially those known to use roads or trails as travel paths. Placing cameras on such paths therefore, is efficient and increases the rate of detection. In forested environments, cameras can easily be attached to trees with bungee cords, nylon webbing straps and other binding ropes/wire. Stakes can be used effectively in areas containing few or no trees.

Surveyor must keep in mind the following while installing camera traps:

- Setup the camera in such a way that best suits one's needs. Setting up of image pixel, capture time lapse and movie length depends on the trapping duration and SD card memory. However, it is recommended to set image size at 3 MB and video length at 10 seconds as images in this resolutions are good enough to identify images
- In case of using two cameras, place one camera on right and another on the left side of trail
- Avoid placing cameras directly facing each other, as camera flashes from one camera can create washout in the opposing camera. Such issue is relatively minor for infrared flash built-in cameras.
- Do not place cameras too close to trails because digital cameras tend to slow trigger speeds resulting in numerous blank photos or partial pictures which lead to battery exhaustion.

- Cameras must be placed at 2-4 m away on either side from the center of the trail (Figure 7.4*Figure 7.4*).

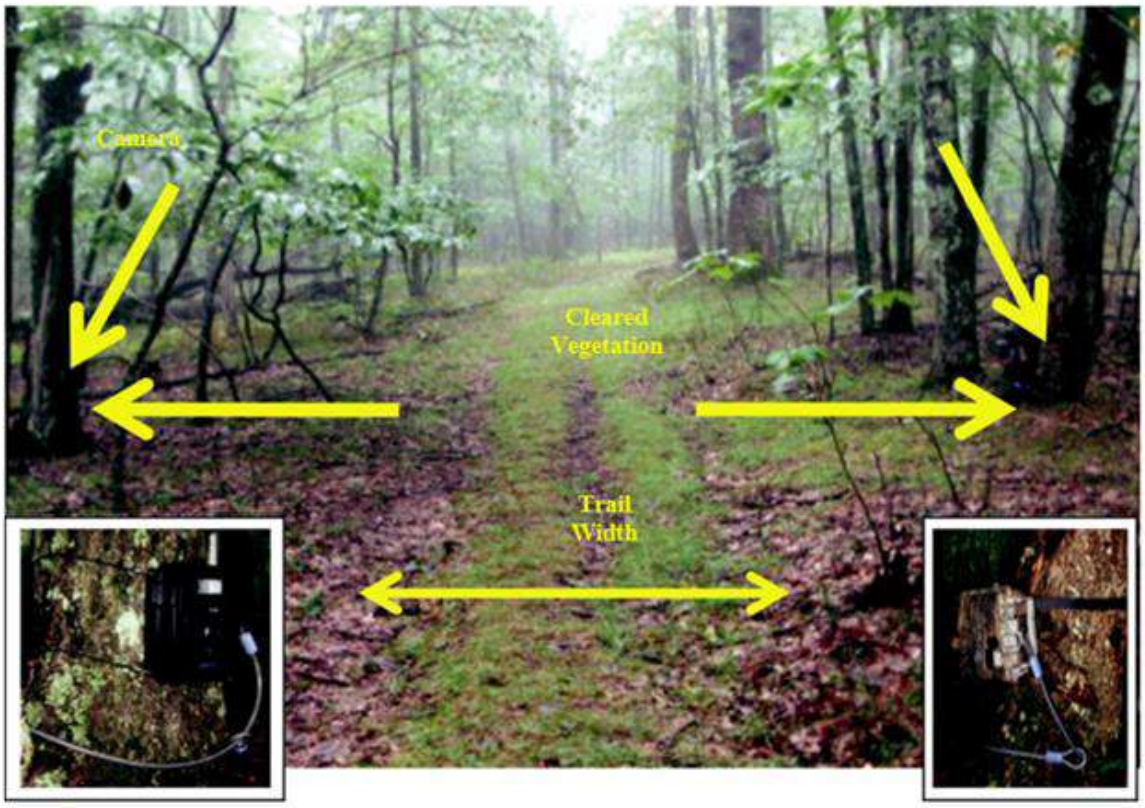


Figure 7.4 Example of field camera placement with 2 cameras per station

- Cameras should not be placed far off the field of view, beyond 6 - 8 m shall be hard to distinguish animals, especially for smaller species. *Refer flash illumination specifications of each camera model to maintain appropriate distance and guidance*.
- Place/fix camera at 20-40 cm or knee height on tree or pole. Bit of height adjustment would be required for elephants and large ungulates to ensure capture of full body parts.
- In case of difficulty in setting up two cameras on a single station, second camera can be set up within 50m along the same trail.
- Cameras should be placed parallel to the ground to ensure effective capture.
- Ensure that the camera is not against the sun and moving objects within the detection zone to avoid capturing ghost/black pictures.
- Once the camera trap is set, fill the datasheet provided (Table 1.4) and then arm the camera

Table 7.4 Data Form for Camera Trap Installation, Monitoring & Retrieval

Grid No	Camera ID	Date (yyyy/mm/dd)	Time	Setup/Monitoring/Retrieval	Altitude	Aspect	Habitat	Surveyors	GPS Latitude [N]	GPS Longitude [E]	Remarks
									Degree decimal	Degree decimal	

Camera functionality check and maintenance

Camera traps placed at a site are usually subject to theft and malfunction due to extreme weather conditions, battery drain-out and damage by wild animals. Therefore, timely monitoring is necessary to ensure its proper functionality and timely replacement.

Surveyor must bear in mind the followings during the survey:

- Always take extra cameras and batteries when replacement is required.
- Do first camera check in 10 days of trapping to make sure everything is operational and to determine photographic rates and battery status.
- After the initial camera check, monitoring shall be done twice a month to avoid the risk of loosing data if early malfunction of the camera occurs or a camera gets damaged by animals
- In the subtropical climatic condition, site clearing of each camera shall be done to avoid obstruction within the detection zone, especially during April – October.
- During the monitoring of camera traps, you should record battery drain (%), photographs taken and general malfunction if any in the remarks corner of forms, *Figure 7.4*. This shall help to evaluate the performance of the camera.
- It can be very easy to lose track of what data came from which camera when downloading memory cards to a computer. An easy solution is to trigger each camera with a placard that has station code, camera number, and date. Alternatively, a stake can be placed into the ground within the camera's viewfinder that records the station code and camera number. However, placard methods are preferred, because the date written on the placard can later be used to recalibrate a camera if data/time stamp becomes corrupted.
- All cameras shall be set to display both time and date on the image as this information is essential in future analyses.
- All cards shall be downloaded at the end of each camera check or at the end of monitoring date so long as SD card storage permits. This shall also avoid data loss if camera gets stolen.
- Ensure cleaning and drying of camera right after retrieval from the field.

Data Compilation and Storage

Data Compilation

The camera trap installation/monitoring/retrieval form should be entered into a spreadsheet by the surveyor. The respective field Offices should keep a copy of raw data (camera trap images) saved in a separate folder giving proper grid IDs. While one set of data is kept as raw, the other set should be sorted species wise for each camera trap station (Figure 7.5).

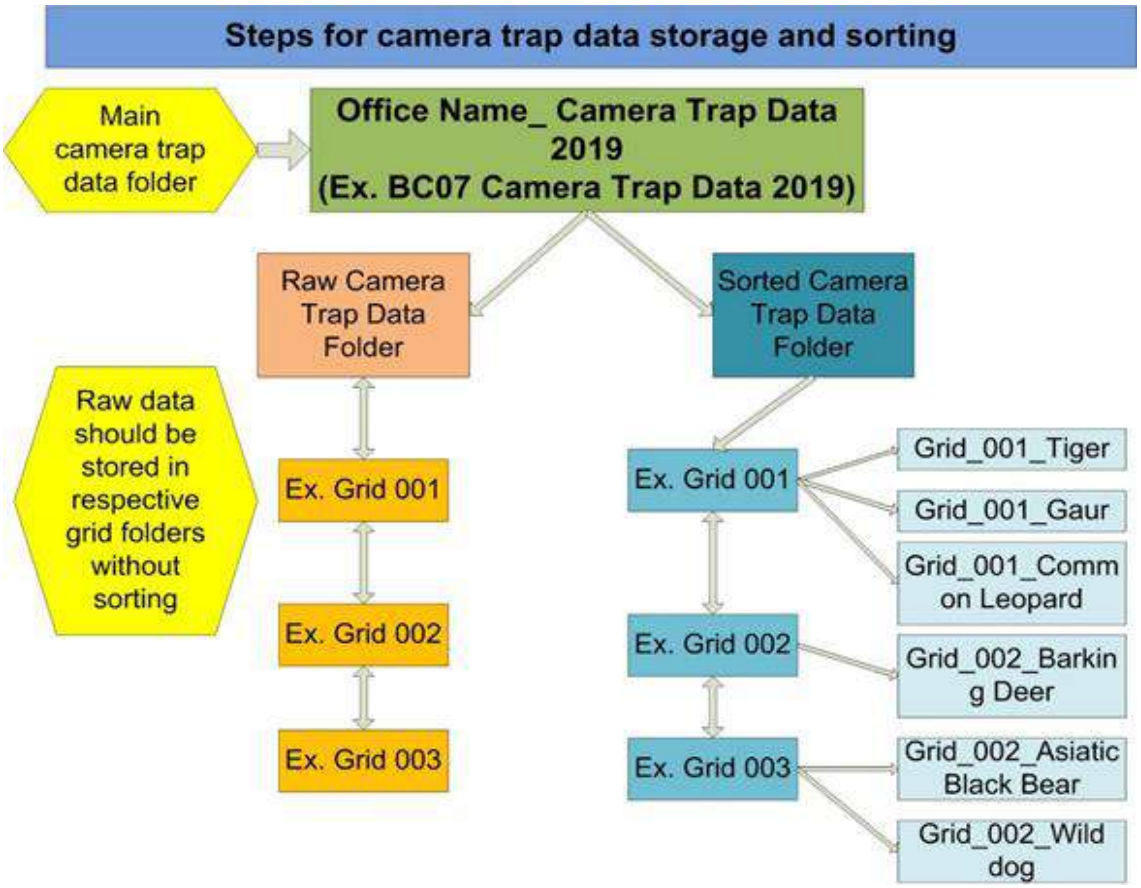


Figure 7.5 Schematic diagram showing the steps of camera trap data sorting and organization

Details of the captured image such as time of capture and number of individuals in the image shall be entered into the spreadsheet manually or using relevant applications such as *ReNamer* or *CameratrapR*, as prescribed in (Table 1.5).

Table 7.5 Sample datasheet for entering camera trap data (Similar sheet should be developed for each species captured in the camera trap)

Species	Asiatic Black Bear				Camera Trap Days																														
Grid ID	Latitude	Longitude	Start Date	End Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1234					0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7.3.4.3.1.2 Data Analysis

Occupancy and habitat use

Using both the transect survey data and camera trap data, occupancy models (MacKenzie et al., 2006) can be used to detect changes in presence of a species or proportion of sites (or area) occupied by the species. For the ease of analysis, single season occupancy models shall be used to understand the occupancy. In case the available data does not fulfill the assumptions of occupancy models, habitat use analyses can be performed (e.g. Phillips, Anderson, &Schapire, 2006). Following steps can be followed for performing the analysis:

- Complete the data compilation and storage process as prescribed above.
- Generate and obtain all the environmental covariates such as elevation, distance from settlement/road, distance from water, forest types, etc., from relevant sources.
- Obtain the naïve occupancy from both camera trap data and transect data. Naïve occupancy is quantified as the number of camera trap locations at which each species is detected divided by the total number of camera trap locations or number of transects where animal signs are detected divided by total transects walked.
- Obtain the required programmes such as PRESENCE, or R with required library such as "unmarked" or "wiqid" for performing the single season occupancy models using the relevant environmental covariates.
- Based on results obtained from occupancy modelling, produce species occupancy maps either on R using the relevant library such as "raster" or in ArcGIS or QGIS.
- For data that does not fulfill the assumptions for occupancy models, site use probability maps should be produced using species distribution models like Maxent, or Generalized Lineaer Models.
- Where possible, comparisons should be made between current results with that of the past conditions to understand the change in occupancy and habitat use pattern of the species for the same area, which shall help determine conservation prescriptions.

Species abundance and density

Using the data from camera trap survey, capture-mark-recapture (CMR) models shall be used to estimate the abundance (population) of a species in a particular area. This is applicable to species which have distinct colour pattern such as tiger, snow leopard, common leopard, clouded leopard etc.

- Spatial Capture Recapture (SMR) models and analysis can be performed either on programme CAPTURE (Efford&Fewster, 2013) or in R using the relevant packages such as "secr' (Efford, 2018).
- Using the results from SMR models, species density map should be produced either on R using the relevant library such as "raster" or in ArcGIS or QGIS.
- Where possible, comparisons should be made between current results with that of the past conditions to understand the change in occupancy and habitat use pattern of the species for the same area, which shall help determine conservation prescriptions.

Index of abundance or relative density

This is commonly known as Relative Abundance Index (RAI) and it is calculated as the number of captures divided by the total sampling effort in days multiplied by 100 (O'Brien 2011; Hedwig et al.2018). Camera

trap data can be used for obtaining the RAI of individual species encountered/captured during the survey. Following formula can be applied for obtaining the RAI.

$$\mathrm{RAI_{spa}} = \text{events} * \frac{100 \text{ camera trap nights}}{\text{sampling effort}} \quad (6)$$

Where $\mathrm{RAI_{spa}}$=relative abundance index for species 'a';

events=number of independent records per species;

100 camera trap nights=unit of standardization to compare data with other studies; and

sampling effort=total amount of nights that the camera trap stations were working.

- Only one individual per species can be counted at each camera trap station within a 24hr period (independent record); with the exception of gregarious species and felids.
- For gregarious species, when instances of more than one individual are recorded at the same time and for the same station, the number of independent records is considered equal to the number of individuals observed in the same frame.
- For felids (or other species where individuals could be identified) consecutive records of the same individual, at the same station can be as independent records when there is a 24h interval between consequetive detections.

Species Activity Pattern

Activity data reflect an important dimension of animal behavior and ecology, as they provide relevant information on species' natural history and ecological niche. Activity patterns of surveyed species can be analyzed using images of the same species taken at intervals of ≥ 1h from each transect.

- Establish activity patterns, analyze the temporal patterns of records using Oriana 4.0 software (Kovach, 2011) or ReNamer (Sanderson & Harris, 2013).
- Analysis can be restricted to species with more than 10 independent photographic records.
- Each photographic record can be classified as diurnal, nocturnal or crepuscular according with the time of local sunrise and sunset.
- Diurnal (≥70% of records occurring during the day), nocturnal (≥70% of records during the night), crepuscular (from 50 to 60% of records during crepuscular periods), crepuscular/nocturnal (from 60 to 70% of records during the night and crepuscular periods), crepuscular/diurnal (from 60 to 70% of records during the day and crepuscular periods) or cathemeral, when records were randomly distributed along the daily cycle. Crepuscular records are those occurring within 1h before or after sunrise or sunset.

Species Accumulation Curve (SAC)

Also known as species-richness curves or collector's curves or species effort curves or species accumulation curve, can be used to estimate the number of species in a particular area. They can also be used to indicate the adequacy of a fauna survey in representing the fauna in a particular area. Using the camera trap data, cumulative number of species detected against the survey effort can be plotted to reach an asymptote when all species have been recorded. While species accumulation curves can be used to compare diversity between different samples, the shape of the curve can vary with the relative abundance of different species (Thompson & Withers, 2003). Communities with a high proportion of abundant species have a steeper initial slope than communities with a high proportion of rare species.

7.3.4.3.1.3 Reporting

The results/inferences drawn from the above-mentioned analysis should be used to make appropriate prescriptions in the conservation management. The details of the analysis and results can be produced in the form of technical reports. Useful summary data such as total number of species captured, total number of trap nights for an entire survey, the total number of photographs "events" for each species and trap rates for each species for an entire survey can be included in the report. The copies of both raw and sorted data should be submitted to FRMD and the NCD.

7.3.4.3.1.4 Other information

Information on small mammals, freshwater fish, macroinvertebrates, herpetofauna, insects etc. may also be collected. Detailed methodology is mentioned in National Biodiversity monitoring protocol described in Volume I of the *Code.*

7.3.4.3.2 Bird Survey

7.3.4.3.2 .1 Sampling Design

The 4x 4 km sampling frame grid shall be subdivided into 16 numbers of 1x1 km survey squares. The survey squares are assigned with unique id codes from (01 – 39,450). The geo-coordinates of the centroids are used to geo-reference any other biodiversity, geophysical and climatic data (Figure 7.6).

Randomly select 5 survey squares in each BMG and conduct the survey using the best applicable method. Random numbers can be selected using random number generators from scientific calculators, from most database packages (such as Excel), or from statistical tables. Alternatively, bits of paper each with the grid coordinates of 1 square can be put into a hat and drawn out blindly (this is only random if every square has a corresponding piece of paper).

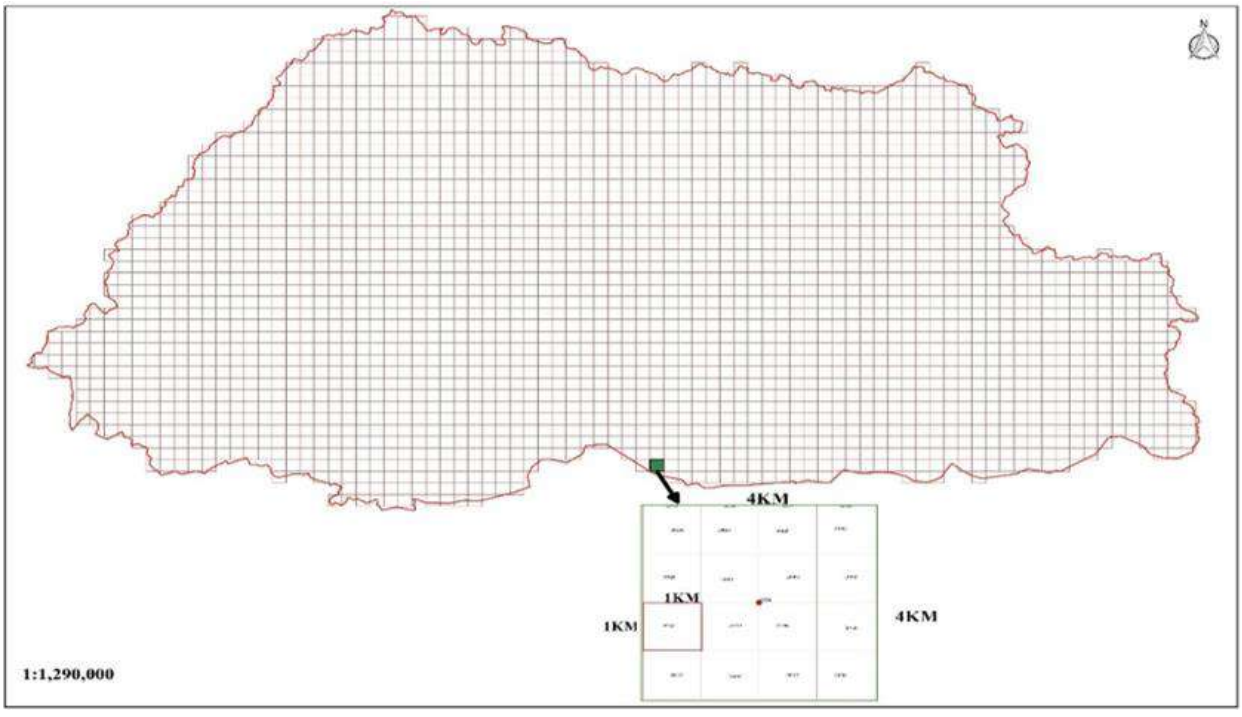


Figure 7.6 Survey design showing National Biodiversity Monitoring Grid (4x4 km) and Survey Squares (1x1 km)

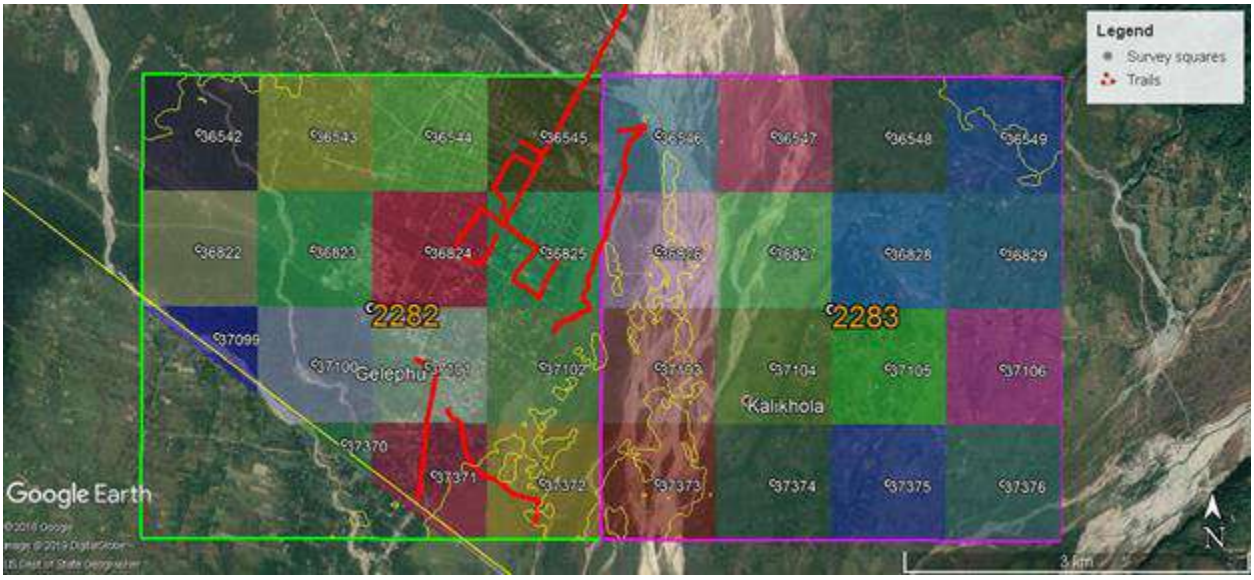


Figure 7.7 Two 4x4 km Biodiversity Monitoring Grids (with Green & Pink polygon outlines) falling on GelephuThrom (2282) &Maokhola (2283) with 1x1 km Survey Squares and trail transects (Red Lines)

7.3.4.3.2.2 Materials required

Binoculars & Camera	Altimeter/GPS Unit/Compass	Field Guide/Bird Songs	Pencil/ Pen	BallPoint
Laser Range Finder	Topographic Map of the Survey Area	Data Form/App		

7.3.4.3.2.3 Methods

Data Collection: Trail Transect

In the 'survey squares' layout 1 km trail transects. In case, the survey square has more than one habitat type, run as many 1 km trail transects as possible. In case the survey square has more than one habitat type, run one 1 km trail transect in each habitat. Each survey square should have 3-5 transects (Gregory et al. 2004. A trail transect involves walking along an existing trail (footpath, animal track, and roads) and recording birds on either side of the observer. The distance a bird is seen or heard from the transect line is normally recorded as an absolute measure, perpendicular to the trail transect line with the laser range finder. The data collection should be done as prescribed the data collection form prescribed in Table 1.6.

Table 7.6 Bhutan Bird Survey Data Form

Grid Code	**Sub-grid Code**	**Transect ID**	**Dzongkhag**	**Gewog**	**Chiwog**	**Park/TD**	**Range**	**Beat**
Date (YYYY-MM-DD)	**Location**	**Weather**		**Northing**	**Easting**	**Altd (m)**	**Time (Hrs)**	
			Start:					
Surveyors			**End:**					
1.	**2.**		**3.**		**4.**			

SPECIES	**COUNT**				**Distance Band (meters)**						
	M	**F**	**Juv**	**Un**	**DIST(m)**	**Hrs**	**Alt(m)**	**Habt**	**BrdC**	**Acty**	**Remark**

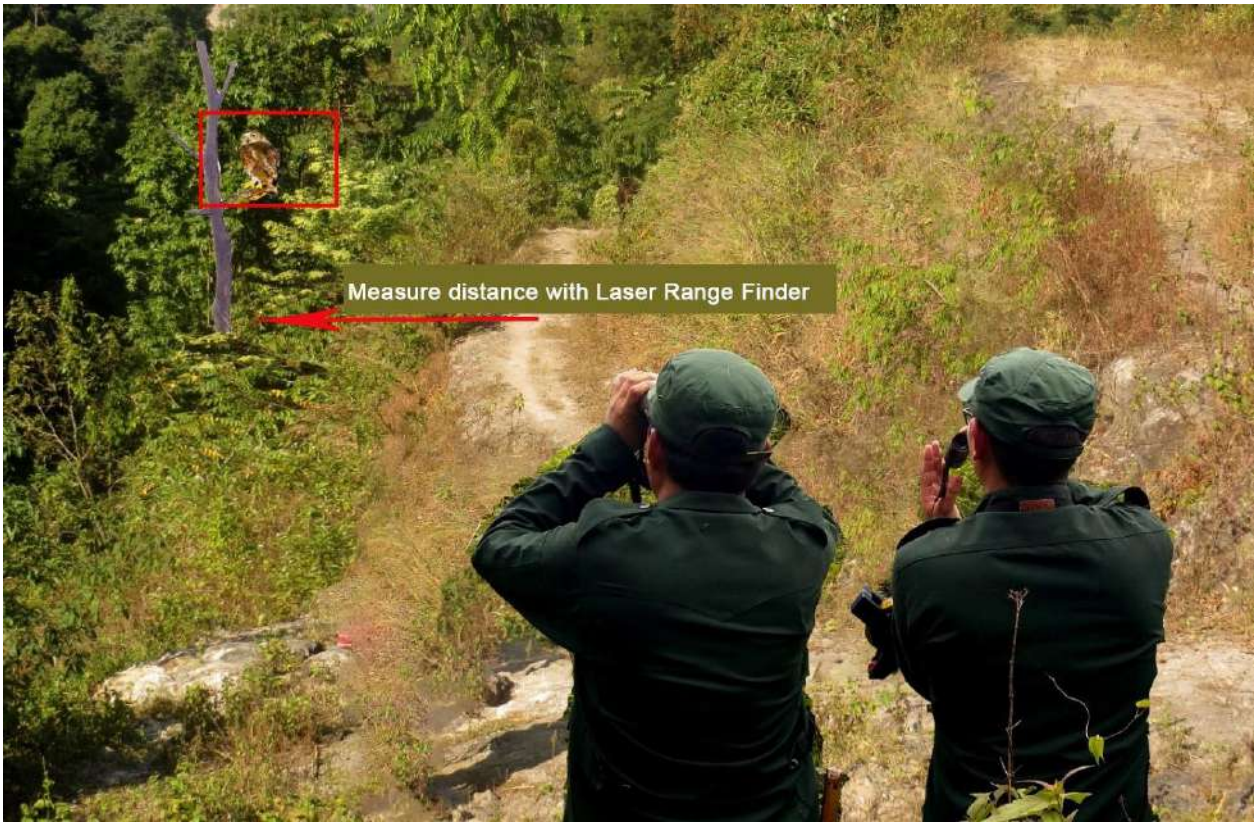


Figure 7.8 Observing birds along the trail transect and measuring perpendicular distance from the trail transect line to the bird sighting using laser range finder.

Box 1.1 Advisory Points

1. ***Listen to Bird Songs:*** Start to listen to bird songs of Bhutan to familiarize with calls and identify bird by songs.
2. ***Study Guide Books***: Constantly study the field guide to the birds of Bhutan to assist easy identification of during the field observations.
3. ***Constant Speed***: On each transect, walk along the transect at a fairly constant speed, looking either side of the line and record all the birds sighted.
4. ***Measure Distance***: For cluster birds consider the perpendicular distance at the center of the cluster from the trail transect line.
5. ***Survey Team***: Compose bird survey team of THREE members (one data recorder & 2 observers).
6. ***Data Recorder***: One data recorder shall be responsible for accurately and consistently recording the bird observations provided by two observers.
7. ***Record Flying Birds***: If birds fly away as you are counting, record them from the point you first saw them.
8. ***Detection***: All the birds on the trail (0m distance) are detected.

9. ***Sighting Position***: More commonly, birds shall be flushed away from you, so keep an eye on the line of travel ahead of you and try to record the positions from which the birds are flushed.
10. ***Bird onto Wings***: If birds are seen to take to the air, then these birds should be included in the count and an estimate of distance is made from the take-off point perpendicular to the line transect.
11. ***Knowing Form***: Familiarize trail transect data form carefully and understand the parameters to be filled.
12. ***Completely Fill***: Leaving the parameters empty shall create problems at the data analysis stage.

MacKinnon Lists

MacKinnon List (ML) is the method of listing all individuals encountered in chronological order of detection. This master list is then broken down into sub-lists or samples of a pre-determined number of species; ten is often recommended. Each list thus provides a sample of the species community at the study site. The ML method shall then be used to derive abundance indices of individual species by calculating the proportion of samples in which each species occurs. This method shall be followed if the purpose is for one-time rapid assessment of birds. Different listings shall be done for different habitats, as prescribed in Table 1.7, Table 1.8 and Table 1.9.

Table 7.7 Datasheet for MacKinnon Listing in Broadleaf Forests

Grid ID:		Trans/Plot ID:	Date (YYYYMMDD):						Habitat:		
Start Time:		End Time:	Weather:						List:		
GPS Start:			GPS End:						Surveyor:		
Sl. No	**Time (Hrs)**	**Species**	**Cluster Size**				**Altd. (m)**	**Evid.**	**Behv.**	**GPS Coordinate**		**Remark**
			M	**F**	**J**	**USex**				**Northing**	**Easting**	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
Habitat Type: SBLF: subtropical broad leaf forest, WBLF: warm broadleaf forest, CBLF: cool broadleaf forest, Remark: keep note of any special observations. CLUSTER SIZE: (M: male, F: female, J: juvenile, USex: Non dimorphic): Keep notes of threats (traps, snares, poaching): Hornbill nest trees. Altd.: altitude, Evid.: evidence (o: observed, c: call, f: feather, db: dead body, d: dropping), Bevh.: behaviour (fd: feed, rt: rest, pn: preen, cs: courtship, fl: fly).												

Table 7.8 Datasheet for MacKinnon Listing in Conifer Forests

Grid ID: **Trans/Plot ID:** **Date (YYYYMMDD):** **Habitat:**

Start Time: **End Time:** **Weather:** **List:**

GPS Start: **GPS End:** **Surveyor:**

SlNo	Time (Hrs)	Species	Cluster Size				Altd. (m)	Evid.	Behv.	GPS Coordinate		Remark
			M	F	J	USex				Northing	Easting	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Habitat Type: DTCF: dry temperate conifer forests (blue pine & spruce), MTCF: moist temperate conifer forest (hemlock, fir), SACF: subalpine conifer forest (juniper, rhodo& willow shrubs)
DCF: dry chirpine forest, CLUSTER SIZE: (M: male, F: female, J: juvenile, USex: Non dimorphic): Keep notes of threats (traps, snares, poaching), Remark: keep note of any special observations
Altd.: altitude, Evid.: evidence (o: observed, c: call, f: feather, db: dead body, d: dropping), Bevh.: behaviour (fd: feed, rt: rest, pn: preen, cs: courtship, fl: fly)

Table 7.9 Data form for MacKinnon Listing in Wetlands

Grid ID:	**Trans/Plot ID:**	**Date (YYYYMMDD):**	**Habitat:**
Start Time:	**End Time:**	**Weather:**	**List:**
GPS Start:		**GPS End:**	**Surveyor:**

SlNo	**Time (Hrs)**	**Species**	**Cluster Size**				**Altd. (m)**	**Evid.**	**Behv.**	**GPS Coordinate**		**Remark**
			M	**F**	**J**	**USex**				**Northing**	**Easting**	
1												
2												
3												
4												
5												

Habitat Type: AS: farmland & settlement, WL: Wetlands (riverbeds, rivers, streams, lakes, marshes), AM: alpine meadows, OM: open meadows

CLUSTER SIZE: (M: male, F: female, J: juvenile, USex: Non dimorphic): Keep notes of threats (traps, snares, poaching), Remark: keep note of any special observations

Altd.: altitude, Evid.: evidence (o: observed, c: call, f: feather, db: dead body, d: dropping), Bevh.: behaviour (fd: feed, rt: rest, pn: preen, cs: courtship, fl: fly)

7.3.4.3.2.4 Data Analysis

Data generated from the survey grids within a BMG shall be managed in an appropriate database software. A qualitative (species richness or accumulation curve, presence-absence and identify important bird areas) and a quantitative (Shannon-Wiener Diversity Index, Mann-Whitney U Test, Single Species Occupancy and Multi-Species Occupancy) analysis shall be performed. Currently available analytical software (Microsoft Excel, SPSS, Minitab and R packages) shall be used to perform aforementioned analysis.

For quantitative analysis, Shannon-Wiener Diversity Index (1) shall be computed and Mann-Whitney U Test (2) performed to compare data across BMG, seasons and habitats. Advanced analysis can be conducted to understand density, relative abundance and estimate population, mapping distributions using Single-Species Occupancy Model (SSOM) and Multi-Species Occupancy Model (MSOM) in R. For management purpose, data analysis shall be carried out using Shannon-Weiner Diversity and Mann-Whitney U Test

Shannon Diversity Index

The Shannon-Wiener Diversity Index is calculated with the mathematical formula (Equation 2).

$$\text{Shannon Index (H)} = \sum_{i=1}^{s} p_i \ln p_i \quad (7)$$

Where;

***s*:** is number of species

***n*:** is number of individuals of a particular species

***N*:** is total number of individuals of all species

***p*:** is the proportion (n/N) of a particular species

***ln*:** is natural log

***i*: *i*th** start at 1

∑: is sum of calculations

Figure 7.9 shows an example to compute Shannon-Wiener Diversity Index.

Habitat	**SBLF**			
Species	**n**	**Pi**	**In(Pi)**	**Pi * In (Pi)**
Ashy Bulbul	7	0.01	-4.70	-0.04
Ashy Drongo	12	0.02	-4.17	-0.06
Asian Brown Flycatcher	1	0.00	-6.65	-0.01
Asian Fairy Bluebird	7	0.01	-4.70	-0.04
Asian Palm Swift	2	0.00	-5.96	-0.02
Barn Swallow	55	0.07	-2.64	-0.19
N	**84**			

Figure 7.9 Example

Mann-Whitney U Test

The Mann-Whitney U Test is computed with mathematical formula (3) and (4). The small value of U_1 and U_2 is used to determine the significance table to infer the difference between two groups of data set. The Mann-Whitney U Test can be performed online (https://www.socscistatistics.com/tests/mannwhitney/).

$$U_1 = R_1 - \frac{n_1(n_1 + 1)}{2} \quad (8)$$

$$U_2 = R_2 - \frac{n_2(n_2 + 1)}{2} \quad (9)$$

Where;

$\mathbf{n_1}$: is the number of species in group 1

$\mathbf{n_2}$: is the number of species in group 2

$\mathbf{R_1}$: is the sum of ranks of species in group 1 when data from group 1 and group 2 are put together and ranked

$\mathbf{R_2}$**:** is the sum of ranks of species in group 2 when data from group 1 and group 2 are put together and ranked

Beside the aforementioned quantitative analysis, a qualitative analysis shall also be performed to extract information to identify important birding areas based on species status in the Red List-IUCN (International Union for Conservation of Nature).

7.3.4.3.3 Flora Survey

7.3.4.3.3.1 *Materials required*

Following tools and equipment are required to carry out the field work.

Compass	**GPS**	Measuring tape	Knife
Altimeter	Clinometer	Camera	Topo map
Spherical densiometer	Diameter tape	Plant Press	Zip lock folder

7.3.4.3.3.2 *Sampling Design*

Flora Survey shall be conducted within the 4X4 km BMG. The following protocol shall be followed:

- In the sampled grid of 4x4km, two plots of 20x20m shall be established as far as possible along altitudinal gradient not less than 0.5km apart.
- Ensure the team enters 200-300m inside the grid.
- Plots shall not be established within 200m from vehicular roads and 100m from the footpath
- Establish vegetation plot inside the grid representing the major forest types of the particular area
- Use SW Maps while navigating to the grid.

7.3.4.3.3.3 *Method*

Laying Tree & shrub plot

Option 1:

Fixed area plot of 20x20m is established by using the nylon ropes and wooden pegs. 4 nylon ropes of 20m length are used with a knot made on all the ropes at 10m to mark the centre of the quadrate. The nylon ropes are pulled towards the 4 cardinal directions from the center of the plot and marked at 10m with wooden pegs corresponding with the knot. These wooden pegs corresponding with the knot are the midpoint of each

side of the quadrate plot. From the midpoint, the two ends of the nylon ropes are further pulled to two respective cardinal directions (north-south and east-west) perpendicular to the centre of the plot to find the corners of the plot. The process is repeated with all the remaining nylon ropes to find the four corners of the quadrate plot and finally, the traverse of all the nylon ropes are closed, eventually forming a 20x20m quadrate plot.

Option 2:

Fixed area plot size of 20x20m is established for the enumeration of trees and shrubs. The establishment of the plot begins from the center of the plot and extends towards each side. This method is based on the Pythagoras theorem wherein the field personnel measures the hypotenuse to get the sides. By doing so, it minimizes errors and ensures that a more accurate square shaped plot is generated as compared to other conventional methods.

Following steps can be followed to layout the 20x20 plot under this option (Figure 7.10).

- Starting from the center, setup an azimuth and walk 14.14 meters diagonally towards A.
- Then 90° right to A, move 14.14 meters towards B from the center
- Then 90° right to B, move 14.14 meters towards C from the center
- Then 90° right to C, move 14.14 meters towards D from the center
- Together, these become the four sides of the plot and should measure exactly 20x20 m. Mark the points A, B, C, and D and install wooded/iron pegs.
- Now secure the four pegs with 20-meter nylon ropes

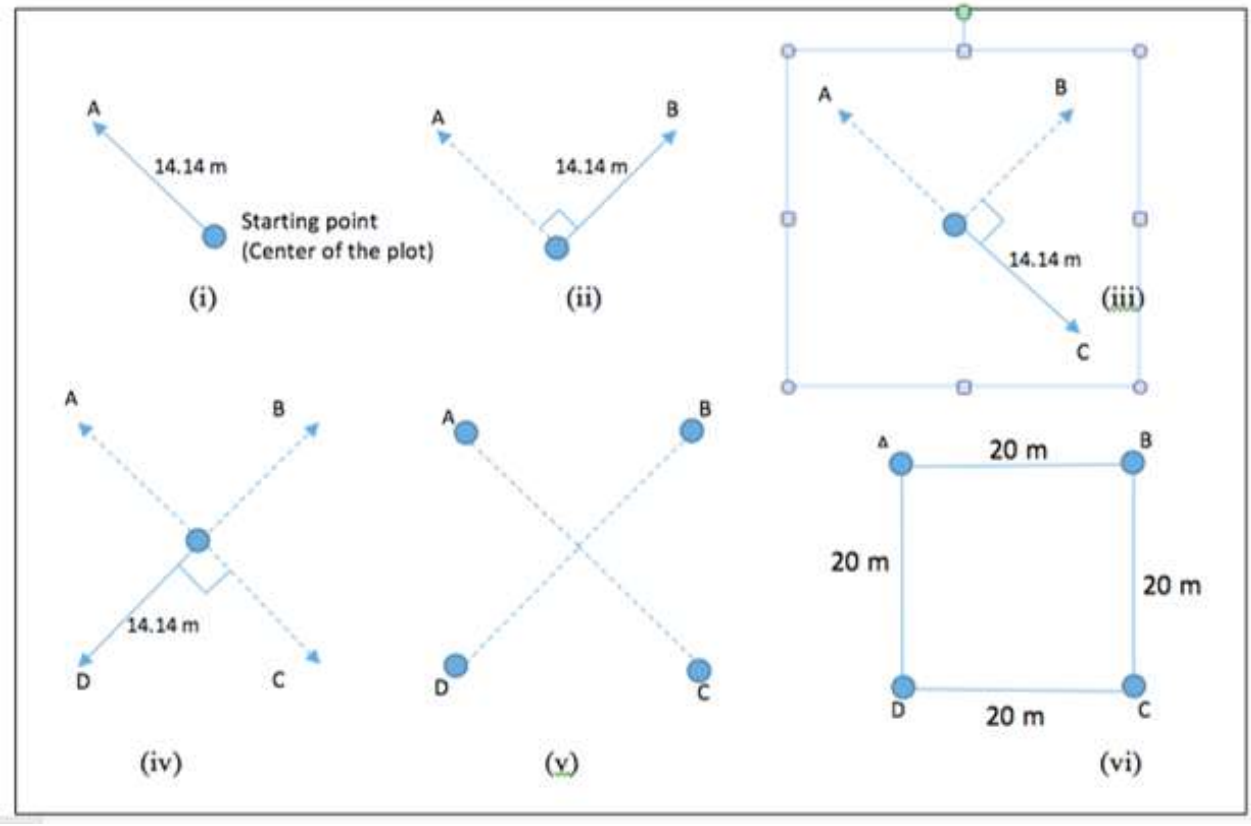


Figure 7.10 Schematic diagram showing the process of laying 20x20 plot

Box 1.2 Cautionary Note

Cautionary notes:

- To save time, it is advisable to keep 4 numbers each of 14.14 and 20-meter nylon ropes ready.
- Ensure that the measurements are correct, avoid too much tension or sagging of rope.
- Avoid trampling and destruction of plants while setting up the plot.
- Use slope correction table while establishing the plot in the absence of hypsometer.

Tree & shrub data collection procedure

1. Record the plot id, both trees and shrubs species on the same data form as in Table 1.10.
2. Collect the voucher specimen incase the species is unidentified.
3. Start measurement from the North direction (clockwise) till completion.
4. Always measure the DBH from uphill and avoid sagging, twisting, buttressed etc...,
5. Measure the DBH of all the individual species using DBH tape above > 1.3m height and height using the hypsometer.
6. Record as "S" for sprout under the stem type column.
7. Tag all species with number.

Table 7.40 Data Form for recording Trees and Shrubs in the vegetation plot of 20x20 m

Data Form for recording Trees and Shrubs in the vegetation plot

Location: Grid No:
Date: Plot No:
Altitude (m): Plot Size
Aspect (°): Recorder
Inclination (°) :
GPS Location: N E:
Threshold: >1.3m, Ht= Height.

Sp. No.	Species name	DBH	Ht.	Status	Stem type

Box 1.3 Cautionary note

Cautionary notes:

1. The growth form of the same species differs significantly, depending on what type of environmental condition they grow, although they belong to the same life-form group.
2. Consider forking above DBH as 2 trees.
3. Multiple stems emerging from the single root system is called "sprout" stem type and this should be considered as one tree, although the measurement should be done for all the sprouts. For calculating the species diversity only one main stem data is taken into consideration.
1. In case of the woody liana and climber species, only DBH is recorded, height/length may not be possible.

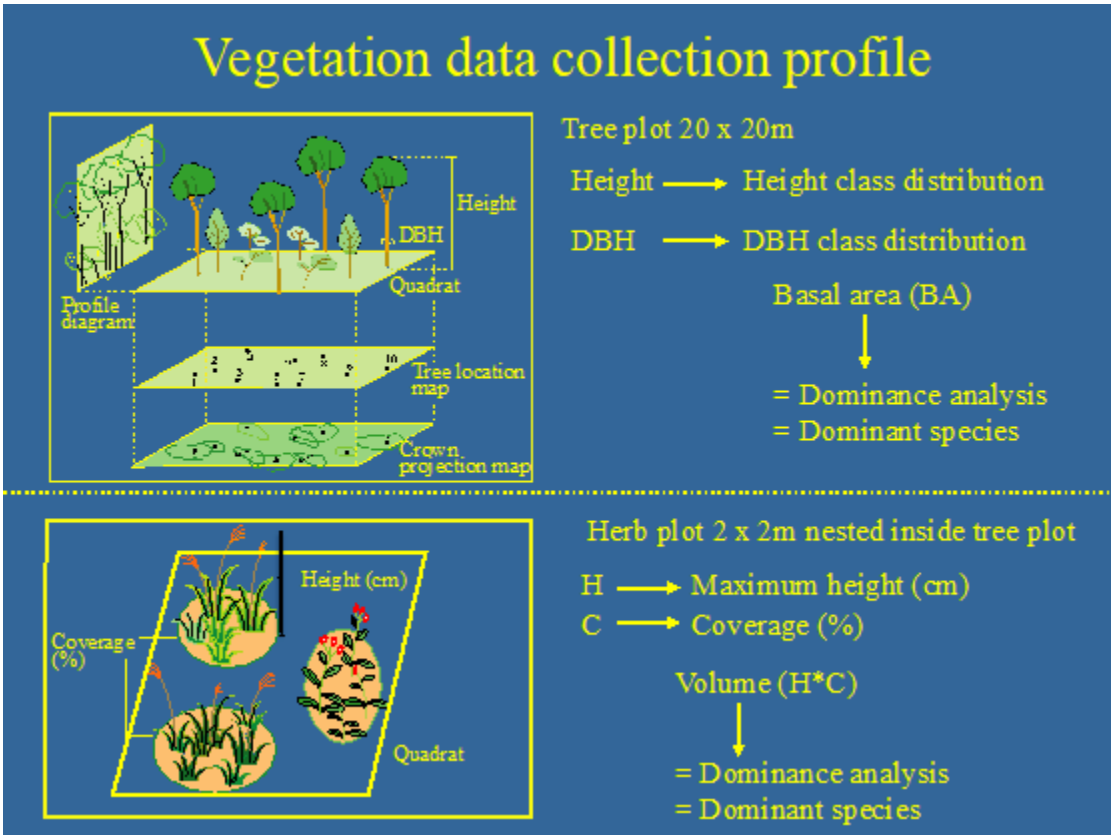


Figure 7.11 Vegetation profile showing the (A) Tree/shrub plot and (B) Herb plot measurement standard practice (Source: Wangda and Ohsawa 2006a)

Crown Cover

The readings of the crown cover % using the densitometer/ fisheye lens (hemispherical photograph) of the crown cover is taken in all the 4 quadrants of 10x10m. The average reading is recorded for the 20x20m plot.

Ground vegetation and plot establishment and procedure

Ground flora is known to be especially sensitive to changes in environmental conditions and provide valuable information about the impact of chronic stresses on the forest ecosystem. The dynamics of ground

flora vary from season to season. Ground vegetation plot size of 2x2m quadrate is established inside the tree and shrub plot of 20x20 m as shown in figure 7.12.

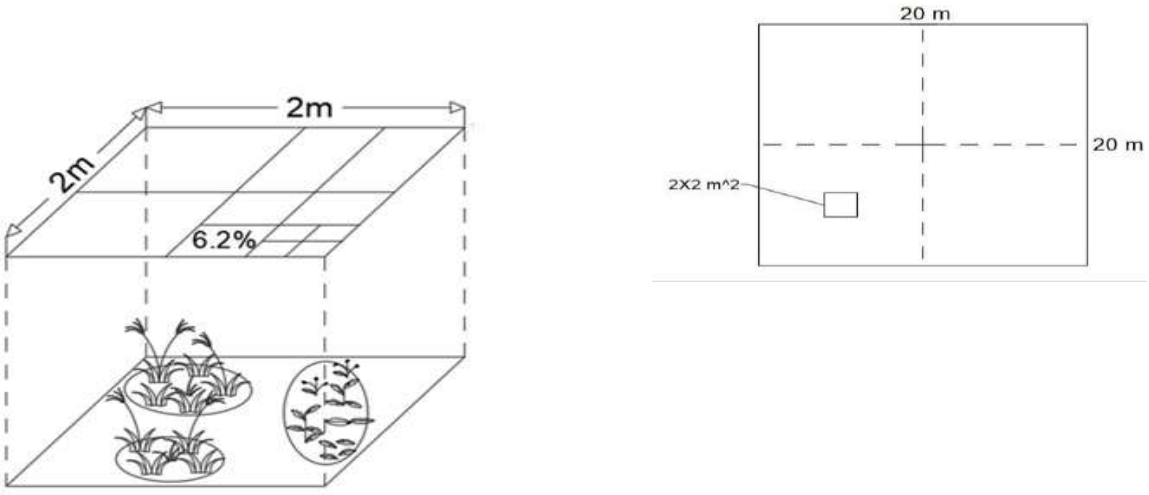


Figure 7.12 2x2m quadrate plot with grid to measure the cover % of each species

Ground vegetation (herbs) data collection procedure

1. Inside the 2x2 m plot, record the plot id and species details as shown in the data form in Table 1.11.
2. Measure height of the tallest species using the 5m-fiber glass tape.
3. Estimate and record the Area of Occupancy (AOO) of each species inside the quadrate in % (IUCN 2001).
4. Collect the voucher specimen of the unidentified species (refer Cautionary for specimen collection).

Box 1.4 Example

Example on how to estimate AOO

Two (2) different plant communities is shown in Figure 7.12 *(A).*

One plant community with long flowering stalk cover % is approx. 25% meaning 1/4 portion of the quadrate is completely occupied.

On the other hand, one plant community with short flowering stalk is just the half of the first one, so the estimate is 12%.

Table 7.11 Data Form for recording ground vegetation (Herbs) in the plot of 2x2 m

Data Form for recording ground vegetation (Herbs)

Location: Grid No:
Date: Plot No
Altitude (m): Sub-plot No:
Inclination (^{o}): Sub-Plot Size:
Aspect: Recorder:

Threshold: Tallest Ht, Ht=Height

Sl/No.	Species	Ht. (cm)	C (%)	Remarks

Box 1.5 Cautionary Note

Cautionary note:

1. In order to avoid trampling of herbaceous species, sapling and seedlings by the survey team members, it is mandatory to collect the data of the ground vegetation first considering the tree & shrub plot is already established.

2. The height of the scrambling or leaning herbaceous species is measured from the tip perpendicular to the ground surface rather then measuring the height of the leaning species from the base to the tip.

3. Always collect the voucher specimen outside the plot

Regeneration Survey inside the herb plot

Regeneration status is recorded within the 2X2 m herb plots as shown in fig. 7.12. Seedlings are counted to find out the regeneration density. The height is measured for all the individual species and the species name is recorded as usual.

Steps:

1. Record the plot Id first
2. Enumerate species details as shown in the form at Table 1.12**.**
3. Measure height of each species using the 5m-fiberglass tape
4. Record the age of each species

Table 7.12 Data Form for recording regeneration status in the plot of 2x2 m

Data Form for recording regeneration status

Location: Grid No:

Date: Plot No:

Altitude (m): Sub-plot No:

Inclination (^{o}): Sub-plot Size:

Aspect: Recorder:

Threshold: Tree species <1.3m in height

Sp. No.	Species name (Seedling)	Ht.	Age	Sp. No.	Species name (Seedling)	Ht.	Age

Box 1.6 Cautionary Note

Cautionary note:

1. In order to avoid trampling of regeneration by the survey team members, it is mandatory to collect the data of regeneration first considering the quadrate for tree & shrub plot is already established.

2. Seedling should not be messed up with the herbaceous species. Regeneration in this context is strictly in reference to the capable tree seedling able to reach its maturity, however there is no guarantee to it.

3. Count the inter nodes to estimate the age and for conifers count the whorl of the branches.

4. During each year of growth, the seedling produces a whorl of branches out from the stem. To get an estimate of the seedling's age, we can count the whorls up the stem, and if the whorls have broken off, we can count the little scars that has remained.

Epiphyte data collection procedure.

1. Record the plot Id first.
2. Enumerate species details within the 20X20m plot as shown in the form as in Table 7.13
3. Count the frequency of species in each individual tree (Refer tree id) separately.

Table 7.13 Data Form for recording epiphytes in the vegetation plot

Data Form for recording epiphytes in the vegetation plot

Location:	Grid No:
Date:	Plot No:
Altitude (m):	Plot Size:
Inclination (^{o}):	Recorder:
Aspect (^{o}):	

Sl/No.	Species	No.	
			Remarks

Box 1.7 Cautionary Note

Cautionary note:

1. Consider the clump for orchid species as one irrespective of size.
2. Consider Runners as one individual.

7.3.4.3.3.4 Data compilation, storage, analysis and reporting

Data sorting, storage and sharing

Once data collection is completed in the field, all the filled data sheets should be converted into digital format, either through scanning or photography. Both material data and digital data should be securely saved. Digitalization is particularly important for saving the data in multiple copies, and to prevent degeneration of the data over time.

All the data should also be adequately processed in Microsoft excel or Microsoft access for analytical purposes. A copy of both raw data and processed data should be shared with the Data Repository and Nature Conservation Division.

Data Analysis

After the data is compiled in the excel sheets, species richness (H'), dominance, cluster and multivariate are analyzed using any of the following statistical analysis software;

1. R Stat
2. SPSS (Social Science and others)
3. GenStat (Agriculture and others)
4. PC-ORD(Ecological analysis package)
5. Excel analysis (Focus)-Many Cases

However, the most commonly used software are Excel analysis and PC-ORD.

A. Excel analysis

Use Microsoft Excel functions to clean, sort and arrange the data

1. Prepare Height class and Diameter at Breast Height (DBH) Class

1. Prepare Height class and Diameter at Breast Height (DBH) class using the function=CEILING(number, multiple), the number is the height/DBH of tree and the multiple is the height/DBH range
2. Arrange and prepare Height and DBH class matrix manually

2. **Calculate indices of a species diversity Shannon-Wiener index (H')**

$$H' = -\sum ni/n \log 2\ ni/n\ ;\ \ OR\ H' = \sum_{i=1}^{s} -(P_i * LnP_i) \quad (9)$$

1. Calculate the Basal Area (BA) using formula =PI()*DBH^2/4
2. Calculate Relative Basal Area % (RBA%) using formula =BA/total basal area(insert $ sign between the letter and the number to fix the value*100)
3. Use the value of PI=PI/100
4. Calculate LogPI using this function=LN(PI/100)

5. Calculate PI*LogPI, sum of all PI*LogPI gives the (H')

3. Pivot Table Analysis

The function of a pivot table is to summarize the data (data reduction process), sort, reorganize, group, count, total or average data stored in a database. It allows its users to transform columns into rows and rows into columns. It allows grouping by any data field and they are very flexible.

1. Find and click on the Pivot table
2. Select the pivot table fields for summarizing the data
3. Click the field to summarize, then drag and drop to the appropriate fields, that is Row, Column and value

4. Dominance analysis

$$d = 1/N \{ \sum_{i \in T} (\chi_i - \chi')^2 + \sum_{j \in U} \chi_j^2 \} \quad (10)$$

Where χ_i is the actual percent sare (relative basal area is adopted here) of the top species (*T*), i.e., in the top dominant in the one-dominant model, or the two top dominants in th two-dominant model and so on; χ' is the ideal percent share based on the model as mentioned above and χj is the percent share of the remaining species *(U). N* is the total number of species.

1. Calculate RBA% for 100% =(RBA%-100)^2 for the species number 1 and=RBA%^2 from the species number 2 onwards
2. Calculate RBA% for 50% =(RBA%-50)^2 for the species number 1,2 and=RBA%^2 from the species number 3 onwards
3. Calculate RBA% for 33.3% =(RBA%-33.3)^2 for the species number 1,2,3 and=RBA%^2 from the species number 4 onwards
4. Repeat the same process for 25%, 20%, 16.6%, 14.3%, 12.5% respectively

B. PCORD

Steps to prepare the main matrix for Cluster analysis in PCORD

1. Arrange RBA% plot wise.
2. Custom sort RBA% from Largest to Smallest for all the plots.
3. Assign species code in each species name (PCORD does not recognize scientific name).
4. Transpose the species from Row to column and delete the scientific names.
5. Fill in the first column & first row with the number of plots and on the second column with the text as "Plot" (thumb rule).
6. Fill in the first column second row with the number of columns/species and on the second column with the text "Species" (thumb rule).
7. Fill in the variable type with capital letter "Q" in the second column third row till the end of the species (thumb rule).
8. Fill in the variable name in the second column fourth row with the species code.

Steps to do cluster analysis in PCORD

PCORD is a windows program for multivariate analysis of ecological data entered in spreadsheets. It emphasizes nonparametric tools, graphical representation, and randomization tests for analysis of

community data. It offers many ordination and classification techniques not available in major statistical packages.

1. Open the PCORD and import the main matrix of the excel sheet.
2. Select the Excel Spreadsheet and file and then open.
3. Click "OK" in the pop up transformed Matrix.
4. Activate the matrix by clicking one of the menu button.
5. Click the button for the result txt syntax for the cluster cycle.
6. Click cluster analysis under the Groups menu.
7. Select the Sorensen (Bray-Curtis) for distance measure and Group Average for Group Linkage Method.
8. Type in the title of the result and the dendrogram results shall be displayed in the Result txt syntax showing cluster cycle.
9. Click cluster dendrogram under the Graph menu for final result.

7.3.4.3.4 Socio-Economic Survey

Social science can help natural resource managers (1) identify and evaluate social as well as ecological trade-offs associated with different management options; (2) make decisions that are better for the environment and human well-being, given that social-ecological systems are integrated and influence one another; (3) make decisions that are more appropriate to a particular social-ecological setting; and (4) obtain information from a broad, scientifically-based sample of people to better anticipate variation in their interests, and in the effects of management decisions on human communities (Charnley et al., 2017). The conservation social sciences can provide unique and important contributions to society's understanding of the relationships between humans and nature and to improving conservation practice and outcomes (Bennett et al., 2017).

Data Collection Protocol

The socio-economic survey could be conducted once at the starting of planning period and during the midterm review as a process of monitoring and evaluation (5 years).

The sources of data required for the planning and monitoring from social perspective shall be relied on the primary data and secondary data collection. The process of obtaining the data are explained in detail below:

Primary data collection

Primary data collection shall be carried out in two main stages involving focus group discussion and followed by household survey. The focus group discussion shall be carried out using semi-structured Questionnaire with mainly open-ended questions, while household survey can be conducted using structured questionnaire that consists of both open and closed-ended questions. These two different sets of questionnaires aim to generate information about selected individual household while PRA helps to generate information about a village holistically (Sperienburg et al., 2002).

Focused group discussion

- The Focus Group Discussion (FGD) can be carried out at Village, Chiwog and Gewog level based on availability of resource, time and field condition. The selection of venue and meeting hall arrangement is crucial to enable conducive environment. Effective communication and interaction shall lead to high-quality results from the FGD. The focused group discussion shall be called once with minimum of 10 heads comprised of minimum 30% of female participation. This shall be guided by the semi-structured questionnaire forms (Table 7.5).

- The duration can vary depending on the dynamics of the participants, but ideally an FGD takes between 60 to 90 minutes.
- At least two people are required to conduct it effectively. Responsibility can be identified between two surveyors as to take the task of 'Facilitator' and 'Transcriptionist' or 'Notetaker'.
- The facilitator is recommended to speak local language to the participants (if possible) as to convey clear message and make them respond at best possible way.
- Transcriptionist should interrupt the session to clarify himself to keep the note as reported, discussed or agreed by the participants. Since questions in PRA are open-ended the follow-up questions to be asked is very important.
- Since response from different gender, age and economic background shall differ, facilitator should take control of dominant respondent or participant throughout the session to ensure that all participants are equally involved in the discussion.
- Use prompting questions to ensure active participation. Split the group to accommodate contrasting views and backgrounds to generate more discussion.
- Record all the information that were discussed. The entire discussion and all points raised should be recorded, because the process is based on open or guiding questions, to ensure nothing is missed or points taken out of context. Note-taking should be shared and, if possible, supplement with a voice recorder with prior permission

Table 7.5 PRA Form

1. Village information

Dzongkhag :
Gewog :
Chiwog
Village :
Location: Lat……..……... Long……..…….. Alt…….
Vegetation type:
Interviewer :
Date:

2. Details of Participants

Sl. no	Name	Age	Sex	Position in the family
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

3. Historical Timeline

2020 (update)

* History of the village, developmental progress, changes of resource use trend, etc.

4. Resource mapping

N

* Resource location & trend, outside users, user conflicts, local rules/regulation,

5. Seasonal Activities Calendar

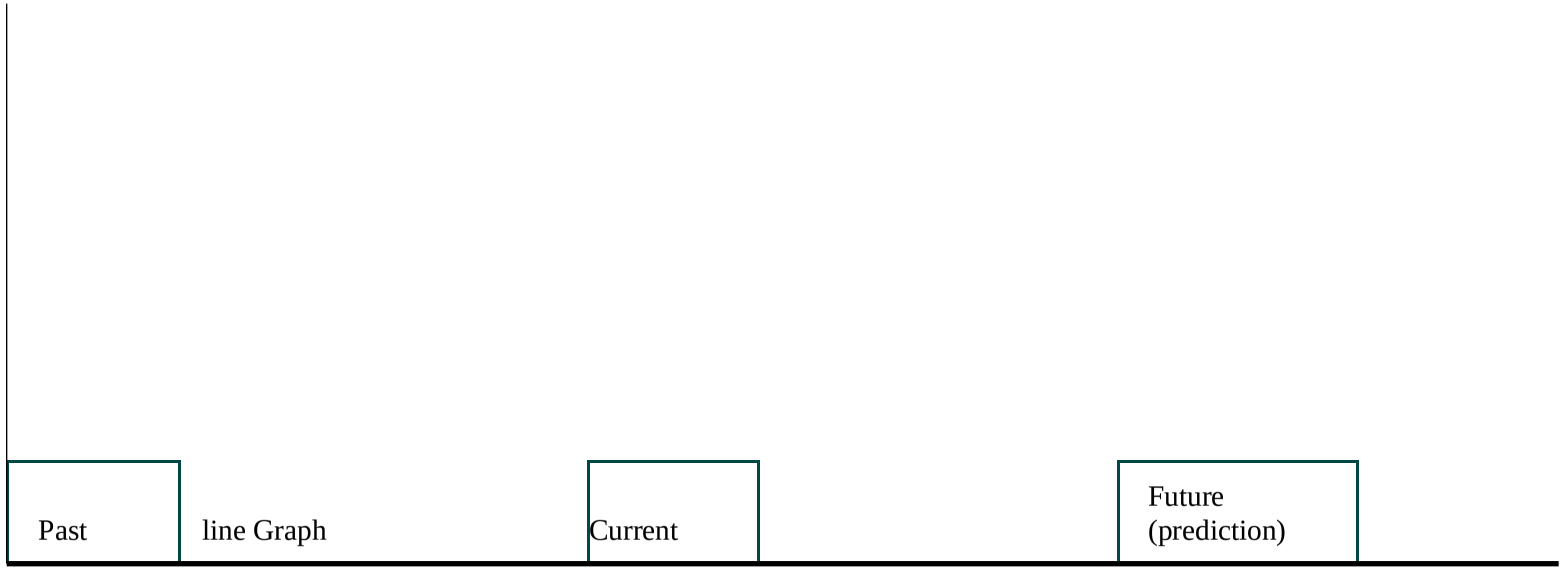
Activities	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks

6. Natural Resources harvesting calendar

Resources	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
Timber													
Bamboo													
Cane													
Pipla													
Chirata													
Agroo													
Honey collection													
Cannabis													
Fishing													
Poaching													
Honey collection													
Others (Specify)													

7. Natural Resources Trend Analysis

*Draw



8. Matrix ranking for Natural Resources use

Uses/species									
Timber									
Fuelwood									
Fodder									
Furniture									
Shinglep									
Medicine									
Flag poles									
Fencing post									
Traditional curving and handicraft									

9. Pairwise ranking for timber species

Species									
	*								
		*							
			*						
				*					
					*				
						*			
							*		

10. Stake holder analysis using Venn diagram (To identify and rank developmental partners in the area (Box 7.1)

10. SWOT analysis on Environment and Conservation

Strength	**Weakness**
Opportunities	**Threat**

11. Problem Tree Analysis and Ranking on Environment and Conservation

Problems
Root Causes
Possible solution

Box 7.1 Stakeholder Analysis

Stakeholder Analysis

Stakeholder analysis is a technique to identify stakeholders and analysis of their needs, interests, and influence. It can be used as an evaluation and monitoring tool to assess how relationships and perceptions of relationships changed over time.

There are many stockholder analysis techniques and methods developed and used in a different field, however, in Bhutan stakeholder analysis and mapping using the Venn diagram is widely practiced while working with local communities considering the low literacy rate.

Resources Required

- A large piece of paper to hang up or lay flat on a table that the group can gather around
- Construction paper circles of various sizes (small, medium, large)
- Tape
- Markers or other writing utensils

How to do

1. Label and date your paper. Also helpful is assigning a note-taker to record any insights uncovered through the process.
2. List the organization whose stakeholders you are assessing (e.g., Gewog developmental program) by writing the organization name on one of the large circles and placing it in the middle of the paper.
3. Have the group identify stakeholders and partners. (You may already have a list that provides a good starting point.) Have the group decide how important each stakeholder is to your organization, choose a corresponding circle size (small = somewhat important; medium = important; large = critically important), and write the stakeholder's name on the circle.
4. Decide how close the current relationship is between the selected stakeholder and organization (e.g. Gewog). If the relationship is close, tape the circle very close to or touching the organization. If the relationship is distant, tape the circle toward the edge of the paper, etc.
5. Assess each stakeholder this way, encouraging group members to write the names on the circles and post them. Disagreement about the importance of stakeholders is okay. Ask questions to understand why members feel the way they do.
6. You have now identified and created a stakeholder map. Have the group assess it as a whole.
    - Does anything strike the group?
    - Are any groups missing?
    - Are any relationship patterns surprising?
    - Does an existing partner have a strong relationship with a partner you would like to work more closely with?
    - Do any problems or opportunities present themselves?
    - Does the group lack a good relationship with any important stakeholders?

Sampling and Sample size

Determining adequate sample size of the total house population is very important to ensure that the survey result is statistically relevant. However, the sample size also has to be balanced with the available resources viz., financial, human and time. Random sampling is used to ensure that the sample is representative of the study area/survey, thus avoiding bias in sampling and ensuring that each household within the sample frame has an equal chance of being sampled judiciously.

Gewog administrative boundary as sampling frame and total households in the Gewog should considered as population. The sample size shall be determined using Yamane's (1967) method which is widely used and accepted in social science surveys.

Using the formula;

The sample allocation shall be proportionate to Chiwog household and household interviews shall be done randomly. The house numbers e.g. MA-12-268 of the sample households shall be tabulated in excel and randomly selected for questionnaire survey.

Determining sample size using Yamane formula (Yamane, 1973)

$$n = \frac{N}{1+N*(e)^2}$$

n=Sample size
N= Population size
e=Margin of error (MoE),
At 95 % confidence interval e= 0.05

Example
Let's assume that the population (Household) in Gewog is 2000. At 5 % MoE, the sample size would be:

$$n = \frac{N}{1+N(e)^2} = \frac{2000}{1+2000*(0.05)^2} = 333 \text{ (Households)}$$

Sample allocation

The sample allocation should be proportionate to Chiwog household.

Example

- If Chiwog 'A' has 1000 hh
  1000/2000 *333 =166.5 (167 hh)
- If Chiwog 'B' has 700 hh
  700/2000 = 116.55 (117hh)
- If 'Chiwog 'C' has 300 hh
  300/2000 * 333 = 49.95 (50hh)

List down the households in the Chiwog (with the name of the head of household) and deploy simple random sampling techniques to select household to be interview. Use whisk social gathering technique which is the most convenient method in the field. Write down, on individual pieces of paper, the number of each household or representative group. Place the pieces of paper in a container, shake it and then pick out the required number at random. You can also use scientific calculator or excel program in the computer to generate random number which can be assigned to the list of households.

Household questionnaire survey (Face to Face interview)

The questionnaire for household survey should be pre-tested before conducting actual survey. The questionnaire shall be both closed and open-ended questions. The main aim of the survey is to collect specific qualitative and quantitative information from the representative households.

It can be conducted "face to face" with respondent considering the less literacy rate (especially in English medium). The surveyor or interviewer need to be very conscious throughout the interview in terms of keeping memo or notes for additional information that respondents provide through the session. The interviewer should follow the following norms:

- Meet with your interviewee and greet with a friendly smile and try to establish a relationship that makes him/her feel comfortable and relaxed. Pay attention to posture and body language.
- Describe the purpose and objectives of the survey and explain the rules on confidentiality.
- Establish ground rules. Explain that it is fine if he/she does not know the answer.

- Keep it short, check the time and, if a respondent becomes restless, change the subject. If he/she stop paying attention, stop or take a break if needed. Do not rush; be patient and calm, but serious. Be prepared to find alternative ways to ask the same question.
- Do not give direction to informant or suggest your own opinion as an answer.
- Be patient and give the respondent time to think.
- Respect the various views, regulations and traditional culture (e.g. a man may not be able to interview female respondent on his own).
- Drop a sensitive issue or put it aside for a second interview. Do not force the informant to answer.
- Let the respondent talk, and even slightly deviate from the question, but not for too long.
- Provide teaching aids, maps or drawings to help you explain an idea.
- Do not make any promises.
- Make sure to thank the informant. Advise respondent that you may need to come back or call for any missing information.

Table 1.15 Household Questionnaire Survey Form

Part I: Interviewer details

Name :	Designation:
Office:	Contact No.:
Email ID:	Date:

Part II: Household information and Source of Income (Give details per household member)

2.1 Respondent Detail

Dzongkhag:	Name of respondent:
Gewog:	Village:
Age/sex: M ☐ F ☐	Cell Phone #:

2.2. Household member Information

			Status of HH member	
Sl.no.	Sex *M/F*	Age	In-Present*/Out-Absent**	Main occupation & responsibility in the family

**with the household (> 6 months/year at home)*

***Registered with HH but not living here (< 6 months/year absent)*

2.3. What are the main sources of income to the family? Rank as per importance as from 1-5 with 1 being the most important and 5 the least. Follow the same ranking for all purposes.

Source	Rank
Agriculture Livestock Horticulture crop NWFPs Tourism/Pottering Labour Employment Business Others (Specify)	

2.3.1 Area of Household Expenses

Particular	Estimated Amount (in Nu.)
School expenditure	
House hold expenses	
Rituals	
Constructions /Renovation	
Pilgrimage	
Leisure items	
Vehicles	
Farm Machineries	
Others (specify)	

2.4. Type of land holdings

Type:	cultivated/used by HH	fallow/unused	sharecropped / rented in	sharecropped / rented out
Chhuzhing, wetland				
Kamzhing, dryland				
Tsesha, kitchen garden/Khemsa				
Orchard				
Tsamdrog				
Others: _ _ _ _ _ _ _ _ _ _ _				

Part III: Agriculture Crops

3.1 Type of Agriculture crop

Which are the main crops grown by the household? *☐ rank in ascending order in order of importance (1 being most important followed by 2,3,etc)*	wetland rice upland rice maize millet	wheat barley mustard potato	radish/turnips bitter buckwht sweet buckwht Chilli	vegetables _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Which are the cash crops grown? *☐ rank in ascending order in order of importance (1 being most important followed by 2,3,etc)*	apple other temp. fruit cardamom	Orange other subtrop. fruit walnut	other nuts _ _ _ _ _ _ _ _ _ _ _ _ _ _	
Does HH have other, special crop or livestock activities *☐ if yes, tick*	☐ grow mushrooms ☐ _ _ _ _ _ _ _ _ _ _	☐ keep silk worms ☐ _ _ _ _	☐ keep bees ☐ _ _ _ _ _ _ _	
What are the main problems for Agriculture? *☐ rank in ascending order in order of magnitude (1 being most problematic followed by 2,3,etc)*	☐damage by wild animals ☐insufficient irrigation water ☐insufficient funds to invest ☐other _ _ _ _ _ _ _ _ _ _ ☐other _ _ _ _ _ _ _ _ _ _	☐insufficient labour ☐pests and diseases ☐insufficient land ☐unreliable transport	☐bad road ☐road/market far ☐erosion ☐poor soil	

3.2 What is the annual income from Agriculture crops?

Sl.#	Type of crops	Quantity (Unit)	Unit cost	Total amount	Remarks
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

3.3 What are the main problems/constrains for Agriculture of the HH? Rank as per importance as from 1-5 with 1 being the most severe and 5 the least.

Problem/Constrain	Rank
Damage by wild animals	
Poor accessibility	
Poor marketing	
Soil erosion	
Poor soil fertility	
Insufficient irrigation water	
Insufficient funds to invest	
shortage of labor	
Pests and diseases	
Insufficient land	
Erratic Climate condition	
Others (Specify)	

Part IV: Livestock holding and importance

4.1. Type of Livestock holdings

Livestock type	Total
Yak	
Horse	
Cattle: Traditional/local breed Jersey breed Brownswiss breed Mithun breed Buffalo	
Bee keeping	
Fishery	
Goat	
Sheep	
Poultry	
Pigs	
Dog	

4.2 What is the annual income from livestock?

Livestock type	Item	Quantity	Unit	Rate/unit in Nu.	Total	Remarks If any….
Yak	Milk					
	Cheese					
	Butter					
	Meat					
	Manure					
	Sale of live animal					
	Others…..					
Buffalo	Milk					
	Cheese					
	Butter					
	Meat					
	Manure					
	Sale of live animal					
	Others…..					

Cattle	Milk Cheese Butter Meat Manure Sale of live animal Others…..
Horse	Transportation charges Sale of live animal Others
Poultry	Egg Meat Sale of live animal Others
Pig	Meat Manure Sale of live animal Others
Goat	Meat Sale of live animals Other
Others	

4.3. What is the importance of livestock to the household? ? Rank as per importance as from 1-5 with 1 being the most important and 5 the least.

	Rank
Source of income Source of food Draught power Manure Means of transportation Others (Specify)	

4.4. What are the main problems/constraints regarding livestock for the HH? ? Rank as per importance as from 1-5 with 1 being the most important and 5 the least.

losses due to predators	insufficient fodder	diseases
low milk yields	insufficient grazing	Parasites
poor quality local breeds	poor quality grazing	other _ _ _ _ _
few extension visits		

Where does the household graze their livestock? *Please Tick*

Improved pasture
Open Forest
Abandon agriculture field
Tethered and Stall feeding

Part V: Forest Resources use & People's outlook

5.1 Does he/she collect Forest resources?

Yes ☐ No ☐

If yes

5.2 What does he/she collect and income from forest resources?

Resources	Qty. With scale/unite		Rate per scale/unit	Annual income from sale	Distance from village to the collection site (Km or hr walk)	Trend (Increasing, Stable, Decreasing)	Remarks
	Consumption	Sale					
Firewood							
Fodder							
Medicinal plants							
Mushrooms							
Incense							
Fern							
Thatch grass							
Canes							
Bamboo							
Fern/leaves for bedding							
Top soil/leaf moulds							
Cordyceps collection							
Agricultural tools							
Religious drums							
Wood burl/burr for *Dhapa*							
Others (specify)							

Note: Annual income from sale can be calculated later

Trend: I=Increasing, S=Stable/Same, D=Decreasing

5.3 List five most preferred timber species for construction purposes?

1)

2)

3)

4)

5)

5.4 What are the threats to forest resources? ? Rank as per importance from 1-5 with 1 being the most important and 5 the least.

1)

2)

3)

4)

5)

Part VI: Wildlife Conservation

6.1 What animals and at what frequency do you sight wild animals in your areas and what is your feeling towards them? Also your views on the population trend

Sl.no	Species	Frequency of sighting	Your feeling to Wildlife	Population trend	Reasons for increase or decrease (use additional sheet if space is not enough to write)

Frequency: A= Always, O=Occasionally. Feelings: L=Like, N=Neutral, D=Dislike

Population Trend: I=Increasing, S=Stable/Same, D=Decreasing

Part VII: Human-wildlife conflict

7.1 Did you get any of the following problems due to wildlife? Please tick in the appropriate cell

Problem	Yes	No	Minor	Severe
Crop Damages				
Livestock predation				
Property damages				
Disease transmission				
SocialHarassment				
Others				

7.2 Has the household lost livestock to wild predators in the past three years? □Yes /□No

		**Indicate* code for the identification evidence of the predator for each case: s=animal seen, h=animal heard, p=pugmarks, t=type of killing, etc.

Type of livestock killed	Breed	Date of Kill *(month/year)*	Age	Sex	Dist. from village (hr or km)	Cost	Predator	Evidence*

7.3. What are the root causes for Livestock depredation?

1.

2.

3.

4.

5.

7.4. What are the prevailing mitigation measures adopted? Rank as per importance from 1-5 with 1 being the most important and 5 the least.

Action	Rank	Remarks
Traditional Fencing (specify types in the remarks column)		
Electric/Solar fencing		
Guarding		
Scarecrow		
Trapping in field		
Hunting in field		
Endowment funds/insurance scheme		
Others (specify)……		

7.5. Do you have any other innovative ideas to curb livestock depredation?

1.

2.

3.

4.

5.

Do the wild animals depredate/damage the crop? □Yes /□No

If Yes, indicate the crops and the order of magnitude for each animal spp.

Crops	Animal species	Month	Qty (Kg, Drey, Sang etc..)	Local Rate per unit	Total Amount	Order of magnitude

What are the possible reasons for wild animals coming to field and damaging the crops?

1)

2)

3)

4)

5)

In your opinion what could be the solution for the conflict?

1)

2)

3)

4)

5)

7.9 Did the wild animals damage your properties in last three years? □Yes □No

If yes, indicate the properties damage by each animal

Type of properties	Animal species	Month	Frequency (Once, Occasionally, frequently)	Specify the damage	Total loss in amount

Part VIII: Climate change and adaptation

Have you ever heard the term Climate Change? Yes ☐ No ☐

If yes, do you notice climate change in your village? Yes ☐ No ☐

If yes, can you please share your experience of climate change in your village? (for example: weather, climate, plant phenology cycle change, movement or migration of birds and animal)

Weather or climate pattern:

i) Rainfall pattern in last 10 years: Increase ☐, decrease ☐ same ☐

ii) Temperature pattern in last 10 years: Increase ☐, decrease ☐ same ☐

iii) Snow fall duration and intensity: more duration and more amount ☐, more duration and less amount ☐, less duration and more amount ☐

iv) Dry weather condition: Increase ☐ decrease ☐, same ☐

B. Plant phenology cycle change (flowering season, budding season, shifting in vegetation, invasive plants etc).

……..…….
……
……

C. Have you signted migratory birds or wild animals you have sighted or occurring in your village that was not present in the last 20 years or more. Please name them in local language or common English name.

……
……
……

D. Have you sighted birds or wild animals that have migrated out from your area? Please name them in local language or common English name.

……
……
……

E. Is there any evidences of drying water sources in your locality?

☐ Yes ☐ No

If yes, Number of water source dried ……..…….

F. How do you feel about the biodiversity and ecosystem of your community before 10 years and today?

Before				Today			
Excellent	Good	Bad	Reasons	Improved	Stable	Worst	Reasons

2. How do you feel about the impact of climate change and vulnerability?

a. Yearly Increasing ☐ b. Yearly Decreasing ☐ c. Same as before ☐

3. What are the probable reasons for climate change in your opinion?

Natural (please describe).....
.....
.....
Human (please describe) .....
.....
.....

3. Have you ever experienced extreme weather events that affected your life in the last 10 years?

Yes ☐ No ☐

4. In what specific ways have this variability's/extreme climate affected your lives?

Nature of climate variability	Rank (*1-5 with one as most important and 5 the least)*	Impact on livelihood (*Yes/No)*	Impact on income (*decrease or Increase)*	Loss of properties / assets (Type)	Loss of lives (*Yes/No*)
Drought					
Flood					
Landslide					
Soil erosion					
Hailstorm /wind					
Forest fire					
Early onset of rain					
delayed onset of rain					
Prolonged rain					
Scanty rain					
Pest and diseases (forests and agriculture crops and diseases for human)					
Others					

5. Have you introduced new varieties of agriculture crops? If yes, why? Please give the reason

Reasons:

…….....

.....

6. Which breeds of cattle is preferred by your community and why? Please give the reasons.

Reasons:

…….....

.....

7. Do you consider it necessary to have adaptation strategies to cope with climate change impacts on livelihood of the society?

Yes ☐ No ☐ If yes, please suggest some strategies to cope with climate change.

1.....

2.....

3.....

Secondary data collection

In addition to the primary data collected at the Chiwog/Gewog level, a need to obtain secondary information about the survey area (Chiwog/Gewog) is important to get a better understanding on the household information and a wider view on different socio-economic well-being of the concerned village. As such, the secondary information required to be gathered at the central level includes the review of relevant scientific articles and journals, plan documents, policy and acts documents, and

national reports. At Gewog/Chiwog level, related information to be collected includes records, Gewog statistics, Gewog plan documents, RNR documents, and other technical reports.

Data Processing and Analysis

Both quantitative and qualitative data collected from the field can be sorted for data entry in MS Excel Worksheet. It can be processed in PivotTable or SPSS (Statistical Package for Social Scientists) and any other widely accepted software and analytical tools. For qualitative data, non-parametric test, frequency distribution, and descriptive statistics may be performed as per need. Descriptive statistics may be applied to calculate the frequency, percentage, minimum value, maximum value, mean, standard deviation and standard error of different numerical and categorical data. To test the significance and relationships, statistical tool such as chi-square is recommended.

In order to derive the expected result out of Socio-economic Survey analysis, each part of the Household Questionnaire Survey and Participatory Rural Appraisal has a set of respective guiding hypothesis, outcome, and objectives.

PRA Analysis

Historical Timeline

Hypothesis: There is either overlap in the development and conservation activities by various agencies in the village or total negligence of the village in development planning with an assumption of being supported by some other than PA.

Expected outcome: Knowledge on chronology and duplication or negligence of all development, religious, social and conservation activities in the village is enhanced.

Objective: To understand the structure of development activities and conservation programs set up in the village.

Resource mapping

Hypothesis: Resource sharing between local people and outsiders in the locality leads to deterioration of natural resources at a faster rate and conflict rises thereof. In some villages, there are village norms (from religious and cultural perspectives) for sustainable resource utilization besides the resource sharing regimes instituted by the DoFPS.

Expected outcome: Areas of various forest resource collections (by the local people and outsiders), degradation/deterioration threats to natural resource and application of existing local norms understood.

Objectives:

i. To determine utilization and area of collection of various forest products.
ii. To understand threats to resources, resource sharing strategy and its associated conflict management in the locality.

Seasonal Calendar Activities

Hypothesis: Local people's farming season is often interrupted by development activities/planning which affect them. Collection of forest resources (NWFPs) is occurring inconsistently beyond the provisions of standing rules.

Expected outcome*:* Knowledge on farming and seasonal off-farm activities prevailing in the locality is enhanced.

Objective: To understand seasonal agriculture and livestock farming activity patterns, and seasonal off-farm activity (including forestry, culture, religious, etc.).

Ranking for natural resources

Hypothesis: Legitimate rights of local people for collection of timber and NWFPs are being respected and forestry personnel assume that their demand is fulfilled. But, in reality local people's desire for better species for some genuine reason always remains unfulfilled.

***Expected outcome*:** Relative significance and utilization of forest resources understood.

***Objective*:** To better understand the importance, priority, and utilization of particular resources (timber and NWFPs) for the local people.

Stakeholder Analysis

***Hypothesis*:** There exists overlap in supporting the development and conservation activities by various agencies in the village or total negligence of the village in development planning with an assumption of being supported by some agencies other than field office

***Expected outcome*:** Institutions or agencies involved in the development planning and funding the activities or program in the locality realized.

***Objective*:** To identify stakeholders involved in planning and funding development activities in different fields (health, education, etc.) other than the RNR sector.

Strength, Weakness, Opportunity, Threats (SWOT) Analysis

***Hypothesis*:** Local people are considered as threats from the perspective of resource sharing and encounter with wildlife, by many people including some conservation agencies. Local people's attitude and behavior in terms of biodiversity conservation are assumed rather negatively without carrying out in-depth situational analysis.

***Expected outcome*:** Four dynamic variables (SWOT) – strength, weakness, opportunity, and threats of community on conservation assessed.

***Objective*:** To determine strength, weakness, opportunity, and threats of local people from the prespective of biodiversity conservation.

Problem Tree Analysis

***Hypothesis*:** Everyone sees different types of problems and look at them differently as an individual. In the case of HWC, conservationists and farmers have different perspectives. Knowledge on driving factors and their interconnectedness to an identified problem of a particular place and specific time is never looked at seriously by both the parties (conservationist and farmer).

***Expected outcome*:** The main driving and underlying factors of specific wildlife associated problems encountered by the local community identified.

***Objective*:** To better understand driving parameters and interconnectedness to an identified problem (e.g. Crop depredation by wild pig) occurring in a particular place and specific time.

Information on wild animals

***Hypothesis*:** Different segments of people have their own perception about wildlife occupancy and their distribution. Local people reason out that stringent conservation policy has resulted in the increase in wildlife population which live nearby agriculture field or forest edge. On the other hand, conservationists assert that fragmentation of natural habitat of wild animals due to infrastructure development is one significant cause for displacement of wildlife from forest to nearby agriculture fields.

Expected outcome: Knowledge on occurrence of wild animals and its frequency of sightings in the locality enhanced.

Objective: To understand wild animal occurrence and rate of sightings by people in the vicinity of villages.

Ecotourism potential and governance

Hypothesis: Some villages in PAs already have community-based ecotourism and governance regime in place. But most of the villages do not have established community-based ecotourism activity other than occasional visit by tourists.

Expected outcome: Governance of existing-community based ecotourism and benefit sharing understood, and potential community-based ecotourism identified.

Objectives:

i. To better understand the management regime or governance of community-based ecotourism and its benefit sharing modalities.
ii. To determine potential area of community-based ecotourism from the perspective of natural, cultural and social values.

Household information and source of income

Hypothesis: Limited land holding may result to State Reserved Forest land encroachment while lack of income source is suspected to resort into illegal wildlife trade including NWFPs and timber. Less number of people living in the village or more people living outside the village as student, monk, employee, etc. is expected to exert less pressure to the Forests in case of natural resource utilization.

Expected outcome: Structure of household composition (age, type of occupation and job responsibility in the family), land holding, source of household income and area of expenses is understood.

Objective: To determine household profile in terms of their resource (human, land and income) and area of expenses.

Agriculture farming

Hypothesis: A lack of income generation and insufficient grains from the sale of agriculture products may induce pressure on forest through NWFPs collection, poaching and trade of wild animals and their body parts. Challenges in agriculture crop protection may entail to killing wild animals by farmers using lethal weapons. Constraints of inadequate irrigation water may lead to food crisis and subsequent impact on forest ultimately.

Expected outcome: Household agriculture farming and its associated problem, and income generation from the sale of agriculture products understood.

Objectives:

i. To understand varieties of crops grown and annual income generated from the sale of agriculture products by a household;
ii. To determine challenges/problems associated with agriculture farming and food security or grain-self-sufficiency of a household.

Livestock farming

Hypothesis: A household involved in rearing various types of livestock enjoys better livelihood than those households which are not rearing cattle at all. On other hand, breed type and mode of rearing of cattle type varies in product and impacts on forest. For example, local breed, mithun and yaks compared to Jersey and Brown Swiss are expected to exert more pressure on the forests compared to Jersey and Brown Swiss and are also more vulnerable to predators as they migrate. So, retaliatory killing of predators by herdsmen for cattle loss is one accounted factor that can decimate or even wipe out predator population in the locality.

Expected outcome: Household livestock farming practices and its associated problem, and income generation from the sale of livestock products understood.

Objectives:

i. To understand various types of livestock (cattle, horse, poultry, pig, etc.) reared and annual income generated from the sale of livestock products;
ii. To determine mode of livestock rearing and their associated problem?

Forest Resource use

Hypothesis: Maximum dependence on various forest resources by the household is assumed to impact adversely and exacerbate the conservation problems in the locality. Unregulated collection of forest products entails to local extinction at a faster rate in the future.

Expected outcome: Household forestry resource use pattern and trend, and income generation from the sale of forest products understood.

Objectives:

i. To understand the use of forest resources and its trend, and income generation from the sale of forest products;
ii. To determine forestry associated challenges and their perception on resource availability.

Wildlife Conservation and people's outlook

Hypothesis: A few segments of local people's positive attitude in respect of conservation is appreciated and acknowledged by conservationist. On the other hand, some people's negative attitude and perceptions are never taken into account rationally. Therefore, frequent occurrence of wildlife species of conservation interest in the locality is more vulnerable in unavoidable situation with human encounter.

Expected outcome: People's attitude and perceptions about wildlife conservation understood.

Objective: To determine the attitude of people about wildlife conservation and perception about the trend of wildlife occurrence in the locality.

Human-wildlife conflict

Hypothesis: Wild animals that are responsible for depredation to agriculture crop depredation and livestock predation are highly vulnerable to retaliatory killing by farmers. Crop protection measures prevailing in the locality are effective only for certain wildlife species. Migratory cattle are largely predated due to complacent herding practices.

Expected outcome: Human-wildlife conflict pattern and prevailing mitigation measure in the locality understood.

Objectives:

i. To better understand driving factors and area of human-wildlife conflict, and its pattern in the locality;
ii. To determine the prevailing HWC measures and potential intervention measures.

Climate change and adaptation

Hypothesis: Local people are the better source for reporting the climate change with predetermined indicators. Interactions between farmers and wildlife have changed over the resource sharing and use pattern due to climate change impacts. People are already into resilient climate change adaptation measures especially in the area of agriculture and livestock farming practices.

Expected outcome: Knowledge on climate change impacts and resilient adaptation measures and interaction with wildlife prevailing in the locality is enhanced

Objectives:

i. To determine the climate change impacts (both adverse and benign) and its trend in the locality in a given time frame;

ii. To understand the prevailing climate adaptation measures and their interaction with wildlife being practiced by the local people.

Household Questionnaire Survey Analysis

Household information and source of income

Hypothesis: Limited land holding may result to State Reserved Forest (SRF) land encroachment while lack of income source is suspected to resort to illegal trade of wildlife, timber or NWFPs. Less number of people living in the village or more people living outside the village as student, monk, employee, etc. is expected to exert less pressure to the forests with regards to natural resource utilization.

Expected outcome: Structure of household composition (age, type of occupation and job responsibility in the family), land holding, source of household income and area of expenses is understood.

Objective: To determine household profile in terms of their resource (human, land and income) and area of expenses.

Agriculture farming

Hypothesis: A small land holding, low income generation from the sale of agriculture products may induce pressure on forest through NWFPs collection , poaching and trade of wild animal parts. Challenges in agriculture crop protection may entail to killing wild animals by farmers. Constraints of inadequate irrigation water may lead to food crisis and subsequent impact on forest ultimately.

***Expected outcome*:** Household agriculture farming and its associated problem, and income generation from the sale of agriculture products understood.

Objectives:

iii. To understand varieties of crops grown and annual income generated from the sale of agriculture products by a household;
iv. To determine challenges/problems associated with argriculture and farming and food security or grain-self-sufficiency of a household.

Livestock farming

***Hypothesis*:** A household involved in rearing various types of livestock enjoys better livelihood than those households which are not rearing cattle at all. On the other hand, breed type and mode of rearing cattle varies resulting in different quality of livestock products and impacts on forest. For example, local breed, mithun and yaks is expected to exert more pressure on the forests and are more vulnerable to predator compared to Jersey and Brown Swiss if they stray into forest areas. So, retaliatory killing of predators by herdsmen for cattle loss is one main factor that can decimate or even wipe out predator population in the locality.

***Expected outcome*:** Household livestock farming practices and its associated problem, and income generation from the sale of livestock products understood.

Objectives:

i. To understand various types of livestock (cattle, horse, poultry, pig, etc.) reared and annual income generated from the sale of livestock products;
ii. To determine mode of livestock rearing and their associated problem

Forest Resource use

***Hypothesis*:** Maximum dependence on various forest resources by the household is assumed to impact adversely and exacerbate the conservation problems in the locality. Unregulated collection of forest products entails to local extinction at a faster rate.

***Expected outcome*:** Household forestry resource use pattern and trend, and income generation from the sale of forest products understood.

Objectives:

ii. To understand the use of forest resources and its trend, and income generation from the sale of forest products;

iii. To determine forestry associated challenges and their perception on resource availability.

Wildlife Conservation and people's outlook

Hypothesis: A few segments of local people's positive attitude in respect of conservation is appreciated and acknowledged by conservationists. On the other hand, some people's negative attitude and perceptions are never taken into account rationally. Therefore, frequent occurrence of wildlife species of conservation interest in the locality is more vulnerable in unavoidable situations with human encounters.

***Expected outcome*:** People's attitude and perceptions about wildlife conservation understood.

***Objective*:** To determine the attitude of people about wildlife conservation and their perception about the trend of wildlife occurrence in the locality.

Human-wildlife conflict

Hypothesis: Wild animals that are responsible for depredation of agriculture crop and livestock are highly vulnerable to retaliatory killing by farmers. Crop protection measures prevailing in the locality are effective for only certain wildlife species. Migratory cattle are largely predated due to complacent herding practices.

Expected outcome: Human-wildlife conflict pattern and effectiveness of the prevailing mitigation measure in the locality understood.

Objectives:

i. To better understand driving factors and the area of human-wildlife conflict, and its pattern in the locality;

ii. To determine the prevailing HWC measures and potential intervention measures.

Climate change and adaptation

Hypothesis: Local people are the better source for reporting climate change with some predetermined indicators. Interactions between farmers and wildlife have changed over the resource sharing and use pattern due to climate change impacts. People are already practicing resilient climate change adaptation measures especially in the area of agriculture and livestock farming practices.

***Expected outcome*:** Knowledge on climate change impacts and resilient adaptation measures and interaction with wildlife prevailing in the locality is enhanced

Objectives:

i. To determine the climate change impacts (both adverse and benign) and its trend in the locality in a given time frame;

ii. To understand the prevailing climate adaptation measures and their interaction with wildlife being practiced by the local people.

7.3.4.4 Zonation

Biosphere reserves aim to achieve integrated management of land, fresh and marine waters and living resources by putting in place bioregional planning schemes based on integrating conservation into development through appropriate zoning. While countries maintain flexibility at the national levels with regard to the definition of zones, the zonation needs to ensure that biosphere reserves effectively combine conservation, sustainable use of resources and knowledge generation through integrated zonation and collaborative management. The zonation of each biosphere reserve should include:

- **Core area(s):** securely protected sites for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research. In addition to its conservation function, the core area contributes to a range of ecosystem services which, in terms of the development functions, can be calculated in economic terms (e.g. carbon sequestration, soil stabilization, supply of clean water and air, etc.). Employment opportunities can also complement

conservation goals (e.g. environmental education, research, environmental rehabilitation and conservation measures, recreation and eco-tourism).

- **Buffer zone(s):** which usually surrounds or adjoins the core areas, and is used for cooperative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism, and applied and basic research. In addition to the buffering function related to the core areas, buffer zones can have their own intrinsic, 'standalone' functions for maintaining anthropogenic, biological and cultural diversity. They can also have an important connectivity function in a larger spatial context as they connect biodiversity components within core areas with those in transition areas.
- **Transition area:** area of interdependence which may contain a variety of agricultural activities, settlements and other uses and in which local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interests and other stakeholders work together to manage and sustainably develop the area's resources.

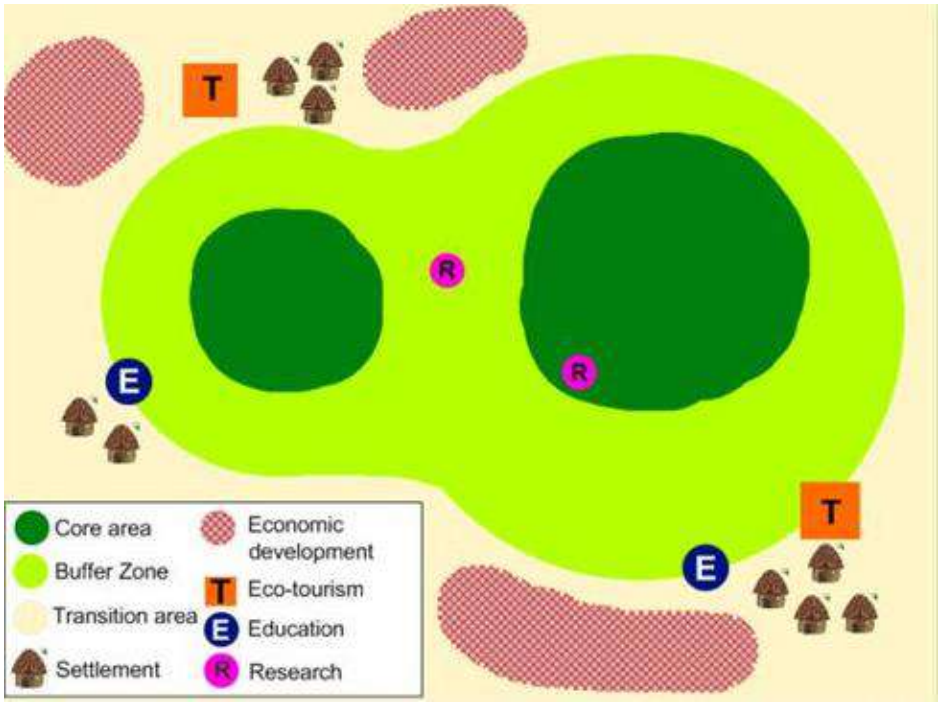


Figure 7.13 Three types of zones in MAB to allow conservation and development

7.3.4.5 Threat analysis

Threat analysis encompasses the assessment of threats in conservation planning and management. Such threats need to be identified and analyzed. It forms the integral part of conservation planning and management. Once the threat has been identified, threat ranking is done with the help of Miradi or any other relevant software, to prioritize interventions.

Some constraints are a function of the natural environment. Examples are the ecological processes which exist in the areas. Constraints may take one or more of the following forms:

- Legal obligations over land.
- Constraints of passages and bottlenecks.
- Managerial constraints.
- Natural features restricting movements.
- Habitat degradation that may need special focus of enrichment/management.

Box 7.2 Threat Analysis with Miradi

In order to determine the rank of the threats, consultative meeting should be held to discuss the various criteria for threat ranking in Miradi. The team should consider the three criteria for threat ranking, 1) scope, 2) severity, and 3) irreversibility. Scope refers to the proportion of the target (area for ecosystems, population for species) that is likely to be affected within 10 years under current circumstances. Severity attempts to categorize the level of damage to the biodiversity target expected within that particular scope and in the specified time frame. Irreversibility is the degree to which the effects of a given threat can be undone and the targets affected by the threat restored, if the threat is stopped. The team should determine the nature of threats as follows for all three criteria.

4 = Very High: The threat is likely to be pervasive in its scope, affecting the target across all or most (71-100%) of its occurrence/population.

3 = High: The threat is likely to be widespread in its scope, affecting the target across much (31–70%) of its occurrence/population.

2 = Medium: The threat is likely to be restricted in its scope, affecting the target across some (11–30%) of its occurrence/population.

1 = Low: The threat is likely to be very narrow in its scope, affecting the target across a small proportion (1-10%) of its occurrence/population

7.3.4.6 Preparation of Management Plan

The management plan shall be prepared as per the Management Plan Outline given in Table 7.6.

Table 7.6 Management Plan outline

Foreword
Preface
Acronyms and abbreviations
1. Background
1.1 History and Significance of MAB site
1.2 Salient features of the plan (Brief summary of each chapter)
1.3 Scope of the Management Plan
2. Vision of the biosphere reserve and objective of the management plan
2.1 Vision, mission and goal
2.2 Objectives and target of the management plan
2.3 Zonation and function
3. Current Status of Biosphere Reserve
3.1 Current national polices and strategies on biosphere reserve
3.2. Landscape Characteristics (elevation, slope, geology, soil, hydrology, and climate).
3.3. Floral description (forests types, total species list, species diversity, density,).
3.4 Faunal description (total list, imp species, different type of species, threatened species names,).
3.5 People and livelihood (socio-economic and cultural condition), resource use, subsidized timber allocation information, resource need, NWFP management, CF regimes, traditional practices,

traditional users, grazing, threats, issues

3.6. Administrative, service delivery and infrastructure

4 Threat Analysis

-Identify conservation threats

Threat analysis encompasses the identification, analysis and assessment of threats in conservation planning and management, threat to be identified and analysed. It forms the integral part of conservation planning and management. Once the threat has been identified and analysed, threat ranking is necessary to prioritize interventions.

-List management challenges

5: Management prescription.

Strategies and actions (***management prescription)*** are defined based on the overall goal of the plan to achieve and maintain proper habitat, species conservation and enhanced social livelihood These strategic actions shall be to solve problems or overcome the barriers that prevent us from achieving the objectives and subsequently the goals. These management prescriptions may include but not limit to the following; NWFP, CF, Habitat, Species, Ecotourism, Watershed, Forest Fire etc.

6: Implementation plan and financial outlay

6.1 Institutional Framework for Implementation of the Management Plan

6.2 Necessary Arrangements for Implementation

A realistic schedule and budget required for implementing the management plan prescriptions as per 7.3.4.10(Implementation framework/schedule) shall be prepared for the plan period of 10 years.

7: Monitoring and Evaluation

The monitoring and evaluation plan shall be part of the management plan and shall include the indicators against which the performance of the protected area shall be measured. The M&E plan shall be prepared as per the format below to ensure synergy with the implementation framework, PA monitoring framework and the conservation operation plans.

Objectives	Action	Output indicator	Baseline	Unit	Yearly target									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Maintain viable population of flora and fauna in the park.	*Action 1: Conduct survey for important floral species*	*Survey report*	0	Nos.		1	1	1						
	Action 2: Conduct surveys for faunal species		0	Nos					1	1				
	Action 3:													

Table. The Table showing example of how monitoring should be carried out.

7.3.4.7 Stakeholder Consultation

In the proposed biosphere reserve where presence of stakeholders and user rights holders have been mapped out, consultation meetings on the proposed management interventions and also on the restrictions and prohibitions shall be carried out thoroughly to avoid future complications.

7.3.4.8 Finalization of the Conservation Management Plan

The management plan shall be finalized by the Chief Forestry Officer (CFO) of the concerned field office.

7.3.4.9 Endorsement and Approval of Conservation Management Plan

The draft plan shall be reviewed by NCD and subsequently endorsed by the Technical Advisory Committee (TAC) of the Department. The technically reviewed and endorsed Plan shall then be recommended for approval to the Ministry by the head of the Department. The Head of the Ministry shall approve the plan for implementation.

7.3.4.10 Implementation Framework

Implementation of Management Plan prescriptions as detailed out in the plan shall be carried out by the respective field office. The implementation plan for the period of 10 years shall be developed as per the implementation framework/format (Table 7.7) with details of when the specific activity would be carried out and also mentioning the amount of funds required

Table 7.7 Implementation framework

Objectives (These are the broad longterm goal(s) that the park wants to achieve)	Strategies (These are methods/plans designed to direct how to achieve the objective)	Action (These are list of activities to achieve the objectives)	Year along with budget (in Nu.m)										Remarks (to include detailed information of the actions such as where, what, etc)
			Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y 10	
Eg. *Objective 1:* *Maintain viable population of flora and fauna in the park.*	*Strategy 1:* *Enhance knowledge on floral and faunal diversity*	*Action 1: Conduct survey for 3 important floral species*		0.3	0.3	0.3							Grass, *Neopicrorhiza* sp., and *Taxus bacata*.
		Action 2: Conduct surveys for 2 faunal species					0.4	0.4					Tiger, SL and Red panda.
		Action 3:											
	Strategy 2:												

7.3.4.11 Preparation of MAB Nomination File

Nomination file shall be prepared as per UNESCO Biosphere Reserves nomination forms available at (http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/images/biosphere_reserve_nomination_form_2013_en.pdf).

7.3.4.12 Presentation of Nomination File to National MAB Committee

The national MAB Committee shall be established including relevant stakeholders to ensure maximum national participation in the international programme, defining and implementing each country's activities. After preparing the nomination file by concerned field office with technical support from NCD, the nomination file shall be presented to national MAB committee.

7.3.4.13 Submission of nomination file to Department

The nomination file shall be presented to the Technical Advisory Committee (TAC) of the Department. The technically reviewed and endorsed Plan shall then be recommended for approval to the Ministry by The Head of the Department. The Head of the Ministry shall approve the plan for implementation.

7.3.4.14 Submission of nomination file to Ministry and Cabinet

The Head of the Ministry shall approve the nomination file and submit to Cabinet for government clearance.

7.3.4.15 Approval of nomination of MAB site by International Coordinating Council (ICC)

After seeking clearance from the government, the nomination file shall be forwarded to Bhutan NatCom Office under Ministry of Education for further submission to UNESCO. Biosphere reserves are designated for inclusion in the Network by the International Co-ordinating Council (ICC) of the MAB programme in accordance with their existing procedure:

7.3.4.16 Periodic Review Process

The periodic review is an important event in the life of a biosphere reserve. It enables a review, every ten years, of the functioning, zoning, scale of the biosphere reserve as well as the involvement of the populations living in the site. The periodic review represents an opportunity to carry out a qualitative survey of the actions implemented and their results. It's a time to take stock of progress made by the biosphere reserve, especially for updating of knowledge, skills and expertise in resource and ecosystem management. It also provides an opportunity to discuss the updating of the zonation system and assess its relevance, question the objectives and means of management policies and examine the issues and problems tied to implementation. It is also a time to discuss weak points/ drawbacks. Its objective is to improve the quality of the biosphere reserves and their functioning as sites for testing and demonstrating approaches to sustainable development.

The periodic review shall be conducted as per the form of periodic review for biosphere reserve in (https://en.unesco.org/sites/default/files/periodic_review_form_english_2013.pdf).

7.3.5 Monitoring and Evaluation

The Management Plan activities shall be monitored and evaluated twice dueing the period of the management plan. The periodic review of the management plan is an important event in the life of a biosphere reserve. It enables a review, every ten years, of the functioning, zoning, and scale of the biosphere reserve as well as the involvement of the populations living in the site. The report shall be considered by the Advisory Committee for Biosphere Reserves for recommendation to International Co-coordinating Council."

7.4. Key Biodiversity Area

7.4.1 Management Context

7.4.1.1 Background

The concept of "key biodiversity area" (KBA) was first introduced in Bhutan in 2005, as part of the Critical Ecosystem Partnership Fund's (CEPF) ecosystem profile for the Eastern Himalayas region (Nepal, Bhutan, North-east India) project, where 25 KBA were identified for globally threatened species of birds, mammals and plants in the region. Of these, 16 were outside of the Protected Area (PA).

For Bhutan, classifying KBA shall be prioritized for landscapes outside the PA. This is because the PA have a primary conservation objective with their core function promoting the in-situ conservation of biodiversity, amongst others, with strong legal support. On the other hand, state reserved forests (SRF) outside PA faces higher degree of anthropogenic threats and have greater risk of losing lots of species. These areas are expected to have biodiversity and ecosystems of great conservation significance. Identification of KBAs and other Effective Area-Based Conservation Measures (OECMS), and, recognition of their governance and management structures provides an opportunity to engage and support a range of new partners in conservation efforts outside the PA.

The KBA are *"sites contributing significantly to the global persistence of biodiversity"* (IUCN, 2016). In the context of Bhutan, the word 'global' in this definition may be replaced with 'national' when deemed necessary, and "sites" shall refer "areas outside protected areas". As such, KBA are "*sites outside protected area networks, contributing significantly to the global and/or national persistence of biodiversity*".

7.4.1.2 Objectives

- Protection of threatened and/or endemic species facing the risk of local extinction for its persistence.
- Protection of critical habitat and ecosystem to ensure enabling conditions for species persistence and flow of ecosystem services.
- In-situ conservation of biodiversity beyond the protected areas

7.4.2 Roles and responsibility

NCD shall be the KBA National Coordination Unit for coordinating the KBA classifying process. while the field identification works shall be done in collaboration with field Divisions. The Technical Advisory Committee (TAC) shall act as a national committee for KBA

7.4.3 Process of Identification of KBA

Office	**Roles and responsibilities**
NCD (KBA National coordination Unit)	• Oversee the KBA identification, delineation and endorsement processes. • Review of proposed KBA sites. • Provide technical guidelines and support. • Conduct monitoring and facilitate implementation of the action plan
Field offices	• Conduct scoping and feasibility assessment, and submit proposal to the National Coordination Unit. • Develop and implement KBA conservation action plan • Monitor and evaluate the plan
KBA National Committee (TAC)	• Review the proposed KBA sites for endorsement as National or forward to the Ministry for submission of the site as Global KBA
KBA Regional Focal Point	• Screen and submit proposed sites to KBA Secretariat for designation as Global KBA.

KBA sites are identified using the KBA criteria and processed for final endorsement by the Department for onward nomination for registration as Global KBA sites. Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories as mentioned in the scientific criterion:

- Verification of identified KBA
- Verification of existing data (If the existing data is inadequate, field survey shall be conducted following prescriptions in Volume III and IV of the *Code*).
- Stakeholder consultation
- Final delineation of KBA boundary

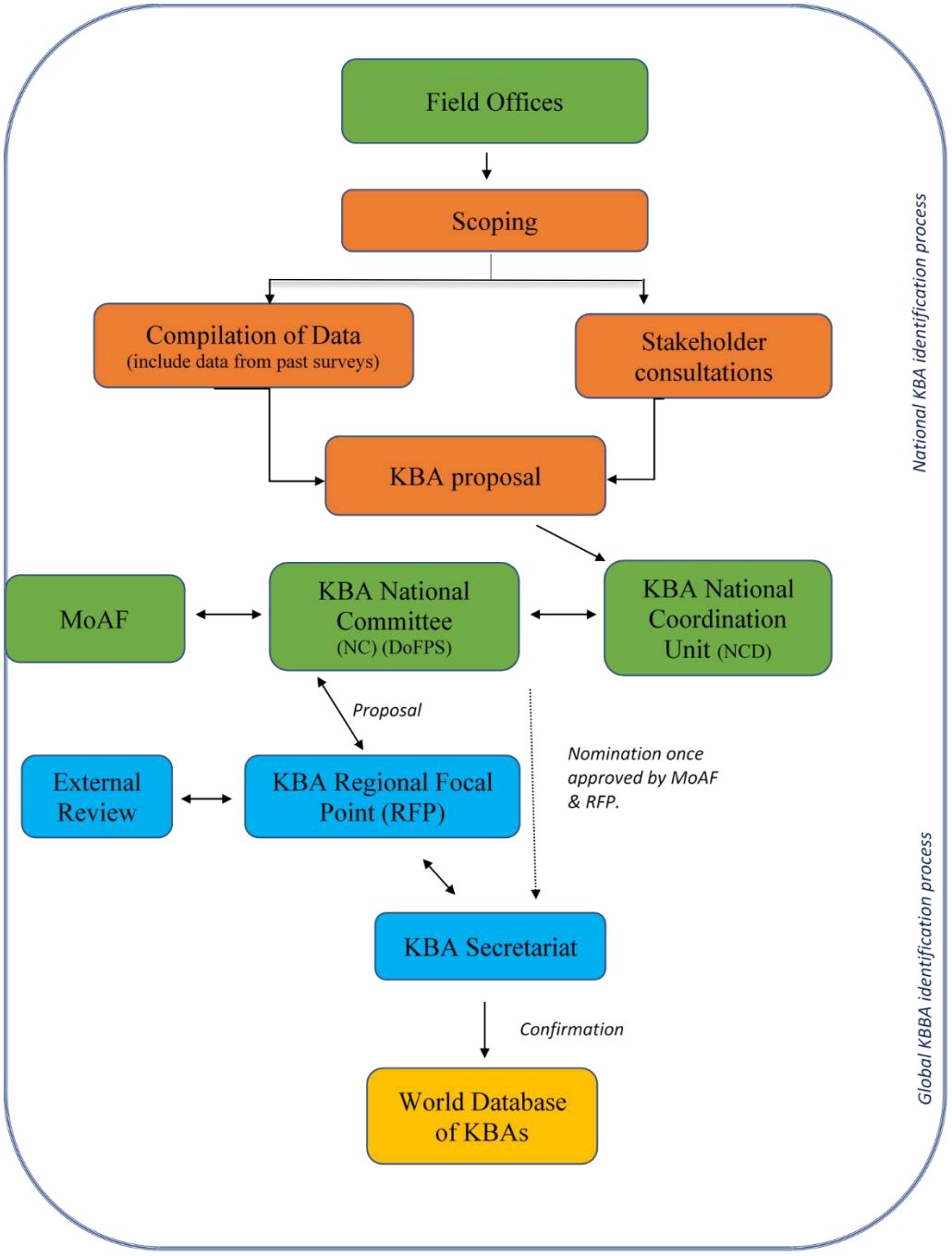


Figure 7.14 schematic representation of KBA identification process

7.4.4 Criteria for Classifying KBA

Two criteria are being assigned for identifying and classifying KBA sites in Bhutan.

i. Scientific Criterion set in KBA Standards of the IUCN
ii. Administrative Criterion for KBA Management

For the site to qualify as global KBA, it shall meet one or more of the 11 scientific criteria and meet all the administrative criteria.

7.4.4.1 Scientific Criterion

A. Threatened Biodiversity

Biodiversity around the world are under serious threat due to anthropogenic pressure and the drivers of biodiversity loss are: population growth, economic growth, socio-political, resource depletion, climate change, land use change and habitat degradation etc.

A1. Threatened species

The species threatened by extinction due to loss of habitat and loss of genetic variation. Habitat loss may occur naturally or driven by the drivers of biodiversity loss as mentioned above.

A2. Threatened ecosystem types

The sites that hold different ecosystem types from threats. Forests, Agriculture and Aquatic ecosystems (rivers, lakes, marshlands and hot springs) are the three major ecosystem types in Bhutan.

B. Geographically Restricted biodiversity

The limited geographic area with few spatial options of species distribution.

B1. Individual geographically restricted species

Endemic species being unique is defined by the zone of an island, nation, country, habitat type of a species not found elsewhere.

B2. Co-occurring geographically restricted species

The sites holding multiple restricted-range species within a taxonomic group, often characterizing centres of endemism.

B3. Geographically restricted assemblages

The sites that hold an assemblage of species within a taxonomic group that is restricted to a bioregion.

B4. Geographically restricted ecosystem types

The ecosystems that are geographically restricted, usually through isolation through geographical circumstances.

C. Ecological Integrity

The sites not significantly altered by humans that have fully functioning ecosystems and maintain the full complement of species in their natural abundances and/or biomass.

D. Biological Processes

The site maintained for a significant proportion of a species' population through the production of juveniles or propagules.

D1. Demographic aggregations

The significant development of amenities in the vicinity of the geographically restricted species without any disturbance to the species with the intention of increasing the number of tourists.

D2. Environmental refugia

The sites that hold a significant proportion of the global population of a species during periods of environmental stress.

D3. Recruitment sources

The places that are critical for reproduction and recruitment of a species.

E. Irreplaceability Through Quantitative Analysis

Table 7.8 Scientific Criterion set in KBA

A. Threatened biodiversity		
A1 Threatened species		Assessment parameters
A1a	≥0.5% of global population size and ≥5 reproductive units (RU) of a CR/EN species	(i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities (vi) distinct genetic diversity
A1b	≥1.0% of global population size and ≥10 RU of a VU species	
A1c	≥0.1% of global population size and ≥5 RU of a species listed as CR/EN due only to past/current decline [= Red List A1, A2, A4 only]	
A1d	≥0.2% of global population size and ≥10 RU of a species listed as VU due only to past/current decline [= Red List A1, A2, A4 only]	
A1e	Effectively the entire population size of a CR/EN species	
A2 Threatened ecosystem types		
A2a	≥5% of global extent of a CR or EN ecosystem type	
A2b	≥10% of global extent of a VU ecosystem type	
B. Geographically restricted biodiversity		
B1. Individual geographically restricted species	≥10% of global population size and ≥10 RU of any species	(i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities (vi) distinct genetic diversity
B2. Co-occurring geographically restricted species	≥1% of global population size of each of a number of restricted range species in a taxonomic group: ≥2 species or 0.02% of the total number of species in the taxonomic group, whichever is larger	
B3. Geographically restricted assemblages		
B3a	≥0.5% of global population size of each of a number of ecoregion-restricted species in a taxonomic group: ≥5 species or 10% of the species restricted to ecoregion, whichever is larger	(i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities

B3b	≥5 RU of ≥5 bioregion-restricted species or ≥5 RU of 30% of the bioregion-restricted species known from the country, whichever is larger	
B3c	Site is part of the globally most important 5% of occupied habitat for ≥5 species in the taxonomic group	(i) relative density of mature individuals (ii) relative abundance of mature individuals
B4. Geographically restricted ecosystem types		
	≥20% of the global extent of an ecosystem type	
C. Ecological integrity		
	Site is one of ≤2 per ecoregion with wholly intact ecological communities	composition and abundance of species and interactions
D. Biological processes		
D1. Demographic aggregations		
D1a	≥1% of global population size of a species, over a season, and during ≥1 key stage in life cycle	# mature individuals
D1b	Site is among largest 10 aggregations of the species	# mature individuals
D2. Ecological refugia	≥10% of global population during periods of environmental stress	# mature individuals
D3. Recruitment sources	Produces propagules, larvae or juveniles maintaining ≥10% of global population size	# mature individuals
E. Irreplaceability through quantitative analysis		

7.4.4.2 Administrative Criterion

A. Sites Outside Protected Area Network

B. Site Under Single Management Unit

C. Minimum area of 0.01km^2

D. Guided by Conservation Plan

Having met one of the scientific criteria and all the administrative criterion, KBA shall effectively protect one or more of the following elements of native biodiversity:

- Rare, threatened or endangered species and habitats, and the ecosystems that support them, including species and sites identified on the IUCN Red List of Threatened Species, Red List of Ecosystems, or national equivalents.
- Representative natural ecosystems.
- High level of ecological integrity or ecological intactness, which is characterized by the occurrence of the full range of native species and supporting ecological processes. These areas shall be intact or be capable of being restored under the proposed management regime.
- Range-restricted species and ecosystems in natural settings.
- Important species aggregations, including during migration or spawning.

- Ecosystems especially important for species life stages, feeding, resting, moulting and breeding.
- Areas of importance for ecological connectivity or that are important to complete a conservation network within a landscape.
- Areas that provide critical ecosystem services, such as clean water and carbon storage, in addition to in-situ biodiversity conservation.
- Species and habitats that are important for traditional human uses, such as native medicinal plants, in addition to in-situ biodiversity conservation.

7.4.5 Conservation management planning

The conservation of the species and/or ecosystem of the recognized KBA shall be guided by a time bound conservation plan, developed by the field division under whose jurisdiction the KBA falls. The conservation plan shall be part of the area-based management plan and developed based on scientific data that were used for qualifying the site as KBA, and shall have a clear goal with desired future state, translating into hierarchy of conservation objectives. The plans scope shall be beyond the delineated KBA boundary and shall consider the socio-cultural interaction of communities around the KBA site. The prescribed actions shall ensure in-situ conservation by mitigating the conservation treats, resulting in species/ecosystem persistence in the long run. The conservation plan shall also prescribe do's and don'ts based on the purpose of KBA identification and its location.

Monitoring and Evaluation shall form an integral part of the plan and results from M & E shall be reported to the Department for policy directives. The development of conservation plan, therefore, shall involve following processes;

A. Analysis of species and/ecosystem information used for qualifying the site as KBA

B. Socio-economic survey of communities nearby the KBA

C. Threat analysis and ranking

D. Setting conservation goals and objectives

E. Prescribing conservation actions

F. Identifying site management actions (Do's and Don'ts)

G. Monitoring and Evaluation framework.

7.4.6 Monitoring and Evaluation

7.4.6.1 Monitoring

Field Offices (DFOs and PAs) shall regularly monitor the implementation of the other conservation areas. NCD shall annually monitor the implementation of OCA. The monitoring shall focus on the implementation of the planned activities, and achieved outputs.

7.4.6.2 Evaluation

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall intervention. Evaluation of the prescriptions of the OCA shall be done as part of the evaluation process of the area-based plan as described in Volume III and IV of the *Code*.

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8. Plantation and Nursery Management

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8. Plantation and Nursery Management

8.1. Management Context

8.1.1 Background

The Constitution of the Kingdom of Bhutan mandates to maintain at least 60% of the land under forest cover for all time. Bhutan has also pledged to remain carbon neutral. The Department has over the years worked towards fulfilling the national and international obligations, wherein forest plantation and nursery management play a key role.

The first forest plantations were established in 1947 along the southern belt with the introduction of commercial harvesting of forest products through a clear-felling system. Large-scale artificial regeneration was introduced with planting of Teak (*Tectona grandis*), Sal (*Shorea robusta*), Champ (*Michelia champaca*) and other valuable tree species to enhance the productivity of the clear-felled area. Since the early 1960s, the program has been expanded to other parts of the country to combat forest degradation by bringing more areas under forest cover.

The afforestation and reforestation program helps in managing the principles of sustainable development policy in the country. Rehabilitation of degraded and barren forest land is one of the core forestry programs and the earliest conservation initiative in Bhutan.

8.1.2 Objectives

The objectives of Plantations are to:

a) protect, rehabilitate and manage critical and degraded watersheds for sustained flow of good quality water;
b) reduce soil erosion and degradation;
c) contribute to biodiversity conservation and reducing pressure on natural forests;
d) contribute towards mitigation of climate change through carbon sequestration;
e) protect and promote native and local species;
f) provide livelihoods opportunities for farmers through community and private forestry programs for both commercial and domestic purpose;
g) improve aesthetic values through development and beautification of landscapes;
h) supplement future timber production; and
i) offset deforestation.

8.2. Roles and Responsibilities

Social Forestry and Extension Division (SFED) is responsible for the overall coordination of the plantation program at the national level. Field Offices shall facilitate planning and budgeting of the plantation program on an annual basis. The implementation of plantation activities shall be the responsibility of any authorized agency (Public/Private) designated by the Government.

Table 8.1 Roles and responsibilities

Office	***Roles and responsibilities***
SFED	• Focal agency to facilitate and provide technical backstopping for plantation and nursery programmes. • Source budget for plantation program. • Develop plans, program and strategies related to plantation. • Verify plantation budget proposals and arrange to issue Administrative and Technical Sanctions for plantation budget. • Conduct Monitoring (Annual) & Evaluation (Mid-term and final) (M&E) to assess the status and impact of all plantations and nurseries in all State Reserve Forest (SRF) land.
Field Office	• Submit estimates for plantations to SFED • Set targets in the Five-Year Plan (FYP) and prepare annual plan based on field situation • Conduct timely M&E within their respective jurisdiction and issue rectification measures to the implementing agencies if deemed necessary and subsequent follow-up • Adopt good coordination linkages between the implementing agencies and clarify roles and responsibilities for planning, execution and M&E of the plantation and nursery programmes. • Ensure implementation of plantation work (both new creation and maintenance of old plantations) by concerned agencies.
Authorised Agency	• Carry out reforestation in the Forest Management Units (FMU) and other sanitation areas. • Carry out plantation in potential, barren and degraded forestland (both new creation and maintenance of old plantations) except for the special or national significant plantation • Industrial firms also carry out plantations on leased out land based on the agreement.

8.3. Types of Plantation

Plantation depends on the objectives and the availability of resources. The most appropriate re-afforestation models to address ecological, social and economical aspects depends on the objectives and site conditions. Plantation may be categorized into the following types:

1. **Afforestation**: The afforestation plantation programmes are broadly classified into two main types i.e. **Normal Plantation** and **Rehabilitation Plantation. Normal Plantation** refers to planting of suitable species in barren, degraded or in watershed areas. These types of areas are mostly available in the vicinity of the settlement. **Rehabilitation plantations** are established in critically degraded areas such as eroded, fire burnt, landslide affected, and mining areas. This includes planting fast growing and soil binding species combined with soil and water conservation techniques.
2. **Reforestation**: Reforestation plantations are confined to the harvested areas. It is the system of establishing forest trees on areas previously occupied by a forest. Under present situation, reforestation is mainly practiced in Forest Management Units (FMUs) by the concerned implementing agencies.
3. **Enrichment plantation:** Planting of desirable species in a forestland having low crown cover (less than 40 % crown cover), no established regeneration (*less than 1600 seedling per ha with 30 cm height of desirable species*) and/or less species diversity. The purpose of such plantation is to:
    - improve the quality and stocking of the forest to make it economically and ecologically viable; and

- enhance the protective and productive roles of forest.

4. **Industrial plantation:** Plantation established and managed by the forest-based industries in the leased forest areas to meet raw material demand on a sustainable basis. The criteria for site selection include:
    - productive site
    - proximity to the industry
    - minimal impact on environment and biodiversity
5. **Institutional plantation**: The institutional plantation includes plantations established in the registered land of the institution, such as Dzongs, Monasteries, Hospitals and other government and private institutions. The objective of this type of plantation is to provide aesthetic value and to protect the institution from pollution and other adverse effects. It is also meant to meet the long-term timber demands from such plantation, for example, the cypress plantations around Dzongs and monasteries shall provide timber to the Dzongs and Monasteries.
6. **Community plantation:** Plantation established and managed by the local community in SRF lands, community lands in the close vicinity of the village by the Community Forest Management Groups (CFMGs) in accordance with the Forest and Nature Conservation Rules.
7. **Private plantation:** The private plantations are those plantations created and managed by the private individuals on their private registered land.
8. **Special or national significant plantation**: Plantation established to commemorate special occasions of national importance (Tendrel plantation, Royal wedding plantation, Dzong renovation plantation, De-suung plantation, Guinness plantation, etc.)
9. **Urban/Avenue plantation**: This kind of plantation includes strip planting along roads and highways, ornamental plantings, shade tree plantings, etc., around Dzongs, Monasteries, Schools, townships and settlements for aesthetic values, beautification, wind protection, soil stabilization and educational purposes.
10. **Compensatory plantation:** Plantation created to compensate for the removal of vegetation cover and mitigation of environmental impacts due to developmental or project activities usually through project funding such as Hydro-power projects, transmission corridors, mining, quarry, etc.
11. **Watershed protection plantation**: Plantation created preferably of native tree species to protect upstream watersheds to revive and regulate sustainable flow of water.
12. **Agro-forestry:** Agro-forestry is the purposeful combination and interaction of trees with crops and/or livestock with the intention of maximizing sustainable production of the agriculture land.

8.4. Procedures for Creation of Plantation

The following conditions shall be considered before undertaking any plantation program;

a) Site specific objectives shall be defined. For e.g. in degraded catchments, the objective of the plantation shall be to rehabilitate the area but not necessarily to meet forest related needs of the people.

b) Native species shall be given emphasis for plantation in order to reap maximum tangible and intangible benefits and minimize future problems.

c) The species for plantation shall be based primarily on the suitability and adaptability to the sites.

d) The chosen method of plantation shall be environmentally sound, socially acceptable and economically feasible depending on the site-specific objectives and site characteristics.

e) The original crop composition shall be maintained unless deemed necessary to change the composition.

f) For dry and desiccated sites, ensure proper water supply.

The steps for creation of plantation are detailed below:

8.4.1 Preparatory Planning Steps

The following steps must be followed prior to the actual starting of the plantation works.

8.4.1.1 Planning and Budgeting

Proper planning is the key to final success of the plantation. Planning and budgeting for the plantation program must be done one to two years ahead of actual implementation. Accordingly, adequate budget provisions must be kept on annual basis.

8.4.1.2 Site Selection

Sites have to be selected in such a manner that the plantation does not conflict with other user's rights or disturb other forms of land use. Site selection for any type of plantation shall be carried out prior to preparation of estimates.

The following steps shall be adhered to while selecting sites for plantation.

i) The sites have to be selected in such a manner that the plantation does not come into conflict with other user's rights or result in a change of land use.

ii) Potential afforestation sites can be:

- Degraded, barren areas in the vicinity of the settlements, since such activities would encourage community-based plantation.
- Degraded sites and fire burnt areas which may further deteriorate if no intervention is taken.
- Areas prone to erosion, landslides, floods or any areas which may require immediate intervention.
- In and around drying water source.
- Areas where negative impacts are prevalent due to the adjacent farming activity and directly threaten human habitat.

iii) Approaches for site selection may include the following:

- Engaging local people during identification of plantation sites is important.
- Review of Gewog level data and information if available.
- Barren and degraded sites identified by the concerned Field Offices.
- Responding to requests from farmers, communities, and other government or private organizations.
- Conduct Rapid Rural Appraisal (RRA) of the site in order to assess the existing land area including ownership and user rights.

8.4.1.3 Choice of species

Emphasis shall be given for native/indigenous/endemic species. Planting of exotic species shall be discouraged as far as possible. One shall consider which species grows best under the given ecological conditions and accordingly prepare seedling stocks for plantation for coming season (Table 8.2). The species shall serve the purpose of plantation and fetch both tangible and intangible benefits.

Table 8.2 Common trees species for plantations

Sl. No	Scientific name	Local name
Cool Temperate (2600-3600m)		
1	*Abies densa*	Dungshing (Dz), Wangshing (Sh),Fir (Eng)
2	*Acer campbellii*	Pchalam (Dz), Sermaling(Sh), Kapasi(Lh)
3	*Benthamedia capitata*	Phoitse (Dz), Namitpashing (Sh), Ram katar (Lh)
5	*Betula alnoides*	Taapshing (Dz), Chharshing (Sh), Saur (Lh)
4	*Betula utilis*	Latap (Dz), Chharshing (Sh), Bhojpatra (Lh)
6	*Juniperus recurva*	Shupshing (Dz), Shukpashing (Sh), Dhupi(Lh), Himalayan Juniper(Eng)
7	*Larix griffithii*	Zashi (Dz), Larch (Eng)
8	*Picea spinulosa*	Ba shing (Dz), Ba shing(Sh), Kalo salla(Lh), E.Himalayan Spruce(Eng)
9	*Borinda grossa*	Ba (Dz), Shi (Sh), Bans (Lh)
10	*Salix wallichiana*	Changmashing (Dz/Sh)
Warm Temperate (1800-2600m)		
1	*Castanopsis armata*	Sokey(Dz), Tshai shing(Sh), Patle kotus(Lh)
2	*Castanopsis clarkei*	Tshai shing sokar(Sh), Patle katus(Lh)
3	*Castanopsis hystrix*	Sokeyshing (Dz), Tshaishing sonag(Sh), Katus Lh)
4	*Castanopsis indica*	Sokey(Dz), Tshai shing(Sh), Aule katus(Lh)
5	*Castanopsis lanceifolia*	Tshai shing(Sh), Patle katus(Lh)
6	*Corydalis nigro*	Sokey(Dz),Tshai shing(Sh), Lekh katus(Lh)
7	*Daphne anrantica*	Dhey shing(Dz), Shogo shing(Sh)
8	*Daphne bholua*	Dhey shing/Dheynap(Dz), Shogo shing(Sh), Kagate(Lh)
9	*Exbucklandia populnea*	Chenjushing (Dz), Lemshing (Sh), Pipli (Lh)
10	*Juglans regia*	Tashing (Dz), Kheshing(Sh), Okhar (Lh)
11	*Magnolia campbellii*	Khashing(Dz), Karshing (Sh), Ghoge champ(Lh)
12	*Nyssa javanica*	Lai-mom-nang shing(Sh), Lekh chilaune(Lh)
13	*Pinus bhutanica*	Druggi Tongphu(Dz), Drukpa chang shing(Sh), Bhutan pine(Eng)
14	*Pinus wallichiana*	Tongphu (Dz), Changshing (Sh),Salla/Dhupi(Lh) Bluepine (Eng)
15	*Quercus griffithii*	Sissishing(Dz), Bainangshing (Sh), Khasru (Lh), Oak(Eng)
16	*Quercus semicarpifolia*	Bjishing (Dz), Beytsenangshing (Sh), Khasru (Lh), Oak(Eng)
17	*Salix babylonica*	Changmashing (Dz/Sh),Weeping Willow (Eng)
18	*Taxus baccata*	Hashing/Kerangshing (Dz/Sh), Yew (Eng)
19	*Tsuga dumosa (T. brunoniana)*	Bashing/Sey shing (Dz), Wanglashing (Sh), Tengre salla(Lh),Himalayan Hemlock (Eng)
Dry Sub-Tropical (1200-1800m)		
1	*Aglaia spectabilis*	Laso shing(Dz), Phang shing (Sh), Lali or Amari (Lh)
2	*Alcimandra cathcartii (Michelia cathcartii)*	Kha shing (Dzo), Kar shing/Chhampey shing(Sh),Tite champ (Lh)
3	*Alnus nepalensis*	Gamashing (Dz), Gamoshing(Sh), Utis (Lh)
4	*Ammora wallichii*	Lasoshing (Dz), Phangshing (Sh), Lali (Lh)
5	*Bauhinia purpurea*	Zibzibshing (Dz), Pekpekshing (Sh) Tanki (Lh)
6	*Bauhinia variegate*	Ruchashing(Dz), Balingshing (Sh), Koiralo (Lh)
7	*Callicarpa arborea*	Khalema(Dz), Jeenlab sey shing(Sh), Guenla(Lh)
8	*Castanopsis tribuloides*	Thomsokey (Dz),Thongpashing(Sh),Musrey katus(Lh)

9	*Catunaregam longispina (Randia dumetorum)*	Shoshoma zoo shing (Sh)
10	*Celtis australis*	Sokum (Dz), Sogsogpashing (Sh), Khari (Lh)
11	*Celtis tetrandra*	Sok-sokpa shing or phantang shing(Sh)
12	*Cephalostachyum capitatum*	Jhi(Dz), Soh(Sh), Dulloo
13	*Cinamomum camphora*	Peomenshing (Dz), Kapur (Lh), Camphor (Eng)
14	*Cinamomum cassia*	Shingtsa(Sh)
15	*Cupressus corneyana*	Tsendhey or chendhey(Dz), Tsendhhen or Chen shing, Weeping cypress(Eng)
16	*Cupressus himaliaca*	Tsenden (Dz), Tsendenshing (Sh), Dhupi (Lh)
17	*Cupressus torulosa*	Tsenden (Dz), Tsendenshing(Sh), Dhupi (Lh)
18	*Daphnephyllum himalense*	Jurooshing (Dz), Aawashing (Sh), Lal Chandan (Lh)
19	*Diploknema butyracea(Aesandra butyracea)*	Yika shing(Dz), Peen shing or Pheen shing(Sh), Chiuri(Lh)
20	*Emblica officinalis (Syn. Of Phyllanthus emblica)*	Omla shing(Dz), Chhorgen say shing(Sh), Amala(Lh)
21	*Ficus roxburghii (F. auriculata)*	Bakushing (dz), Chongmashing (Sh)Nebaro (Lh)
22	*Lyonia ovalifolia(Pieris ovalifolia)*	Zentu shing(Dz), Shajula shing(Sh), Angeri(Lh)
23	*Parasassafras confertiflora*	Shing-mar(Dz), Singsee/Selung shing(Sh), Kalo bori(Lh)
24	*Percea fructifera(Machilus edulis)*	Gulishing (Dz),Lapche kawla/ Phuntse(Lh)
25	*Pinus roxburghii*	Thetongphu (Dz),Roinashing (Sh), Dhup(Lh), Chirpine (Eng)
26	*Prunus cerasoides*	Boraang lengshing/Drem lengshing(Sh)
27	*Quercus glauca*	Thomp shing(Dz), Thongpa shing(Sh), Musre phalant(Lh)
28	*Quercus lamellose*	Bangkashing/Thomp sokey(Dz),Fangkoimashing,(Sh), Bajranth(Lh)
29	*Quercus lanata*	Ghum (Dz), Beytsenangshing (Sh)
30	*Rhododendron barbatum*	Tag shing(Dz/Sh), Lal chimal(Lh)
31	*Rhododondron arboretum*	Aetoh metog (Dz), Zhu-daangshing(Sh), Gurans/Gurass (Lh)
32	*Sapindus mukorossi*	Nakapani (Dz), Kilingshing (Sh), Ritha (Lh)
33	*Symplocos paniculata*	Pangtse shing(Dz/Sh)
34	*Toona cilliata*	Chhunshing (Dz), Rawashing (Sh), Tooni (Lh)
Humid Sub-Tropical (600-1200m)		
1	*Agapetes saligna*	Amile/Ongarey (Lh)
2	*Alangiium Chinese*	Luma shing (Dz), Benthong shing (Sh), Okane or Akhane(Lh).
3	*Albizia lebbeck*	Prekprekshing(Dz), Sershing(Sh), Kalo siris (Lh)
4	*Albizia procera*	Sekpalashing(Dz), Khirthangshing (Sh), Seto siris(Lh)
5	*Albizia sherriffii*	Lam shing(Dz), Lhari siris(Lh)
6	*Anthocephalus cadamba*	Kadamshing(Dz), Kadam(Lh)
7	*Aquilaria malaccensis*	Agoor (Dz), Aghori (Lh), Eagle wood (Eng)
8	*Bischofia javanica*	Chumshing (Dz), Kainjal (Lh)
9	*Choerospondias axillaris*	Charashing (Dz), Throongchung (Sh), Lapsi (Lh)
19	*Chukrasia tabularis*	Chuzim, (Dz), Checkrasi (co)
11	*Cinamomum glaucescens(Cinamomum cecicodapne)*	Shingtsazim (Dz), Durkashing (Sh), Maligari (Lh)
12	*Dillenia indica*	Abee-dhoro shing(Sh), Panchphal or Panchphale(Lh)
13	*Duabanga grandiflora*	Patangshing(Dz), Grandanglashing(Sh) Lampatey (Lh)

14	*Eleacarpus lanceifolius*	Quequeshing(Dz),Gashathungshing(Sh),Badrasey(Lh)
15	*Ficus religiosa*	Jangchubshing (Dz/Sh), Pipal (Pipal)
16	*Gmelina arborea*	Gamarshing(Dz), Kholomshing(Sh), Khamari(Lh)
17	*Lithocarpus fenestratus*	Thasa sokey(Dz), Shodhka Tshai shing(Sh), Arkaula(Lh)
18	*Litsea monopetala*	Sey chhangloo shing(Sh), Bonsum(Lh)
19	*Michelia champaca*	Kashing (Dz), Karshing (Sho, Aule Champ (Lh)
20	*Michelia doltsopa(M. excelsa)*	Khashing (Dz), Karshing (sh), Rani Champ/Seto champ(Lh)
21	*Morus laevigata(M. macroura)*	Tshendhey (Dz),Sengdenshing (Sh), Kimbu (Lh)
22	*Pteropsersum acerifolium*	Dhashom(Dz),Mongnangloshinh(Sh)Hatipaley(Lh)
23	*Schima wallichii*	Puyamshing (Dz), Zalashing(Sh), Chilauney (Lh)
24	*Sterculia villosa*	Phraang shing (Sh), Odal(Lh)
25	*Syzygium cumini*	Nyeshing (Dz), Mentsu or Mentse sey shing(Sh), Jamuna (Lh)
26	*Terminalia bellerica(T. bellirica)*	Baru (Dz/Sh),Barra (Lh)
27	*Terminalia myriocarpa*	Bupshing (Dz), Bakhaloshing (Sh), Panisaj (Lh)
28	*Terminalia tomentosa*	Alashing (Dz), Pakhasaj (Lh)
29	*Tetradium fraxinifolium*	Dongmarshing (Dz), Khanakpa (Lh)
30	*Tetrameles nudiflora*	Kadongshing (Dz),Maina (Lh)
Wet Sub-Tropical (150-600m)		
1	*Acacia catechu*	Toeja (Dz/Sh), Khair(Lh)
2	*Adina cordiflolia*	Halwashing (Dz), Anashing(Sh), Haldu (Lh)
3	*Ailanthus grandis*	Pekashing(Dz/Sh), Gokul (Lh)
4	*Aquilaria malaccensis (Aquilaria agallocha)*	Aarnag(Dz), Aarnag(Sh), Agar(Lh), Eagle wood or Aloe wood
5	*Aquilaria sinensis*	Agoor (Dz), Agoorshing(Sh), Agar (Lh), Eagle wood or Aloe wood(Eng)
6	*Artocarpus heterophyllus*	Damtse (Dz), Dremlingshing(Sh) /Jackfruit (Eng)
7	*Azadirachta indica (Melia azadirachta)*	Ja shing(Dz), Ja shing or Neyra shing(Sh), Bakaina(Lh), Neem tree(Eng)
8	*Bombax ceiba*	Pemagayser (Dz/Sh) Simal (Lh)
9	*Carpinus viminea*	Rutoshing (Dz),, Lung shing(Sh)
10	*Cassia fistula*	Chakajumshing(Dz), Dhongkoshing(Sh),Rajbriksha/ Sunalo(Lh)
11	*Dalbergia sissoo*	Sissooshing (Dz), Sisoo (Lh)
12	*Jacaranda mimosifolia*	Jakashing (dz), Jacaranda (co)
13	*Lagerstroemia parviflora*	Dongkashing(Dz),Baramshing(Sh), Sidha (Lh
14	*Mangifera indica*	Aamchukuli (Dz), Aamshing(Sh), Amp (Lh)
15	*Melia azedarach*	Jashing (Dz), Neyrashing (Sh), Bakaina (Lh)
16	*Mesua ferrea*	Chag shing(Dz), Per shing(Sh), Nagersuri(Lh), Iron wood(Eng)
17	*Oroxylum indicum*	Champaka(Dz), Namkaling metog(Sh),Totola(Lh)
18	*Shorea robusta*	Gotenshing (Dz), Sal shing(Sh), Sakhua(Lh)
19	*Tectona grandis*	Tsomarshing (Dz),Teak shing(Sh), Sogun (Lh),Teak (Eng)
20	*Zizyphus jujube*	Tsoshing (Dz), Bayer (Lh)

8.4.1.4 Technical and administrative Approval

On confirmation of budget for the particular financial year, a detail plantation estimates, with write-up, site maps (shape file) and GPS coordinate shall be prepared by the field implementing agency and submit to the respective field office who shall verify and process for the administrative, financial and

technical approval for implementation. The DoFPS HQ shall be the final authority to accord technical sanction for all the plantation and nursery activities.

8.4.2 Site Survey

The site selected for the plantation shall be surveyed with GPS and mapped. Some patches of the land within proposed area may not be feasible for planting. In such circumstances, non-feasible area shall also be surveyed but excluded in the estimates. The surveyed area maps shall be produced clearly along with the total area suitable for planting.

Comprehensive estimate shall be preparaed and supported by brief write up of the proposed areas along with the maps. Budget shall be prepared as per the norms and within the ceiling issued by the Department from time to time.

8.4.3 Site Clearance

The understory vegetation which consists of small trees, shrubs, bushes and herbs are comparatively more in broadleaf forest area than in conifer. Similarly, there is more understory vegetation in the subtropical forests in comparison to the temperate zone. This has considerable effect on the cost because of difference in unit cost requirement for site clearance and soil preparation. The existing valuable trees found within the proposed areas shall not be cleared. However, the site clearance may not be required especially for wildlife habitat plantation, watershed protection and land management.

8.4.4 Burning and Disposal of Debris

As far as possible, burning shall be avoided (especially in conifer forest) to reduce forest fire and damages to surrounding trees. The debris may be stacked in lines or periphery of plantation areas.

8.4.5 Alignment and Stacking

Alignment and stacking is necessary to maintain uniform spacing between the plants, depending on the types and objectives of plantation. Generally, alignment is not necessary for wildlife habitat improvement, spring watershed protection plantation and enrichment plantation. If the alignment and stacking is not required, it shall be excluded from cost estimation.

Stacking shall be done with bamboo or stick of 1 and 1.5-meter length for temperate zone and tropical respectively. The stacking shall also be done for refilled seedlings during maintenance.

8.4.6 Implementation

The plantation activities are season bound and timely implementation of the program is necessary to ensure its survival and success. Therefore, all the activities shall be implemented as per the Seasonal Calendar.

Table 8.3 Seasonal calendar for plantation

Seasonal Calendar for Plantation Activity													
Sl.	**Activities**	**Jan**	**Feb**	**Mar**	**April**	**May**	**Jun**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
I	**PREPARATORY WORKS**												
a	Finalization of Budgets												
b	Site selection, Survey and estimation												
c	Verification of estimates and accord Technical Sanctions												
d	Release of plantation funds												

Seasonal Calendar for Plantation Activity													
Sl.	**Activities**	**Jan**	**Feb**	**Mar**	**April**	**May**	**Jun**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
e	Purchase of equipment and fencing materials												
II	**PLANTATION WORKS**												
a	Clearing of plantation sites												
b	Fencing works					Fencing works shall be complete before starting of the seedling plantation							
c	Stacking and planting pit digging						Pit digging shall be done well in advance for weathering purposes						
d	Procurement and transportation of seedlings						Seedlings shall be procured and transported to plantation sites and kept under shed and regular watering for hardening at least for 2 to 4 weeks						
e	Planting of seedlings							Planting shall be done right after the start of rainy season or onset of monsoon					
III	**MAINTENANCE WORKS**												
a	1st weeding in the same year of the creation											Timing for weeding depends on site conditions and weed growth	
b	2nd weeding in the same year of the creation												
c	1st weeding in the 2nd year of creation												
d	2nd weeding in the 2nd year of creation												
e	3rd weeding in the 2nd year of creation												

8.4.7 Sign Board

It is important that the forest nurseries and plantations shall have signboard which contains information such as objective of plantation, type of plantation, species planted, total area, altitude, location/Division/Gewog, Dzongkhag, year of creation, funding agency, etc.

The information in the form of sign board are important aspect of maintaining records and for easy references in locating the plantations in the field. The agencies or communities raising plantations shall follow the standard design of signboard provided below to ensure uniformity.

i. Dimension: 1 m x 1.4 m
ii. Background: Green
iii. Lettering: Yellow

Figure 8.1 An example of a standard signboard for plantation

8.4.8 Maintenance

i. Maintenance of plantations refers to weeding, cleaning, replacement of casualties, and repair of fencing. Where there are large-scale plantations, it shall be necessary to engage watchman to protect plantation from human, animal and fire damages. Proper maintenance is important for a successful plantation. Therefore, any investment for establishment of plantation without proper maintenance shall be a waste.

ii. Ideally, a plantation usually takes 5 to 10 years to be fully established from the year of creation in Bhutan. Species composition and eco-zones are important factors that determine the maintenance period. Based on these factors, maintenance shall be carried out at least three times a year in broadleaved forest and twice a year for conifer for a minimum specified period (five years).

iii. A separate budget provision shall be made to meet the maintenance cost. This includes production of seedlings or purchases of seedlings in case of casualty replacement and daily wages for the watchman. However, deploying watchmen for small-scale plantation is not appropriate from the economic point of view.

8.4.9 Record Keeping

Plantation and Nursery records are maintained in the form of journal. This consists of plantation register and maps maintained as per the format prescribed under Section 8.5.3 Methodology and Approaches for M&E. It becomes difficult to locate the plantation on the ground and to understand the historical changes of crop composition in absence of proper maps and description. The document is equally important for handing and taking over of plantation activities during transfer and posting field staff to ensure continuity of proper maintenance.

Table 8.4 Plantation Journal

Plantation Journal

Name of the Plantation: …….....

Dzongkhag :…….....

Dungkhag:…….....

Gewog :…….....

Village:…….....

Location:…….....

Year of Creation…….....

Attach map with boundary details, measurements and reference points: (Map shall be prepared on scale/Google earth/GPS, indicate reference point and shall have index)

PART A: PLANTATION CREATION
1. INTRODUCTION

- Location: ……...
- Year of creation: …….……
- Area: .....……...…….....…Ha: ….....Acres

2. SITE DESCRIPTION

2.1. Geographical descriptions
2.1.1. Altitude (m)…….....……..
2.1.2. Aspect……...
2.1.3. Slope (degree)…….

2.2. Soil and rainfall
2.2.1. Soil type: ……..
2.2.2. Soil PH: ……
2.2.3. Depth (Hard soil/Soft soil): …….....
2.2.4. Texture: ……
2.2.5. Colour: ……...
2.2.6. Rainfall (Annual average rainfall in mm)…….....……..
2.3. History of the area
Describe the status of the land before establishment of nursery.

Description of original stock

Sl. No.	Plant Species	Quantity (approximate)	Remarks
1			
2			
3			
4			
5			

Species and volume of the timber extracted from the area

Sl. No.	Plant Species	Quantity (approximate)	Remarks
1			
2			
3			
4			
5			

Total sale proceeds

Sl. No.	Plant Species	Quantity (approximate)	Remarks
1			
2			
3			
4			
5			

Regeneration of survey records (if there is any regeneration of tree species taking place in the proposed plantation site)

Types of Plantation (describe whether plantation is)

Sl. No	Types of plantation	Tick	Description
1	Rehabilitation of fire burnt and landslides areas		
2	Normal Plantation		
3	Reforestation in harvested areas		
4	Wild life habitat enrichment plantation		
5	Urban recreation plantation		
6	Plantation of forest fire resistant species in fire prone areas		
7	Plantation for water shed/ land Management		
8	Non Wood Forest Produce (NWFP) Plantation		
9	River and stream bank protection plantation		
10	Avenue and road side Plantation		
11	Plantation in mining sites		
12	Industrial plantation		
13	Plantation in heritage forest		
14	Compensatory plantation		
15	Enrichment plantation		
16	Commercial Plantation		

3. METHOD OF PLANTATION

Describe the method of plantation applied in the particular plantation site. May be one or two of the following methods:

3.1. Direct Seeding

Sl. No.	Method of Seeding	Species	Quantity	Remarks
1	Thalis			
2	Line/terraces			
3	Scarification and broadcasting in the entire plantation site			
4	Dibbling			

3.2. Seedling Planting

Sl. No.	Method of Seeding	Species	Quantity	Remarks
1	Entire planting (bare root planting, may be wildings or the seedlings raised in nursery)			
2	Planting of poly pot seedlings			
3	Planting of seedlings with ball of earth (in some species it is necessary to transport seedlings with ball of earth to ensure its survival)			
4	Percentage of species mixture			

3.3. Seedling Planting

Sl. No.	Method of Seeding	Species	Quantity	Remarks
1	Stump plantation			
2	Rhizomes			

4. DETAILS OF CREATION ACTIVITIES

Site preparation:

Cutting, Slash and burn (this work is done normally in clear – felled areas)

Alignment and stacking (to maintain correct spacing as prescribed in the estimate/ plan for the area)

Spacing (describe spacing from plant to plant, line to line, pit to pit, thali to thali etc in meters)

Soil work: (as prescribed in the plan/estimate)

Species wise number of seedlings planted Quantity & quality of seedlings)

Sl. No.	Type of Seeding	Quantity	Height	Age	poly pot sizes
1					
2					
3					
4					
5					

Protection work: (describe the type of protection works) (May be wooden fencing, social fencing, plantation guard deployed, Fire line etc)

5. FINANCIAL INPUT

Creation cost: (shall include no. of labors, quantity of materials consumed, money spent,

Sl. No.	Items of works	Unit	Quantity	Amount (Nu)	Total Amount (Nu)	Remarks
A	PLANTATION WORKS					
1	Survey of proposed plantation area					
2	Site Clearance. Cutting of bushes. Clearing & burning					
3	Alignment and stacking including. Collection of sticks.					
4	Cost of seedlings					
5	Transportation of seedlings					
6	Digging of pit size 30 cm dia. X 30 cm dia in hard and rocky soil					
7	Planting of seedlings in readymade pits					
8	Sign board making					
9	Fixing sign board					
	Subtotal (A)					
B	FENCING WORKS					
Sl. No.	Items of works					
1	Royalty for fencing post					
2	Cost barbed wire and u-nails					
3	Transportation of barbed wire					
4	Transportation fencing post					
5	Application of preservatives					
6	Pit digging and erection of post					
7	Fixing and stretching of barbed wire including carriage up to working site and putting u nails					
8	Cost of making style (wooden stair case)					
	Subtotal (B)					
C	CREATION OF FIRE LINE					

1	Fire line construction around plantation					
	Subtotal (C)					
	Grand total					

PART B: MAINTENANCE AND REFILLING (to be started from separate page)

1. **WEEDING AND CLEANING:**

Activities	Area in hectares	Mandays/Unit Cost	Amount (Nu)	Remarks
1st Year				
1st weeding				
2nd weeding				
3rd weeding				
2nd Year				
1st weeding				
2nd weeding				
3rd weeding				
3rd Year				
1st weeding				
2nd weeding				
3rd weeding				
4th Year				
1st weeding				
2nd weeding				
3rd weeding				
5th Year				
1st weeding				
2nd weeding				
3rd weeding				
Grand Total				

2. **REFILLING**

a. Percentage of area taken up ……

b. Number of seedling replaced……...

c. No. of mandays:…….…….Nu……...

3. **FENCING REPAIR**

   a. No. of fencing post replaced:……. Percentage……..
   b. Cost of fencing post:……..
   c. No. of mandays …….. Nu……..……
   d. Others……...

4. **PLANTATION GUARDS**

a. No of months …….....Nu…..... (for large scale plantation only and not for small scale plantation)

PART C: OTHER DETAILS

a. Survival survey and growth information

b. Record of thinning operation (1st thinning, 2nd thinning, sanitation thinning etc)

c. Problem and constraints (financial, physical, technical etc)

d. Pest and diseases

e. Wild animal damages (if any)

f. Plantation, In-charge (Name, designation and initial)

Visitors Note: a separate page has to be maintained at the end of the journal of each plantation for remarks by the inspecting officers, experts etc)

Sl.No.	Name & Designation	Date of visit	Purpose of visit	Comments	Signature
1					
2					
3					
4					
5					

Table 8.5 Nursery Journal

Nursery Journal

Name of the Nursery: …….....

Dzongkhag: …….....

Dungkhag: …….....

Gewog: …….....

Village: …….....

Location: …….....

Year of Creation: …….....

Attach map with boundary details, measurements and reference points: (Map shall be prepared on scale/Google earth/GPS, indicate reference point and shall have index)

PART A: NURSERY CREATION

1. INTRODUCTION

- Location……..
- Year of creation…….……
- Area of creation……....……Ha….....Acres

2. **SITE DESCRIPTION**

2. 1. Geographical descriptions

2.1.1 Altitude (m)…….....……

2.1.2 Aspect…….

2.1.3 Slope (degree)…….

2.2. Soil and rainfall

2.2.1. Soil type: ……..

2.2.2. Soil PH: ……

2.2.3. Depth (Hard soil/Soft soil): …….....

2.2.4. Texture: ……

2.2.5. Color: ……...

2.2.6. Rainfall (Annual average rainfall in mm)…….....……..

3. **HISTORY OF THE AREA**

Describe the status of the land before establishment of nursery.

Record of existing vegetation

Sl. No.	Plant Species	Remarks
1		
2		
3		
4		
5		

4. **TYPES OF NURSERY**

Sl. No.	Types of Nursery	Tick (□)
1	Permanent	
2	Temporary	

5. **OBJECTIVES OF NURSERY**

a. To raise seedling for plantation

b. To raise flower seedling

c. To raise ornamental seedling

d. To raise medicinal/aromatic seedling

e. Others (if any):

6. **BEDS CONSTRUCTION**

Types of Bed	No. of Beds	No. of Raised/ Sunken Beds	Edging (Stone/ Bricks/ Bamboo post)
Full Bed			
Half Bed			
Quarter Bed			

7. **SHED CONSTRUCTION**

Total shed construction	Roofing (Bamboo mat/ green net/ grass thatch)	Poles (GI pipe/bamboo post/ wooden post)	Remarks

8. **SEEDS COLLECTION**

8.1. Seed collection details

Sl. No.	Species	Location	Date of collection	Method of collection	Quantity (Kg)	Remarks
1						
2						
3						
4						
5						

8.2. Seeds sowing

Sl. No.	Species	Method of Treatment	Duration of treatment	Date of sowing	Quantity (Kg)	Remarks
1						
2						
3						
4						
5						

8.3. Seeds germination

Sl. No.	Species	1st Week	2nd Week	3rd Week	4th Week	2 Months	2 Months & Above
1							
2							
3							
4							
5							

8.4. Observation Table

Sl. No.	Species	Germination date	% of germination rate	Date of transplantation	No. of seedlings transplanted	Remarks
1						
2						
3						
4						
5						

8.5. Record of the seedling vitality

Sl. No.	Species	No. of seedling died	Types of casualties	Remarks
1				
2				
3				
4				

8.6. Species wise number of seedlings planted (Quantity & quality of seedlings)

Sl. No.	Type of seedling	Quantity	Quality (Height/age/poly pot sizes)
1			
2			
3			
4			
5			

8.7. Hardening

Sl. No.	Species	No of plantable size seedlings	Duration of hardening	Methods of hardening	No of seedlings survived after hardening	Remarks
1						
2						
3						
4						
5						

9. **FINANCIAL INPUT**

Nursery Creation cost: (shall include number of labours, quantity of materials consumed, money spent, etc)

Sl. No.	Items of works	Unit	Quantity	Amt (Nu)	Total Amt (Nu)	Remarks
A	NURSERY WORKS					
1	Soil works					
2	Leveling and dressing of bed					
3	Manure, sand and soil					
4	Nursery shed construction					
5	Poly pot works and seed sowing					
6	Watering, weeding and spraying bio pesticide					
	Subtotal (A)					
B	FENCING WORKS					
1	Royalty for fencing posts					
2	Cost barbed wire and u-nails					
3	Transportation of barbed wire					
4	Transportation fencing posts					
5	Application of preservatives					
6	Pit digging and erection of posts					
7	Fixing and stretching of barbed wire including carriage up to working site and putting u nails					
8	Cost of making style (wooden stair case)					
	Subtotal (B)					
C	CREATION OF FIRE LINE					
1	Fire line construction around plantation					
	Subtotal (C)					
	Grand total					

PART B: DEMAND AND SUPPLY OF NURSERY SEEDLINGS

Demand and supply of seedlings from the nursery shall be maintained for information on availability of stock.

Sl. No.	Species	Total production in stock	No. of seedling supplied	Supplied to (whom)	Rate (Nu.)	Amount (Nu.)	Stock balance
1							
2							
3							
4							
5							

PART C: OTHER DETAILS

a. Survival survey and growth information

b. Problem and constraints (financial, physical, technical etc)

c. Pest and diseases

d. Wild animal damages (if any)

e. Nursery, In-charge (Name, designation and initial)

Visitors Note: a separate page has to be maintained at the end of the journal of each nursery for remarks by the inspecting officers, experts etc)

Sl. No.	Name & Designation	Date of visit	Purpose of visit	Comments	Signature
1					
2					
3					
4					
5					

8.4.10 Plantation Norms and Standards

The Norms and Standards for Nursery and Plantation is a standard guideline for smooth implementation of nursery and plantation activities. The standards for various forestry activities relating to nursery and plantation which are prescribed shall be strictly adhered to as the activities involved for creation of nursery and plantation can vary according to different site and situations. Technical sanction shall be obtained prior to implementation of plantation and nursery creation/maintenance activities based on the estimates prepared in line with the plantation norms and standards.

The man-days/unit costs required for different activities in creation and maintenance of plantation/nursery, such as seed collection, fire line construction, fencing, root balling is prescribed in this section for preparing estimates. Period of seed collection, sowing time, seed viability and treatment are also incorporated for guiding the field staff.

Activities related to engineering structures namely. check dams, road linkages, water channels, water tank, nursery caretaker house, the estimate shall be based on Bhutan Schedule of Rates (BSR) and obtain technical endorsement from the respective Dzongkhag engineers.

Following section describe the basic contents required for the implementation of nursery and plantation activities.

8.4.10.1 Specific period of seed collection and sowing

Before seed collection, collectors must clearly understand for what purpose seedlings shall be planted. Based on its purpose, seeds shall be collected and stored with utmost care and treatment. He/she shall have adequate knowledge on seed collection especially on the selection of mother trees, seed ripening and its dispersal time which differs from species to species. Seed collected and sown before ripening or maturity are usually infertile and shall germinate poory or may not even germinate at all.
Table 8.6 provides information on the specific period for collection and sowing of seeds of different species. The implementing agency has to plan in advance for collection of seed of a particular species and collect accordingly.

Table 8.6 Specific period of seeds collection and sowing

Sl. No	Scientific name	Local name	Collection Time	Sowing Time
1	*Abies densa*	Dungshing (Dz), Wangshing (Sh), Fir (Eng)	Oct-Nov	Feb-Mar
2	*Acacia auriculiformis*	Jimshing (Dz), Lanungshing(Sh), Akashmoni(Lh)	Jan-Apr	Apr-May
3	*Acacia catechu*	Toeja (Dz/Sh), Khair(Lh)	Nov-Mar	Apr-May
4	*Acer campbellii*	Pchalam(Dz), Sermaling(Sh), Kapasi(Lh)	Nov-Dec	Mar-Apr
5	*Acrocarpus fraxinifolius*	Chashing(dz), Choktseshing(Sh), Mandaney (Lh)	Apr –May	Apr-May
6	*Adina cordiflolia*	Halwashing (Dz), Anashing(Sh), Haldu (Lh)	Mar-June	Mar-Jun
7	*Ailanthus grandis*	Pekashing(Dz/Sh), Gokul (Lh)	April –May	April-May
8	*Albizia lebbeck*	Prekprekshing(Dz), Sershing(Sh), Kalo siris (Lh)	Dec-Feb	Mar-Apr
10	*Albizia procera*	Sekpalashing(Dz), Khirthangshing (Sh), Seto siris(Lh)	Dec-Jan	May-Jun
11	*Alnus nepalensis*	Gamashing (Dz), Gamoshing(Sh), Utis (Lh)	Dec-Mar	Mar-Apr
12	*Ammora wallichii*	Lasoshing (Dz), Phangshing (Sh), Lali (Lh)	Mar-May	Apr-May
13	*Anthocephalus cadamba*	Kadamshing(Dz), Kadam(Lh)	July-August	July-August
14	*Aquilaria malaccensis (Aquilaria agallocha)*	Aarnag(Dz), Aarnag(Sh), Agar(Lh), Eagle wood or Aloe wood(Eng)		
15	*Artocarpus heterophyllus*	Damtse (Dz), Dremlingshing(Sh) /Jackfruit (Eng)	June-July	July
16	*Artocarpus lacucha*	Dramday (Dz), Badahar (Lh)	Jun-Aug	July-Aug

Sl. No	Scientific name	Local name	Collection Time	Sowing Time
17	*Aquilaria malaccensis*	Agoor (Dz), Aghori (Lh), Eagle wood (Eng)	Mar-June	Mar-June
18	*Bauhinia purpurea*	Zibzibshing (Dz), Pekpekshing (Sh) Tanki (Lh)	Feb-Mar	May-June
19	*Bauhinia variegata*	Ruchashing (Dz), Balingshing (Sh), Koiralo (Lh)	Mar-May	May-June
20	*Benthamidia capitata (Cornus capitata)*	Phoitse (Dz), Namitpashing (Sh), Ram katar (Lh)	Oct –Dec	Feb-Mar
21	*Betula utilis*	Latap (Dz), Chharshing (Sh), Bhojpatra (Lh)	Aug-Oct	Jan-Mar
22	*Betula alnoides*	Taapshing (Dz), Chharshing (Sh), Saur (Lh)	Oct-Feb	Nov- Mar
23	*Bischofia javanica*	Chumshing (Dz), Kainjal (Lh)	Dec –March	Jan-Apr
24	*Bombax ceiba*	Pemagayser (Dz/Sh) Simal (Lh)	Mar-May	Apr-May
25	*Bridelia retusa*	Trretashing (Dz), Menchashing (Sh), Gayo (Lh)	Oct-Nov	Mar-Apr
26	*Carpinus viminea*	Rutoshing (Dz), Lung shing(Sh)	July-Oct	Feb-Mar
27	*Cassia fistula*	Chakajumshing(Dz), Dhongkoshing(Sh),Rajbriksha/ Sunalo(Lh)	Mar-Apr	Apr-Mar
28	*Castanopsis hystrix*	Sokeyshing (Dz), Tshaishing sonag(Sh), Katus Lh)	Oct-Nov	Dec- Jan
29	*Castanopsis tribuloides*	Thomsokey (Dz),Thongpashing (Sh), Musrey katus(Lh)	Nov-Jan	Mar-Apr
30	*Cedrus deodara*	Shubdarshing (Dz), Deodar (co), Cedar (Eng)	Oct-Dec	Dec-Jan
31	*Celtis australis*	Sokum (Dz), Sogsogpashing (Sh), Khari (Lh)	Oct-Dec	March
32	*Choerospondias axillaris*	Charashing (Dz), Throongchung (Sh), Lapsi (Lh)	Nov-Feb	Mar-Apr
33	*Chukrasia tabularis*	Chuzim, (Dz), Checkrasi (co)	Mar-June	May-Jun
34	*Cinamomum camphora*	Peomenshing (Dz), Kapur (Lh), Camphor (Eng)	Sep-Nov	Feb-Mar
35	*Cinamomum glaucescent s (Cinamomum cecicodapne)*	Shingtsazim (Dz), Durkashing (Sh), Maligari (Lh)	Oct-Nov	Mar-Apr
36	*Cupressus corneyana*	Tsendhey or chendhey(Dz), Tsendhhen or Chen shing, Weeping cypress(Eng)		
37	*Cupressus himaliaca*	Tsenden (Dz), Tsendenshing (Sh), Dhupi (Lh)	Oct-Nov	Nov-Jan
38	*Cupressus torulosa*	Tsenden (Dz), Tsendenshing(Sh), Dhupi (Lh)	Dec-Mar	Feb-Mar
39	*Dalbergia sissoo*	Sissooshing (Dz), Sisoo (Lh)	Mar-May	Feb-April
40	*Duabanga grandiflora*	Patangshing(Dz), Grandanglashing(Sh) Lampatey (Lh)	Nov-Feb	May- Jun
41	*Daphnephyllum himalense*	Jurooshing (Dz), Aawashing (Sh), Lal Chandan (Lh)	Nov-Dec	Jan-Mar
42	*Dendrocalamus spp.*	Bamboo (Co)	Rhizome	May – Jun
43	*Eleacarpus lanceifolius*	Quequeshing(Dz),Gashathungshing(Sh),Badrasey(Lh)	Nov-Feb	May -Jun
44	*Epilobium conspersum*	Namsey metog(Dz), Namsey(Sh)		
45	*Erythrina arborescens*	Chaseeshing (Dz), Kharshing (sh), Faledo (Lh)	June-Aug	Apr-Jun
46	*Erythrina variegate*	Thasachasee (Dz), Kharshing (Sh) Faledo (Lh)	June-Aug	Apr-May
47	*Exbucklandia populnea(Bucklandia popunea)*	Chenjushing (Dz), Lemshing (Sh), Pipli (Lh)	Dec-Mar	Mar-Apr

Sl. No	Scientific name	Local name	Collection Time	Sowing Time
48	*Ficus roxburghii(F. auriculata)*	Bakushing (dz), Chongmashing (Sh)Nebaro (Lh)	Jun- Sep	July- Aug
49	*Ficus religiosa*	Jangchubshing (Dz/Sh), Pipal (Pipal)	Apr – May	May-Jun
50	*Ficus infectoria*	Samda (Dz), Wangom (Sh), Kabra (Lh)	Cutting	June-July
51	*Ficus semicordata (F. cunia)*	(Ridangshing(dz),Barachongma(Sh) Khanew(Lh)	July-Aug	July-Aug
52	*Fraxinus floribunda*	Draythub (Dz), Lakuri (Lh) , Ash tree (Eng)	Sep-Oct	Mar-Apr
53	*Gmelina arborea*	Gamarshing(Dz), Kholomshing(Sh), Khamari(Lh)	Apr-June	Apr-Jun
54	*Jacaranda mimosifolia*	Jakashing (dz), Jacaranda (co)	Feb-Mar	Mar-Apr
55	*Juglans regia*	Tashing (Dz), Kheshing(Sh), Okhar (Lh)	Sep-Dec	Feb-Mar
56	*Juniperus recurve*	Shupshing (Dz), Shokpashing (Sh), Dhupi(Lh), Weeping blue Juniper(Eng)	Apr-June	Apr-June
57	*Kydia calicina*	Chambaktangshing(Sh), Kubindey (Lh)	Dec-Mar	Mar-Apr
58	*Lagerstroemia hirsute*	Dongkashing(Dz),Baramshing(Sh),Jarul (Lh)	Jan-Mar	Apr-May
59	*Lagerstroemia parviflora*	Dongkashing(Dz),Baramshing(Sh), Sidha (Lh	Jan-Mar	Apr-May
60	*Larix griffithii*	Zashi (Dz), Larch (Eng)	Oct-Nov	Mar-Apr
61	*Leucaena leucocephala*	Tsa shing(Dz), Tsee shing(Sh), Ghans siris (Lh), Leucaena (Eng)	Nov-Jan	Apr-May
62	*Mangifera indica*	Aamchukuli (Dz), Aamshing(Sh), Amp (Lh)	May-Aug	July-Aug
63	*Magnolia campbellii*	Khashing(Dz), Karshing (Sh), Ghoge champ(Lh)	Aug-Sept	Sept-Oct
64	*Melia azedarach*	Jashing (Dz), Neyrashing (Sh), Bakaina (Lh)	Nov-Mar	Mar-July
65	*Michelia champaca*	Kashing (Dz), Karshing (Sh0, Aule Champ (Lh)	July-Aug	July-Aug
66	*Michelia doltsopa(M. excelsa)*	Khashing (Dz), Karshing (sh), Rani Champ/Seto champ(Lh)	Aug-Sept	Sept -Oct
67	*Morus laevigata(M. macroura)*	Tshendhey (Dz),Sengdenshing (Sh), Kimbu (Lh)	Mar-Apr	Mar-Apr
68	*Oroxylum indicum*	Champaka(Dz), Namkaling metog(Sh),Totola(Lh)	Dec-Feb	Feb-Mar
69	*Percea fructifera (Machilus edulis)*	Gulishing (Dz),Lapche kawla/ Phuntse(Lh)	Nov-Jan	Feb-Mar
70	*Persea odoratissima*	Matchu shing(Dz), Sha-golee shing(Sh), Lali kawla(Lh)		
71	*Phoebe altenuata*	Theinab (Dz),Angaray (Lh)	Sep-Oct	Jan-Feb
72	*Picea spinulosa*	Ba shing (Dz), Ba shing(Sh), Kalo salla(Lh), E.Himalayan Spruce(Eng)	Sep-Nov	Feb-Mar
73	*Pinus roxburghii*	Thetongphu (Dz),Roinashing (Sh), Dhup(Lh), Chirpine (Eng)	Jan-Mar	Feb-Mar
74	*Pinus wallichiana*	Tongphu (Dz), Changshing (Sh),Salla/Dhupi(Lh) Bluepine (Eng)	Sep-Nov	Feb-Mar
75	*Populus ciliate*	Kashing (Dz), Ka shing(Sh), Pipal patey (Lh) Poplar (Eng)	Apr-June	June-July
76	*Prunus nepalensis*	Khamgoshing (Dz/Sh)), Aru-patey (Lh)	Oct-Dec	Mar-Apr
77	*Pteropsersum acerifolium*	Dhashom(Dz),Mongnangloshinh(Sh)Hatipaley(Lh)	June-July	July-Aug

Sl. No	Scientific name	Local name	Collection Time	Sowing Time
78	*Quercus griffithii*	Sissishing(Dz), Bainangshing (Sh), Khasru (Lh), Oak(Eng)	Nov-Feb	Feb-Mar
79	*Quercus lanata*	Ghum (Dz), Beytsenangshing (Sh)	Nov-Dec	Feb-Mar
80	*Quercus lamellose*	Bangkashing/Thomp sokey(Dz), Fangkoima shing (Sh), Bajranth(Lh)	Oct-Dec	Feb-Mar
81	*Quercus semicarpifolia*	Bjishing (Dz), Beytsenangshing (Sh), Khasru (Lh), Oak(Eng)	Jun – Aug	July-Aug
82	*Rhododondron arboretum*	Aetoh metog (Dz), Zhu-daangshing(Sh), Gurans/Gurass (Lh)	Aug-Mar	Mar-Apr
83	*Robinia pseudoacacia*	Chhashing (Dz), Robinia (Co)	Oct-Dec	Feb-Mar
84	*Salix babylonica*	Changmashing (Dz/Sh),Weeping Willow (Eng)	Apr-May	Apr-May
85	*Sapindus mukorossi*	Nakapani (Dz), Kilingshing (Sh), Ritha (Lh)	Sep-Feb	Apr-May
86	*Saurauja nepaulensis*	Mangmadom (Dz), Nyabjala shing or mingdhormu(Sh) Gogun (Lh)	Mar-Apr	Mar-Apr
87	*Schima wallichii*	Puyamshing (Dz), Zalashing(Sh), Chilauney (Lh)	Jan-Apr	Apr-May
88	*Shorea robusta*	Gotenshing (Dz), Sal shing(Sh), Sakhua(Lh)	May- Jun	May-June
89	*Stereaspermum suaveolens*	Tsarimshing (Dz), Aboshing (Sh) Parari (Lh)	Dec-Jan	June-July
90	*Syzygium cumini*	Nyeshing (Dz), Mentsu or Mentse sey shing(Sh), Jamuna (Lh)	Jun –Aug	July-Aug
91	*Taxus baccata*	Hashing/Kerangshing (Dz/Sh), Yew (Eng)	Nov-Dec	Feb-Mar
92	*Tectona grandis*	Tsomarshing (Dz),Teak shing(Sh), Sogun (Lh),Teak (Eng)	Dec-Feb	Feb-Mar
93	*Terminalia myriocarpa*	Bupshing (Dz), Bakhaloshing (Sh), Panisaj (Lh)	Dec-Jan	Mar-Apr
94	*Terminalia tomentosa*	Alashing (Dz), Pakhasaj (Lh)	Oct-Dec	Apr-May
95	*Terminalia bellerica*	Baru (Dz/Sh),Barra (Lh)	Nov-Feb	Feb-Mar
96	*Terminalia.chebula*	Aru (Dz/Sh), Harra (Lh)	Dec-Mar	Feb-Mar
97	*Thuja orientalis*	Yutashupshing (Dz), Mayurpankhi (Lh)Thuja(Co)	Oct-Dec	Oct-Dec
98	*Toona cilliata*	Chhunshing (Dz), Rawashing (Sh), Tooni (Lh)	Apr-June	May-June
99	*Tetrameles nudiflora*	Kadongshing (Dz),Maina (Lh)	May-Jun	Mar-Apr
100	*Tetradium fraxinifolium (Evodia fraxinifolium)*	Dongmarshing (Dz), Khanakpa (Lh)	Nov-Feb	Dec-Feb
102	*Tsuga dumosa*	Bashing/Sey shing (Dz), Wanglashing (Sh), Tengre salla(Lh), Himalayan Hemlock (Eng)	Nov-Dec	Mar-Apr
103	*Zanthoxylum armatum.*	Thingngeyshing (Dz), Khaigee/Geshing (Sh), Bale Timbur (Lh)	June-Aug	Mar-Apr
104	*Zizyphus jujuba*	Tsoshing(Dz), Bayer (Lh), Khangkaling (Sh)	Dec-Mar	Feb-Mar

8.4.10.2 Seed collection and extraction

This section describes the approximate numbers of seeds per kg for different trees species and its unit cost for seed collection. The quality of nursery seedlings depends on the quality of seeds collected. As such, seeds shall be collected from the locally available plus trees.

Plus trees are those trees which are middle aged to near maturity, dominant, vigorously growing, having good form, straight cylindrical boles, good crown development, free from diseases and infections. Therefore, collectors shall avoid seed collection from young, over mature, abnormal, diseased and insect infested trees.

Table 8.7 Seed collection and extraction

Sl.No	Species Scientific Name	Common Name	Aprox.no of seeds/kg.	Qty (kg)
1	*Abies densa*	Fir	16,700	1
2	*Acacia auriculiformis (CS)*	Akashmoni	40-50,000	1
3	*Acacia catechu (P)*	Khair	32-40,000	1
4	*Acer campbellii (CS)*	Kapasi	15-20,000	1
5	*Acrocarpus fraxinifolius (P)*	Mandaney	32,000	1
6	*Adina cordiflolia*	Haldu	11,000,000	1
7	*Aesandr.a butyracea (Fr)*	Yika	450	1
8	*Ailanthus grandis (P)*	Gokul	1,700	1
9	*Albizia lebbeck*	Kalo siris	8-15,000	1
10	*Albizia procera*	Seto siris	15-21,000	1
11	*Alnus nepalensis*	Gamashing, Utis	570,000	1
12	*Ammora wallichii (CS)*	Lali	132-155,000	1
13	*Anthocephalus cadamba*	Kadam	9-10,0000	1
14	*Artocarpus champlasa*	Latar	700-1,800	1
15	*Artocarpus heterophyllus*	Damtse/Jackfruit	100-150	1
16	*Artocarpus lacucha*	Badhar	6,000	1
17	*Bauhinia purpurea (CS)*	Tanki	3-4,000	1
18	*Bauhina variegata*	Tanki	2-3,000	1
19	*Benthamedia capitata / Cornus capitata (Fr)*	Phoetse	9 - 9,500	1
20	*Betula utilis (Fr)*	Brich/ latap	1,500,000	1
21	*Betula alnoides (Fr)*	Birch	5,000,000	1
22	*Bischofia javanica*	Kainjal	60-100,000	1
23	*Bombax ceiba (CS)*	Simal	21-38,000	1
24	*Bridelia retusa*	Gayo	15-18,000	1
25	*Carpinus viminea*	Rutoshing	-	1
26	*Calamus spp.*	Cane	-	1
27	*Cassia fistula (CS)*	Rajbriksh	6,300	1
28	*Castanopsis hystrix (CS)*	Sokey,Chestnut	3-350	1
29	*Castanopsis tribuloides*	Wild chest nut	200	1
30	*Cedrus deodara*	Deodar	7,900	1
31	*Celtis australis*	Khari	4500 – 11,000	1
32	*Choerospondias axillaris(s)*	Lapsi	150	1
33	*Chukrasia tabularis (CS)*	Chuckrasi	1,000,000	1
34	*Cinamomum camphora*	Camphor, Kapur	5-11,000	1
35	*Cinamomum glaucescens*	Maligari	2,000	1
36	*Cryptomeria japonica*	Cryptomeria	2-300,000	1
37	*Cupressus corneyana (CS)*	Tsenden	1-250,000	1
38	*Cupressus torulosa (CS)*	Tsheden	250,000	1
39	*Callistemom lanceolatus*	Bottle brush	-	1
40	*Dalbergia sissoo (P)*	Sissoo	50,000	1

41	*Duabanga grandiflora (Fr)*	Lampatey	100,000	1
42	*Dorcynia indica*	Monkey apple	20000	1
43	*Eleacarpus spp (S)*	Badrasey	150 –200	1
44	*Eleacarpus varuna*	Rudrax	-	1
45	*Eleacarpus lancifolous*		143	
46	*Erythrina arborescens(CS)*	Coral tree	2,000	1
47	*Erythrina variegata (CS)*	Coral tree	2,000	1
48	*Erythrina suberosa (CS)*	Coral tree	2,000	1
49	*Exbucklandia populnea*	Pipli	200,000	1
50	*Ficus roxburghii (Fr)*	Fig	8,000,000	1
51	*Ficus religiosa (cs)*	Pipal/ Jangchub	2,000,000	1
52	*Ficus semicordata (Fr)*	Khanew	1,000,000	1
53	*Fraxinus floribunda*	Ash tree	7,400	1
54	*Gmelina arborea (CS)*	Gamari	2,000	1
55	*Gordonia exelsa*	Rhambi	-	1
56	*Jacaranda mimosifolia*	Jacaranda	50,000	1
57	*Juglans regia (S)*	Walnut (hard shell)	60-100	1
58	*Juniperus recuvera*	Junifer	3,600	1
59	*Kydia calicina*	Kubindey	2,000,000	1
60	*Lagerstroemia hirsute*	Jarul	120,000	1
61	*Lagerstroemia parviflora*	Sidha	3,600	1
62	*Larix griffithii (CS)*	Larch	100,000	1
63	*Leucaena leucocephala*	Leucaena	22-26,000	1
64	*Mangifera indica (S)*	Mango (wild)	20-30	1
65	*Magnolia campbellii*	Karshing	11348	1
66	*Melia azedarach (Fr)*	Bakaina	1,500	1
67	*Michelia champaca (CS)*	Champ	100000	1
68	*Michelia doltsopa (CS)*	Rani Champ	6000-8000	1
69	*Mintse(No scientific name)*	Mintse	2000	1
70	*Morus lavigata (CS)*	Malberry	4-500,000	1
71	*Nyssia javanica*	Lek Chilauney	-	1
72	*Oroxylum indicum (CS)*	Champaca	10-15,000	1
73	*Percea fructifera (Fr)*	Gulishing	216	1
74	*Phoebe altenuata*	Angaray	250-300	1
75	*Picea spinulosa (CS)*	Spruce	64,000	1
76	*Pinus roxburghii (CS)*	Chirpine	12,000	1
77	*Pinus wallichiana (CS)*	Bluepine	21,400	1
78	*Prunus nepalensis (Fr)*	Aru-pati	1,400	1
79	*Pteropsersum acerifolium*	Hatipoile	3600	1
80	*Quercus griffithii*	Sissi	1310	1
81	*Quercus lanata*	Ghum	170	1
82	*Quercus lamellose*	Oak	900	1
83	*Quercus semicarpifolia*	Bji shing	140	1
84	*Rhododondron arboretum*	Aeto shing	1,200,000	1
85	*Robinia pseudoacacia (P)*	Robinia	35-50,000	1
86	*Sapindus mukorossi*	Nakapani	770-840	1
87	*Sauruaia nepualensis*	Gogun	4-8,000,000	1

88	*Schima wallichii (CS)*	Chilauney	300,000	1
89	*Shorea robusta (WS)*	Sal	450-1000	1
90	*Stereaspermum suaveolens*	Parari	27000	1
91	*Syzygium cumini*	Nyesi	1-1,300	1
92	*Taxus baccata*	Yew	8,000	1
93	*Tectona grandis (Fr)*	Teak	1300-1500	1
94	*Terminalia myriocarpa*	Panisaj	100,000	1
95	*Terminalia tomentosa*	Pakhasaj	700	1
96	*Terminalia arjuna*	Arjuna	-	1
97	*Termenilla beleceria*	Baru	400-450	1
98	*Termenilla Chebula*	Aru	150-220	1
99	*Thuja orientalis*	Thuja	40-60,000	1
100	*Toona cilliata*	Tooni	550,000	1
101	*Tsuga dumosa*	Hemlock	400,000	1
102	*Zanthoxylum rhetsa*	Thingney	40-60,000	1
103	*Zizyphus mauritiana (Jujuba*	Bayer	7-1,800	2
104	*Rhizomes*			
105	*Bamboo Rhizome (large)*	Bamboo	Rhizome	1
106	*Bamboo Rhizome (small).*	Bamboo	Rhizome	1
107	*Calamus spp.*	Cane	Rhizome	2
108	*Cuttings*			
109	*Populas species*	Poplar	Up to 3 inch , 1 m length	1
110	*Vibernum spp*	Asarey	Do	
111	*Jatropha carcus*	Hedge cadam	-	
112	*Vitex nugando*	Vitex/Simali	-	
113	*Erythiana spp*	Phaledo	-	
114	*Hibiscus spp*	China Rose	-	
115	*Sapium insignia*	Akha taruwa	-	
116	*Euphorbia*	Lal pattti	-	
117	*Ficus species*	Ficus	-	
118	*Stumps preparation in nursery*			
119	*Tectona grandis*	Teak	-	
120	*Gmelina arborea*	Gamari	-	

The cuttings are basically recommended for bio engineering works. S-Stone, CS-Clear seeds, Fr-Fruits, P-Pods, WS-Winged seeds.

8.4.10.3 Forest Nurseries

The norm for nursery creation and maintenance has been prepared based on activities being implemented in standard forest nurseries. Information about working tools, equipment, polythene tube, top soil, leaf mould, sand, beds and numbers of seedlings per beds are described. Civil and electrical structural works in establishment of nursery shall be based on the BSR and technically sanctioned/approved by the head of the respective organization.

Site Selection

The selection of an appropriate nursery site is the most important decision affecting the efficient production of good quality plants. Wherever possible, following criteria shall be applied while selecting sites for establishing nurseries. Under ideal condition (Figure 8.2), the site shall be:

- Close to water source
- Accessible by motorable road
- Nearby the settlement or within the vicinity of field office
- Centrally located
- As flat as possible or having not be more than 30% slope
- Having favorable slope and aspect. In the lower elevations, north facing slopes are suitable and for higher elevations, warmer southern slopes are favorable for establishment of nurseries.
- Close to planting sites to reduce carrying and handling damage
- Fertile, free from big boulders and have deep soil. Soil shall be well drained and sandy loam or loam. Clayey soils shall be avoided as the aeration and drainage is poor.

The above criteria are general and may be adapted according to the site and local climatic conditions.

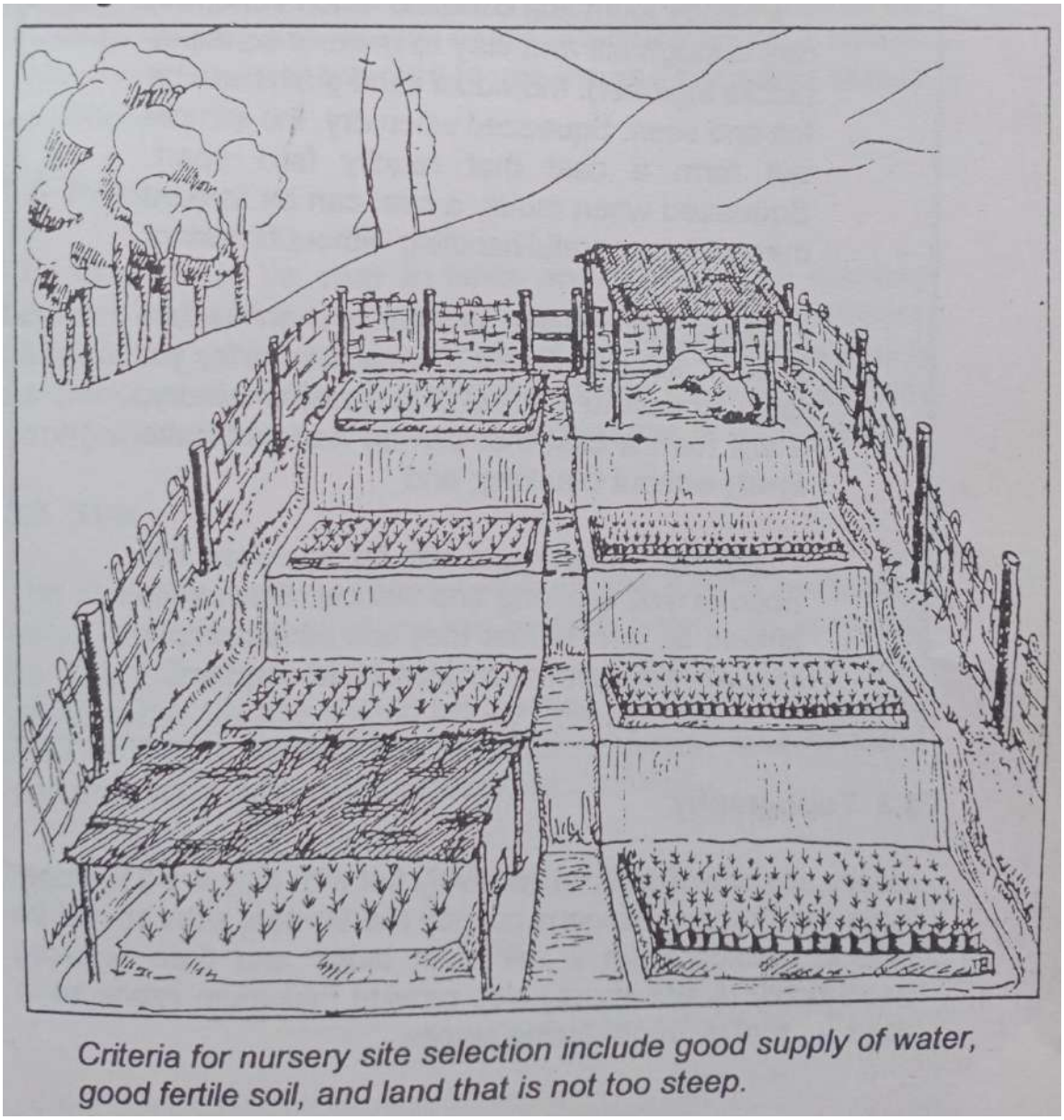


Figure 8.2 Nursery site selection

Layout and Planning

It is necessary to have proper planning and layout while preparing nursery beds. As far as possible, the nursery beds shall be laid along the contour and the beds shall be oriented from East to West (facing easterly aspect).

Essential Materials

- Shading and fencing materials such as thatch grass, bamboo mats, green nets, wooden poles, bamboo poles, fencing post, nails, barbed wires and binding wires are essential materials. If some items like thatch grass, bamboo mats are not available within the locality, but have to be purchased, there shall not be duplication in cost by adding unit cost required for collection of these materials.
- Irrigation equipment such as PVC pipe, sprinkler, rose can, water pump, water tank, etc.
- Soil, sand, top soil, leaf-mould, manure, and boulders, hollow blocks, bricks, fertilizers, rooting hormone, compost, decomposed manure, etc.

Table 8.8 shows the standard requirement of tool (life of tools for five years).

Table 8.8 Tools for nursery work (1 Hectare)

Sl.No	Name of tools	Standard no. of tools
1	Pick-axe	5
2	Fork	5
3	Spade	5
4	Shovel	4
5	Sickle	5
6	Axe	1
7	Rose-can	4
8	Pan (Karai)	4
9	Sieving Net	2
10	Water sprinkler	2
11	Measuing tape	1
12	Rake	4
12	Hammer (5 Kg)	1
13	Claw hammer	2
14	Hand-saw	1
15	Weeding hoe	5
16	Knife (Patang)	3
17	Pruning scissors	2
18	Wheel barrow	3
19	Crow bar	3
20	Chemical sprayer	1
21	Hook crow bar	1
22	Seedling tray for loading/transportation	10
23	Seed tray	50
24	Hand trowel	2
25	Grass cutter machine	1
26	Power Chain	1
27	Secauteur	5

Fencing of Nursery

Six stranded barbed wire shall be provided for fencing nursery with cross wire wherever necessary. The recommended gap between the fencing posts is 2m. Fencing materials shall be based on the type of

nursey and depending upon the locally available materials. The specification of the fencing strand gaps shall be maintained as described for fencing in 0.

Nursery Beds

Type of Nursery Beds

There are two main types of nursery beds, namely raised bed and sunken bed

a. **Raised Bed:** It is raised 15-20cm above the ground and is commonly practiced in Bhutan for production of bare-root seedlings and stumps (root-shoot cuttings). The process of design and layout of the raised bed construction is illustrated in the Figure 8.3

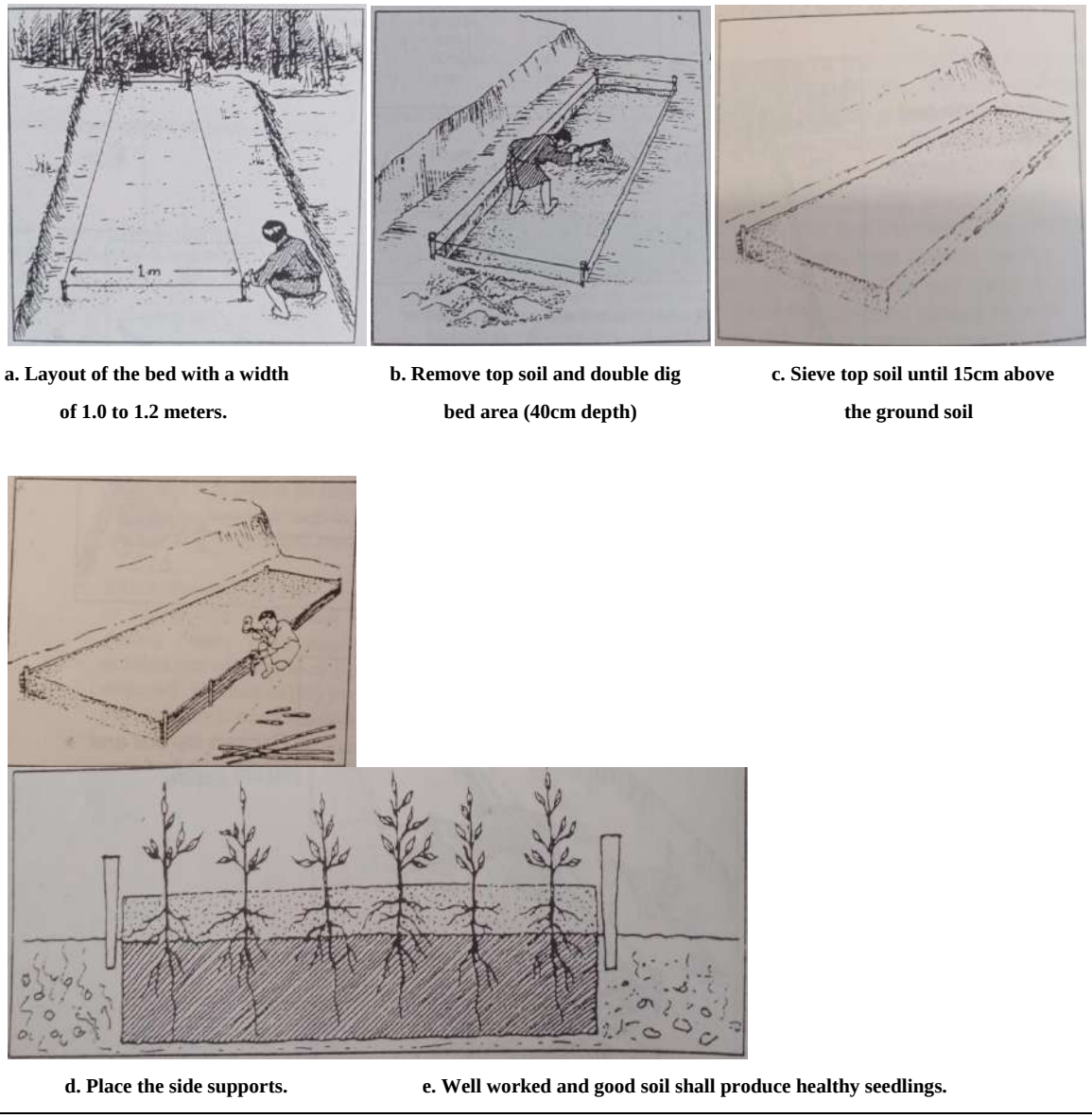


Figure 8.3 Construction of raised beds

b. **Sunken Bed:** It is prepared 15-20cm below the main level of the ground and generally practiced in dry, arid conditions, such as desert climates. The gap between bed to bed shall not be less than 1 m, in order to have convenient working environment for all nursery works like weeding, watering, etc.

Edging of nursery beds

Edging with wooden materials is recommended for the nursery beds that have to be maintained for less than 3 years (temporary) and the stone/ brick for more than 3 years (permanent). This has to be decided by the field officers based on the type of nursery to be raised during planning and budgeting.

Standard size of Bed

The standard size of nursery bed are as follows;

Full bed : 12m x 1.2m

Half bed : 6m x 1.2 m

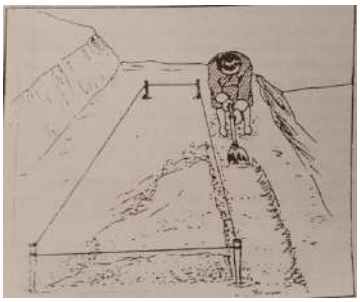
Quarter bed : 3m x 1.2m

No. of nursery bed (full size) per ha.	300
No. of bare-root seedlings per bed (15 cm x 15 cm)	640
Average no. of poly pot seedlings per bed (8 cm dia.)	1,300

Polypot Beds

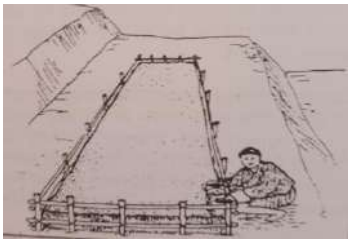
Poly pots are used to produce containerized stock (seedlings grown in a container) commonly practiced in Bhutan. The beds must be provided with side supports to secure polypots in an upright position. The process of polypot bed construction is illustrated in Figure 8.4.

a. Lay out of the bed with a width of 1.0 to 1.2 meters.

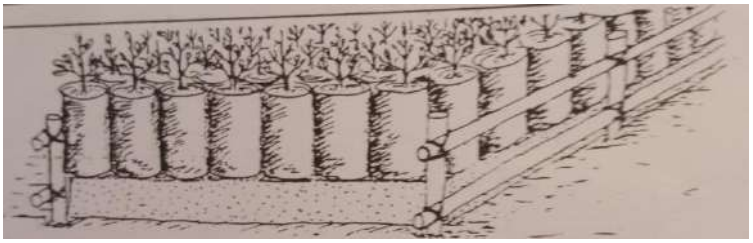


b.Spread soil on top of the bed.

c. Leveland pack the soil down.



d.Place the side supports.



e. Well prepared bed provides good drainage and support for polypots.

Figure 8.4 Polypot bed construction

Polypot per bed

The polypots measuring 18cm diameter and above are not required to be kept in beds but are recommended to be placed in terraces or open ground for growing large saplings. Large size saplings are recommended to be raised in UV proof polybags, as these materials are more durable and can be reused after transplanting the saplings. Number of poly pots per nursery bed is calculated as below.

$$\text{Number of polypots in one bed} = \text{Area of bed}/\text{area of polypot} \quad (11)$$

Table 8.9 Number of polypots accommodated in the full beds

Sl. No	Diameter of polypot	Height	No of polypots in 12 m x1.2 m bed	No of polypot per Kg
1	6 cm	10 cm	3840	
2	7 cm	15 cm	3790	376
3	8 cm	12 cm	2866	
4	8 cm	15 cm	2866	257
5	8 cm	20 cm	2866	206
6	10cm	15 cm	1834	
7	15 cm	20 cm	815	
8	18 cm	25 cm	566	
9	20 cm	30 cm	458	38-63
10	30 cm	35 cm	203	
11	30 cm	50 cm		15
12	(UV) 45 cm	45 cm	50	20

Quantity of soil per bed

It is very important for the implementing agency to know the appropriate/correct quantity of sand, leaf mould and top soil required to fill certain number of polypots of given dimension. The requirement of sand, leaf mould and soil in the ratio of 1:2:3 respectively is calculated based on the various size of the poly pots. The volume shown in the Table 8.10 is calculated on sieved materials and therefore, needs to add 20% on the volume calculated in order to compensate the wastage during sieving.

Table 8.10 Total sand, leaf mould and soil requirement for different dimension of polypots.in the full beds

Sl.no	Poly pot size (Dia x Height)	No of poly pot required	Type of soil with ratio: 1:2:3 (Sand: Leaf mould: Topsoil).		
			Sand	Leaf mould	Top soil
1	6 cm x 10 cm	3840	7 cft	13 cft	19 cft
2	7 cm x 15 cm	3790	13 cft	26 cft	39 cft
3	8 cm x 12 cm	2866	10 cft	20 cft	31 cft
4	8 cm x 15 cm	2866	13 cft	26 cft	39 cft
6	8 cm x 20 cm	2866	17 cft	34 cft	51 cft
7	10 cm x 15 cm	1834	13 cft	25 cft	38 cft
8	15 cm x 20 cm	815	26 cft	51 cft	77 cft
9	18 cm x 25 cm	566	21 cft	42 cft	64 cft
10	20 cm x 30 cm	458	25. cft	51 cft	76 cft
11	28 cm x 50 cm	203			

Management practices

Watering

Watering is necessary to keep the soil moist in order to promote germination and growth of seedlings. Water requirement and frequency of watering varies from species to species. As the seedlings establish,

the frequency of watering shall be reduced (one time on alternate day) in morning or afternoon. Water storage tank shall be placed at a reasonable height to generate pressure to operate the water sprinklers.

Protection of seeds

Seed storing and treatment

Seed shall be collected from plus trees. Seeds of some species require certain treatment/protections while storing and before sowing in the nursery beds. Protection and seed treatment vary from species to species and can be achieved by some of the following methods:

- Store only new, mature, healthy and well-dried seeds.
- Keep seeds in dry and cool place which shall help to extend their viability.
- Seeds easily re-absorb moisture. To maintain dryness, keep seeds in air-tight containers like tin cans or glass jars with tight fitting lids. Put in some moisture absorbing material. Dry wood ash, dry charcoal or small pieces of newspaper are recommended.
- Label the containers with the type of seed/species, date and place of collection.
- Before storing in containers, mix with dry ash, a powdered seed of black pepper or neem leaves to protect seeds from insects and fungi.
- Protect seeds from rodents and birds during storage.
- Red lead, kerosene oil and camphor are used as repellants. About 1 litre of kerosene oil can be sprinkled over 20-30 kg of seeds.
- Small sized seeds shall be mixed with ash, earth, cow dung etc., before sowing to protect them from birds, insects, etc.

Shading

Seedlings of different species in the young stage demand shade and protection from frost, heat, rain-splash, hailstorm or snow, etc. As such, the estimate for construction of shed for shading (using bamboo mat, nylon roofing mat etc.,) has to be prepared depending upon the locality and the characteristics of species proposed to be raised. For permanent beds, it is recommended to use angle iron or GI pipes. Roofing shall be constructed in slanting manner (with height of 1.40m upslope and 1.15 m above the ground downslope) to drain off rain water.

Weeding

Weeds shall be controlled in nurseries. Weeds can be reduced by burning leaf litter and other debris over the seed bed before sowing. Regular manual weeding is a must. Mulching sheet can be used in the nursery to suppress the weeds and reduce the cost of weeding.

Shifting of polypots

Shifting of polypots shall be done to enable uniform growth of seedlings due to effects of side lighting and also to avoid plants becoming rooted into the sub-soil. Regular shifting (monthly basis) shall produce stronger and healthier planting stock

Thinning

Thinning is mostly required for the direct seeded seed beds and polypots to achieve proper growing space where small and weak plants shall be removed when the seedlings attends height of 5-10 cm. Seedlings in raised beds shall be spaced at 10-15 cm between seedlings within rows and 15-20 cm between rows.

Hardening off

Hardening is the process of exposing transplants (seedlings) gradually to outdoor conditions. It enables the seedling to withstand the changes in environmental conditions when planted in the field like high/low temperature and hot/dry wind conditions. Hardening is also the physiological processes wherein; the plants accumulate more carbohydrates reserves and produce additional cuticle on the leaves. In this process, seedlings are given some artificial shocks at least 1-2 weeks before uprooting and transplanting. These shocks include;

- Gradual removal of all the shedding nets, polythene sheets, roof and fence until full exposure to sunlight.
- Gradually decrease the frequency of watering.

The following effect may be observed by the hardening;

- Hardening improves the quality and modifies the nature of colloids in the plant cell enabling them to resist the loss of water.
- Hardening increases the presence of dry matter in the plants but decrease the percentage of freezable water and transpiration per unit area of leaf.
- Decreases the rate of growth in the plants
- Hardened plants can withstand better against unfavourable weather conditions like hot day winds or low temperature.

Nursery Caretaker

Caretaker shall be placed for permanent nurseries inorder to ensure effective management of nurseries and production of good quality planting stock. The nursery caretaker shall be responsible for weeding, cleaning, watering, minor repair of shed, fencing, transplanting of seedlings, etc.

Nursery store / accommodation for caretaker

A store is necessary for storing seeds and nursery equipment. The forest nursery shall also have accommodation facility for the caretakers. This would facilitate to actively engage them in nursery activities to maintain quality nursery.

Soil Mixing Shed

Soil mixing shed is indispensable in all types of nursery. It shall function as the storage house of sand, leaf mould and top soil and prevent washing off of materials and soil nutrients. This shall also provide shelter to employees and protect from rain, heat and other natural calamities that hampers the work progress.

Transportation of Materials

Cost for transportation of materials shall depend on different mode of transportation and the distance involved. Accordingly, estimates shall be prepared depending on the field situations. On an average, a truck (14 ft length, 7ft width and 2.5 ft height) carries 250 numbers of fencing post (2m long and 12-15 cm diameter), 3000 numbers of bricks, 8 m^3 of leaf mould, top soil & sand each and 3500 kgs of barbed-wire (average weight of 30 kgs per roll).

Cost of Seedlings

The cost of seedlings shall depend on age, size and type of seedlings and shall include all the expenses required for production of seedlings till it reaches plantable size (45 cm height). The cost of seedling shall be revised from time to time with the increase in production cost.

Organic Pest Control

The organic pest management does not have adverse impact to the environment and is advised to be adopted in the forest nurseries. There are various types of bio-pesticides such as (i) Neem oil solution**,** (ii)garlic spray, (iii) chilli spray, (iv) ash spray, (v) golden shower (*Cassia fistula*) and (v) soap nut spray (*Sapindus mukrosii*).

Box 8.1 Organic bio-pesticide

Organic bio-pesticide

Ingredients:

i. Chili/Garlic/Ginger – ½ Kg OR
ii. *Artemesia sp* -1 Kg or neem can also be used
iii. Cooking Oil – 1 tsp
iv. Water- 1 Litre
v. Liquid detergent soap – 5 g
vi. Muslin cloth

Process:

i. Chop the plants (1/2 kg of chili or Garlic or Ginger or 1 kg artemisia or neem, golden shower, soapnut) and wrap in a muslin cloth.
ii. Mix 5 gram of washing soap in 1 litre of water.
iii. Add a spoon of cooking oil in the water and soak the muslin cloth in the mixture for an hour and apply on the aerial parts of the plants for effective effect.
iv. Ensure that the extract is properly filtered before application to the plant to avoid clogging of the sprayer.

Standard for seedling production in nursery

The standard for nursery development for production of seedlings is calculated based on the unit cost per hectare. While preparing the estimate, the implementing agency shall carefully analyze the site condition; select the work items and materials required as given in Table 8.11.

Table 8.11 Unit cost for seedling production in nursery.

Sl. No	Item of works	Qty	Unit	Unit cost (New creation)	Unit cost (Maintenance)
1	Feasibility study				
2	Consultation meeting with relevant stakeholders	1	No	Nu. 8000.00	
3	Site survey with GPS	1	Ha	Nu. 1,000.00	
3.1	Land demarcation	1	Event	Nu. 10,000.00	
3.4	Cost of pillars (1 site 8 nos)	1	No	Nu. 1,000.00	
4	**Site clearance**				
4.1		0.25	Ha	Nu. 7,500.00	Nu. 2,500.00
4.2		0.50	Ha	Nu. 15,000.00	Nu. 5,000.00
4.3		0.75	Ha	Nu. 22,500.00	Nu. 7,500.00
4.4		1.00	Ha	Nu. 30,000.00	Nu. 10,000.00
5	**Hoeing of sites and removal of debris and boulder**				
5.1		0.25	Ha	Nu. 19,000.00	Nu. 7,500.00
5.2		0.50	Ha	Nu. 37,500.00	Nu. 15,000.00
5.3		0.75	Ha	Nu. 56,500.00	Nu. 22,500.00

5.4		1.00	Ha	Nu. 75,000.00	Nu. 30,000.00
6	**Layout and planning**				
6.1		0.25	Ha	Nu. 2,500.00	
6.2		1	Ha	Nu. 5,000.00	
7	**Construction of terraces**				
7.1	Construction of terraces by manually or mechanical in sloppy area.	1	m^2	Nu. 114.00	Nu. 114.00
8	**Levelling and dressing of beds**				
8.1	Full bed 12m x 1.2m.	1	Bed	Nu. 250.00	Nu. 250.00
8.2	Half bed. 6m x 1.2 m.	1	Bed	Nu. 125.00	Nu. 125.00
8.3	Quarter bed. 3 m x 1.2 m.	1	Bed	Nu. 63.00	Nu. 63.00
9	**Construction of edging by raising 15-20cm high with stone /hollow blocks/bricks**				
9.1	**Cost of bricks.(1 bed is)**	1	No	Nu. 16.00	
9.1.2	Mechanical transportation of bricks (1 TL is 3000 nos).	1	T/L		As per the prevailing rate
9.1.3	Loading	1	No	Nu. 1.00	Nu. 3.00
9.1.4	Unloading and carriage of bricks to nursery site.	1	No	Nu. 1.50	
9.1.5	Edging around the beds with bricks 12m x 1.2m.	1	Bed	Nu. 1,500.00	Nu. 500.00
	Or				
9.2	**Cost of hollow block**	1	No	As per the prevailing rate	As per the prevailing rate
9.2.1	1 bed is 64 nos (8 cm x 15 cm)				
9.2.2	1 bed is 76 nos (10 cm x 15 cm)				
9.2.3	Loading	1	No	Nu. 3.00	
9.2.4	Unloading and carriage to the site	1	No	Nu. 3.00	
9.2.5	Mechanical transportation of hollow blocks (3000 nos per 1 T/L)	1	T/L	As per the prevailing rate	As per the prevailing rate
9.2.6	Edging around the beds with hollow blocks size 39cm x 19 cm x 19 cm. 1full bed is 68 nos.	1	Bed	Nu. 1,500.00	Nu. 500.00
	Or				
9.3	Collection of stone slabs, loading, unloading and carriage to the nursery site.	1	T/L	As per prevailing rates	
9.3.1	Mechanical transportation of stone	1	T/L	As per the prevailing rate	As per the prevailing rate
9.3.2	Edging around the beds with stone slab 12m x 1.2m.	1	Bed	Nu. 1,500.00	Nu. 500.00
	Or				
9.4	Collection of wooden post for edging (5 posts per bed) 6m long and 10 cm diameter	1	meter	Nu. 42.00	Nu. 42.00

9.4.1	Edging around the beds with wooden post, and bamboo poles 12 m x 1.2m	1	Bed	Nu. 500.00	Nu. 500.00
9.4.2	Transportation of wooden post	1	T/L	As per the prevailing rate	As per the prevailing rate
9.4.3	Soil. (Sand, Leaf mould, Top soil) with ratio of 1:2:3. For standard size bed.				
10	**Sand:**				
10.1	Royalty of sand.	1	T/L	Nu.50.00	Nu.50.00
10.2	Cost of sand, if directly procure from supplier.	1	T/L	Nu. 2,500.00	Nu.2,500.00
10.3	Loading and unloading of sand	1	T/L	Nu. 1,500.00	Nu. 1,500.00
10.4	Mechanical transportation of sand	1	T/L	As per the prevailing rate	As per the prevailing rate
11	**Leaf mould:**				
11.1	Royalty of leaf mould.	1	T/L	Nu. 60.00	
11.2	Collection of leaf mould.	1	M^3	Nu. 1,470.00	Nu. 1,470.00
11.3	Manual carriage of leaf mould from collection site to road point	1	M^3	Nu. 735.00	Nu. 735.00
11.4	Cost of leaf mould if directly procure from supplier. (1 bed is 0.86M^3)	1	M^3	Nu.	
11.5	Loading and unloading of leaf mould	1	T/L	Nu. 1,500.00	Nu. 1,500.00
11.6	Mechanical transportation of leaf moud	1	T/L		As per
12	**Top soil**				
12.1	Royalty of top soil	1	T/L	Nu.110.00	Nu.110.00
12.2	Collection of top soil.	1	M^3	Nu. 490.00	Nu. 490.00
12.3	Manual carriage of top soil from collection site to road point	1	M^3	Nu. 490.00	Nu. 490.00
12.4	Cost of Top soil if directly procure from the supplier	1	M^3	As per the prevailing rate	As per the prevailing rate
12.5	Loading and unloading of top soil	1	T/L	Nu. 1,500.00	Nu. 1,500.00
13	**Nursery Shed construction.** The higher side post height shall be 1.70 M. The lower side post height shall be 1.45 M.				
13.1	**Post (10 cm- 15cm dia) per bed.** 1.70 M height is 4 nos 1.45 M height is 4 nos.				
13.2	**Poles (5-10 cm dia)per bed** 4 M long is 6 nos 1.4 M long is 26 nos.				
13.3	Royalty of post.	1	No	Nu. 6.00	
13.4	Felling, cross cutting, collection, debarking and carriage of post from source up to road point (1km distance). 1 bed is 8 nos 2 m long.	1	M	Nu. 42.00	Nu. 42.00

13.5	Mechanical transportation of post for shed construction. 1 T/L is 200 nos.	1	T/L	As per the prevailing rate	As per the prevailing rate
13.6	Loading and unloading of post	1	T/L	Nu. 1,500.00	Nu. 1,500.00
13.7	Dressing of post.	1	No	Nu. 10.00	Nu. 10.00
14	**Royalty of pole s. (1 bed: 3 m =8 nos, 1=10 nos)**				
14.1	Felling, cross cutting, collection, debarking and carriage of post from source up to road point (1km distance). 1 no bed is 26 number poles with 2 m long of 10-15 cm dia for nursery roofing.	1	M	Nu. 42.00 Fraternity unweavering	Nu. 42.00
14.2	Mechanical transportation of poles. 1 T/L is 200 nos.	1	T/L	As per the prevailing rate	As per the prevailing rate
14.3	Loading and unloading of poles	1	T/L	Nu. 1,500.00	Nu. 1,500.00
14.4	Dressing of poles	1	No	Nu. 10.00	Nu. 10.00
14.5	Purchase of bamboo poles for shade construction from community forest/ Private forest/ near by community.	1	No	As per the prevailing rate	As per the prevailing rate
14.6	Loading and unloading of bamboo poles.	1	T/L	Nu. 1,500.00	Nu. 1,500.00
14.7	Mechanical transportation of bamboos. 200 numbers per T/L.	1	T/L	As per the prevailing rate	As per the prevailing rate
14.8	Purchase of cement fencing post	1	No	As per the prevailing rate	As per the prevailing rate
14.9	Mechanical Transportation of the post. Wooden post: 150/TL	1	T/L	As per the prevailing rate	As per the prevailing rate
15	Collection of bamboo materials including preparation of mats transportation up to nursery sites.	1	Bed	Nu. 2,500.00	
	Purchase of Green Poly Nets instead of bamboo mats for shading. (14m x 3m)	1	M^2	Nu. 40.00	Nu. 40.00
	Purchase of binding wires	1	Kg	Nu. 130.00	
	Purchase of nails	1	Kg	Nu. 100.00	
	Preparation of sheds by fixing poles & post with nails by providing bamboo mat in 12mx1.2m bed size	1	Bed	Nu. 1,500.00	Nu. 1,500.00
	Repair and maintenance of Nursery shed in every two years	1	Bed		Nu. 1,000.00
16	**Poly pot works and seed sowing**				
	Purchase of UV poly pot	1	Kg	As per the prevailing rate	As per the prevailing rate
	Purchase of non-UV poly pot	1	Kg	As per the prevailing rate	As per the prevailing rate
	Sieving and mixing of, sand, manure and topsoil in the ratio1:2:3 and filling in the poly pots including arrangement in bed (No of poly pots				
	6 cm dia x 10 cm height	1	Pot	Nu. 1.00	Nu. 1.00

	15 cm dia x 15 cm height	1	Pot	Nu. 2.00	Nu. 2.00
	15 cm dia x 30 cm height	1	Pot	Nu. 2.00	Nu. 2.00
	18 cm dia x 18 cm height	1	Pot	Nu. 2.00	Nu. 2.00
	18 cm dia x 23 cm height	1	Pot	Nu. 3.00	Nu. 3.00
	20 cm dia x 30 cm height	1	Pot	Nu. 7.00	Nu. 7.00
	24 cm dia x 30 cm height	1	pot	Nu. 5.00	Nu. 5.00
	'' U V'' 45 cm dia x 45 cm height	1	Pot	Nu. 13.00	Nu. 13.00
	Sowing of seeds by dibbling with uniform spacing (Number of mother beds)	1	Bed	Nu. 125.00	Nu. 125.00
	Sowing of seeds by broadcasting and light covering with fine soil/mulch (No of mother beds)	1	Bed	Nu. 50.00	Nu. 50.00
	Pricking out seedling from the mother bed and transplanting in the readily filled poly pot	1	No	Nu. 1.50	Nu. 1.50
	Seed treatment for hard shelled species such as Teak, Melia, Walnut, Gameria	50	Kg	Nu. 500.00	
17	**GI pipe 15mm dia. (Cost of GI pipe) for one full bed (1.2 m X 12 m)**				
	Length-0.64m (Both side Threaded)	12.8	M		
	Length-1.00m (Both side Threaded)	28.0	M		
	Length-2.00m (Both side Threaded))	8.00	M		
	Length-1.25m(Both side Threaded)	2.50	M		
	Cost of Threading GI pipe				
	Length-0.64m(Both side Threaded)	20.0	Nos		
	Length-1.00m(Both side Threaded)	28.0	Nos		
	Length- 2.00m(Both side Threaded)	4.00	Nos		
	Length-1.25m(Both side Threaded)	16.0	Nos		
	Cost of GI "T" 4 Way Cross and 3 Way Corner Connector				
	15 mm GI 3 Way Right angle Connector	8.00	Nos		
	15 mm GI " T"	24.0	Nos		
	15 mm GI Cross connector	6.00	Nos		
18	**Watering.**				
	Watering with sprinklers	1	Bed	Nu.10.00	Nu. 10.00
	Watering with rose cane	1	Bed	Nu. 25.00	Nu. 25.00
	Watering with pipe	1	Bed	Nu. 8.00	Nu. 8.00
19	**Weeding nursery beds including cleaning**				
	Temperate region	1	Bed	Nu. 170.00	Nu.170.00
	Sub-tropical	1	Bed	Nu. 250.00	Nu. 250.00
20	**Preparation of manure**				

	Making of pit (3m x 3m x 2m)	1	Pit	Nu.2,500.00	Nu. 2,500.00
	Preparation of manure pit	1	Pit	Nu.1,500.00	Nu. 1,500.00
21	**Foot path**				
	Construction of foot path(1 m wide x 20 cm height)	1	M	Nu. 100.00	Nu. 100.00
22	**Working shed (Temporary)**				
	Post (4 m long 9 nos)	1	No		
	Poles (6 m long 3 nos)	1	No		
	CGI sheet 10'' (16 nos)	1	No		

8.4.10.4 Forest Plantation

Forest plantation plays a vital role in maintaining the sustainable supply of forest resources. It also balances the ecosystem, control erosion and landslides, improve water retention capacity and wildlife habitat. The appropriate method of plantation, depending upon the factors mentioned in this section, has to be considered by the executing agency. Eg. Large size pit in dry and rocky soil, terrace plantation in slope more than 45 degree.

For success of plantation, adequate fund provision has to be kept for maintenance (replacement of casualties and weeding). Plantation with 70 % survival after five years shall be considered successful. For success of plantations, the following considerations shall be kept in mind.

Slope

It is necessary to consider the slope of the planting site. Depending upon the slope, planting area has been classified into the following 3 categories:

- Land with slope up to 22.55 degree or 50 % slope.
- Land with slope up to 45 degree or 100 % slope.
- Land with slope up to 60 degree or 130 % slope.

Terrace plantation is recommended in dry areas with slope of 45 degree and above. To retain the moisture and control soil erosion/run off, the slope of the terrace shall be inclined towards uphill side.

Soil

Physical properties of soil and surface condition impact the working cost. It is recommended to avoid rocky surface, hard soil, soft surface and sandy conditions. Under unavoidable circumstances, the top soil and leaf mould shall be supplemented in areas where plantation site is rocky in nature.

Planting Tools

The implementing agency shall decide the planting tools as best suited to the locations.

Spacing

Spacing between plant-to-plant depends on the type of species, growth rate and site conditions. It is also governed by the objective of plantation. The following spacing are commonly practiced within the country:

Table 8.12 Recommended spacing

Sl. no	Spacing	Remarks
1	2m X 2 m	Commercial plantation with fast growing species (short rotation)
2	2 m X 2.5 m	Dry areas
3	2.5 m X 2.5 m	Standard
4	3 m X 2.5 m	
5	3 m X 3 m	
6	3.5 m x 3.5 m	For large trees (long rotation)

Pit size

Pit size (Table 8.13) shall be decided by the site condition, type and size of seedlings. If bare rooted seedlings are to be planted, their root lengths shall be considered. On drier, rocky or shallow soil sites, large sized pits are recommended for retaining moisture. This shall help in free rooting in the initial stage.

Table 8.13 Pit size specification

Sl. no	Types of soil	Dia. X Depth (Small)	Remarks
1	Hard soil	20 cm x 30 cm	Bare root plantation
2	Hard soil	30 cm x 30 cm	Poly potted seedling plantation
3	Hard soil	30 cm x 45 cm	Poly potted seedling plantation
4	Hard soil	40 cm x 40 cm	Bush root balled plantation
5	Rocky soil	45 cm x 50 cm	Poly potted plantation
6	Hard soil	80 cm x 80 cm	Root balled tree plantation
7	Soft soil	20 cm x 30 cm	Bare root plantation
8	Soft soil	30 cm x 30 cm	Poly potted seedling plantation
9	Soft soil	40 cm x 40 cm	Bush root balled plantation
10	Soft soil	80 cm x 80 cm	Root balled tree plantation

The pits shall be dug about 2-weeks to one month in advance for weathering. Unwanted materials like stones and debris shall be removed and filled with top soil during planting. Normally such activities have to be carried out in March-April before the rainy season (*Refer:*Table 8.3 Seasonal calendar for plantation).

Planting of seedling

Timing of plantation time is also one of the important factors for success of the plantation. Seedling shall be planted from April and be completed by June (*Refer:*Table 8.3 Seasonal calendar for plantation).

Plantation Maintenance

Plantation maintenance refers to activities like fence repairing, replacement of dead saplings, weeding, cleaning, watering, etc. It shall be carried out periodically to ensure success of plantations. In general, plantations take five years to get established. Among many factors, inadequate fund for plantation maintenance is one of the factors affecting the success of plantation. Adequate fund should be allocated for the maintenance of plantation. The unit cost creation and maintenance of plantation is estimated in Table 8.14 and Table 8.15.

Table 8.14 Unit cost required for plantation creation

Sl No	Items	Quantity	Units	Cost/Unit
1	Site selection			
2	Public consultation meeting for finalization of the site.	1	Event	Nu. 5,000.00
3	Surveying of the plantation area.	1	Ha	Nu. 1,000.00
	Survey shall be preferably done by using GPS. The estimates have to be submitted along with the map, coordinates and a brief write up explaining situation of the area. If few patches falling within the survey area are not feasible forplantation, it also must be clearly spelt in the estimates and map.	2 to 5	Ha	Nu. 2,000.00
		6 to 10	Ha	Nu. 3,000.00
		10 to 15	Ha	Nu. 4,000.00
		16 to 20	Ha	Nu. 5,000.00
		21 to 30	Ha	Nu. 6,500.00
		31 to 40	Ha	Nu. 8,000.00
		41 to 50	Ha	Nu. 9,000.00
		51 to 75	Ha	Nu. 10,000.00
		76 to 100	Ha	Nu. 13,000.00
4	**Site clearing**			
	Clearing, cutting and arrangement of debris in line along the periphery.			
4	Broadleaf area	1	Ha	Nu. 10,000.00
4	Conifer area	1	Ha	Nu. 7,500.00
5	**Alignment and Staking**			
5	Collection of bamboo or wooden stick of 2-3 cm dia and1.5 m height.	1	Stick	Nu. 3.00
	Alignment of lines and staking for all areas including transportation to plantation sites.			
6	**Digging of pits**			
6	**Digging of pits in rocky soil**			
	45 cm x 50 cm depth	1	Pit	Nu.
6	**Digging of pits in hard soil**.			
	20 cm dia x 30 cm depth	1	Pit	Nu.16.00
	30cm dia x 30 cm depth	1	Pit	Nu. 17.00
	30 cm dia x 45 cm			
	40 cm dia x 40 cm depth	1	Pit	Nu. 42.00
	45cm dia x 50cm depth	1	Pit	Nu. 33.00
	55 cm dia x 60 cm dia depth			
	80 cm dia x 80 cm depth	1	Pit	Nu. 125.00
6	**Digging of pits in soft soil**			
	20 cm dia x 30 cm depth	1	Pit	Nu. 12.00
	30cm dia x 30 cm depth	1	Pit	Nu. 13.00
	40 cm dia x 40 cm depth	1	Pit	Nu. 13.00
	40 cm dia x 60 cm depth	1	Pit	Nu. 34.00
	80 cm dia x 80 cm depth	1	Pit	Nu. 63.00
7	**Terrace construction.**			

	Making of terrace of 50 cm wide, 15cm deep along the contour at an interval of 2.5m.			
	In rocky/hard soil	1	m^2	Nu. 25.00
	In normal soil	1	m^2	Nu. 19.00
	Carriage of seeds to sowing site within 1km distance	1	Ha	Nu. 1,000
	Sowing of seeds in terraces with light soil coverage	1	Ha	Nu. 5,000.00
8	**Cost of seedlings**			
	The cost of seedling shall be applicable if purchased from other nurseries. While preparing estimates for technical sanction, the seedling cost shall not be reflected if seedlings are available in own nurseries to avoid dublication of cost.	1	No	As per prevailing rate.
	The cost of seedling shall differe according to the size and species			
	Carriage of seedling from nursery to truck, loading, unloading and siding in shaded areas			
	Normal seedling	1	Seedling	Nu.2.00
	Medium size seedling	1	Seedling	Nu. 4.00
	Large size seedling	1	Seedling	Nu. 6.00
9	Mechanical transportation of seedlings from nursery to nearest motor able road at planting site. No of seedlings in a truck shall vary depending upon the size of poly pot. Average number of seedlings carried by a truck as below	1	Truck load	As per quotation
	1 T/L is 1400 nos for normal seedlings			
	1 T/L is 230 nos for medium size seedling			
	1 T/L is 115 nos for large size seedlng.			
	1 load of double cabin bolero carries 300 nos for normal seedling			
10	**Planting of bare-root seedlings/stumps**			
	Uprooting of seedlings, packing in soaked gunny bags /hessian cloth, sacks etc into bundles of 10 seedlings each.	1	Bundle	Nu. 17.00
	Carriage of seedlings up to planting site within 1 km distance	1	Nos	Nu. 2.00
	Planting of seedlings in ready made planting pit	1	No	Nu. 7.00
	Planting of stumps by making crowbar holes	1	Nos	Nu. 4.00
11	**Planting of seedlings with ball of earth**			
	Uprooting of seedlings and packing in soaked gunny bags/hessian cloths.	1	No	Nu. 8.00
	Carriage of seedlings up to planting site within1km distance	1	No	Nu. 2.00
	Planting of seedling in ready made planting pit	1	No	Nu. 8.00
12	**Planting of Poly potted seedlings**			
	Normal size seedling ranging from 7 cm-15 cm dia	1	Nos	Nu.8.00
	Medium size seedling ranging from 18 cm -30cm dia	1	No	Nu.16.00
	Large size seedling ranging from 30 cm-40 cm dia	1	No	Nu 22.00

13	**Making of thalis and seed sowing**			
	Carriage of seeds up to sowing site within 1km distance	1	Ha	Nu. 1,000.00
	Making thalis of 30cm dia and 15cm depth. (Hard and soft soil)	1	Thalie	Nu. 10.00
	Making thalis 45 cm dia and 15 cm depth (Hard and soft soil)	1	Thalie	Nu. 15.00
	Making thalis 60 cm dia and 15 cm depth (Hard and soft soil)	1	Thalie	Nu. 20.00
	Sowing of seeds in thalis with light soil cover	1	Thalie	Nu. 2.00
14	**Water supply system.**			
	In arid and dry region plantation, provision for watering the plants shall be kept for better survival. The estimates for water supply shall be prepared depending upon the site condition. The procurement of sintex tank, water pump, pipes, and construction of concrete tank may be executed only if it is genuinely required.			
	Cost of pipes	1	Roll	As per prevailing rate
	Cost of sintex tank	1	No	-do-
	Cost of concrete tank construction	1	No	-do-
	Cost of construction of pound	1	No	-do-
	Water pump			-do-
15	**Signboard**			
	Making and writing of signboard	1	No	Nu. 10,000.00
	Fixing signboard	1	No	Nu. 1,000.00
16	**Entry gate**			
	Making of style (Entry gate, staircase) excluding the materials.	1	No	Nu. 1,000.00

Table 8.15 Unit cost required for plantation maintenance

Sl. no	**Items**	**Qty**	**Unit**	**Cost/unit**
1	**Maintenance in the same year of creation (1st Maintenance)**			
1.1	**Broadleaf area**			
	1st Weeding- clearing all over the area, weeding and mulching around plants (July-August)	1	Ha	Nu.10,000
	2nd Weeding-weeding around plants (Sept-Oct)	1	Ha	Nu. 10,000
	3rd Weeding-weeding and mulching around the plants (May-June)	1	Ha	Nu. 10,000
1.2	**Conifer area**			
	1stWeeding- clearing all over the area, weeding and mulching around plants (July-Sept)	1	Ha	Nu. 5000.00

	2nd Weeding-weeding and mulching around plants (April-June)	1	Ha	Nu.,5000.00
2	**Maintenance in second year of creation (2nd Maintenance)**			
2.1	**Fencing**			
	Fencing post requirement depends upon spacing that has been maintained between posts to post. The 10% of the total post and nails to be procured			
	Replacement of 10% fencing post	1	Post	Nu. 63 00
	Procurement of 10% nails	1	Kg	
	Weeding/cleaning			
2.2	**Broadleaf area**			
	1st Weeding- weeding and mulching around plants (July-August)	1	Ha	Nu. 10,000.00
	2nd Weeding- clearing all over the area, weeding and mulching around the plants (Sept-Oct)	1	Ha	Nu. 10,000.00
	3rd Weeding-weeding around the plants (April-May)	1	Ha	Nu. 10000.00
2.3	**Conifer area**			
	1st Weeding- clearing all over the area, weeding and mulching around plants (May-June)	1	Ha	Nu..5000
	2nd Weeding-weeding and mulching around the plants (July-Sept)	1	Ha	Nu. 5,000.00
2.4	**Casualty replacement:** The implementing agency shall carry out casualty replacement till the establishment of the plantation.			
	Pit digging	1	Pit	Nu. 8.00
	Planting of seedlings	1	No	Nu. 8.00
3	**Maintenance in third year of creation. (3rd Maintenance)**			
	20% casualty replacement shall be accepted in third year			
3.1	**Fencing**			
	Replacement of 20% fencing post	1	No	Nu. 120.00
	Procurement of 20% nails			
	Weeding/cleaning			
3.2	**Broadleaf area**			
	1stWeeding- weeding and mulching around plants (March-April)	1	Ha	Nu.10000
	2nd Weeding- clearing all over the area, weeding and mulching around the plants (June-July)	1	Ha	Nu.10000
	3rd Weeding-weeding around the plants (October)	1	Ha	Nu.10000
3.3	**Conifer area**			
	1st Weeding- clearing all over the area, weeding and mulching around plants (May-June)	1	Ha	Nu.5000

	2nd Weeding-weeding and mulching around the plants (July-August)	1	Ha	Nu. 5,000.00
3.4	**Casualty replacement**			
	Pit digging	1	Pit	Nu.8.00
	Planting	1	Pit	Nu.8.00
4	**Maintenance in fourth year of creation).**			
4.1	**Fencing**			
	30% of fencing post replacement	1	No	Nu.120.00
	30% of nails to be procured	1	Kg	
	Weeding and Cleaning			
4.2	**Broadleaf area**			
	1st weeding- weeding around the plants	1	Ha	Nu..10000
	2nd weeding- weeding around the plants	1	Ha	Nu..10000
	3rd weeding- weeding around the plants	1	Ha	Nu..10000
4.3	**Conifer area**			
	1st weeding- weeding around the plants	1	Ha	Nu. 5,000.00
	2nd weeding- weeding around the plants	1	Ha	Nu. 5,000.00
4.4	**Casualty replacement(10% in 4th year if required)**			
	Pit digging 10%	1	Pit	Nu. 8.00
	Planting 10%	1	No	Nu. 8.00
5	**Maintenance of 5th year of creation**			
5.1	**Fencing**			
	30% of fencing post replacement	1	No	Nu.120.00
	30% of nails to be procured	1	Kg	
	Weeding and Cleaning			
5.2	**Broadleaf area**			
	1st weeding and mulching	1	Ha	Nu.10000
	2nd weeding	1	Ha	Nu.10000
	3rd weeding and mulching	1	Ha	Nu.10000
5.3	**Conifer area**			
	1st weeding- weeding around the plants	1	Ha	Nu. 5,000.00
	2nd weeding- weeding around the plants	1	Ha	Nu.5,000.00
6	**Tending operation from 5th -10th Year**			
	Climber cutting and removal of dead and unwanted plants			
	Sub-tropical broadleaved area	1	Ha	Nu. 10,000.00
	Temperate broadleaf	1	Ha	Nu.5,000.00

Weeding and clearing

- The frequency of weeding or tending operation shall be more in tropical and subtropical forests due to heavy growth of weeds, creepers and climbers.
- In all the regions, one-time clearing, weeding and mulching of whole area around the planted seedlings is required in same year of creation.
- Maintenance of plantation in tropical and subtropical regions from 1st to 5th year require three times clearing of whole area in addition to one time weeding and mulching.
- Maintenance of plantation in temperate regions from 1st to 5th year require two time clearing of whole area in addition to weeding and mulching (usually during following the financial year).

Tending operation

- The maintenance of plantation shall be followed by a series of tending operations like climber cutting, pruning, removal of dead and dying species, sanitation operation, to create healthy growing environment.
- The executing agencies shall keep budget provision for these activities. The tending operation shall be carried out from the 6th year onwards till plantation attains the age of 10 years. Plantations after 11th year may require other silvicultural treatments.

Table 8.16 No of seedling per hectare under different spacing

Sl. No	Spacing in Meters	No. of Seedlings
1	1.0 x 1.0	10,000 seedlings
2	1.0 x 1,5	6,666 seedlings
3	1.0 x 2.0	5,000 seedlings
4	1.0 x 2.5	4,000 seedlings
5	1.0 x 3.0	3,333 seedlings
6	1.0 x 3.5	2,857 seedlings
7	1.0 x 4.0	2,500 seedlings
8	1.0 x 4.5	2,222 seedlings
9	1.0 x 5.0	2,000 seedlings
10	1.5 x 1.5	4,444 seedlings
11	1.5 x 2.0	3,333 seedlings
12	1.5 x 2.5	2,666 seedlings
13	1.5 x 3.0	2,222 seedlings
14	1.5 x 3.5	1,904 seedlings
15	1.5 x 4.0	1,666 seedlings
16	1.5 x 4.5	1,481 seedlings
17	1.5 x 5.0	1,333 seedlings
18	2.0 x 2.0	2,500 seedlings
19	2.0 x 2.5	2,000 seedlings
20	2.0 x 3.0	1,666 seedlings
21	2.0 x 3.5	1,428 seedlings
22	2.0 x 4.0	1,250 seedlings
23	2.0 x 4.5	1,111 seedlings
24	2.0 x 5.0	1,000 seedlings

25	2.5 x 2.5	1,600 seedlings
26	2.5 x 3.0	1,333 seedlings
27	2.5 x 3.5	1.142 seedlings
28	2.5 x 4.0	1,000 seedlings
29	2.5 x 4.5	888 seedlings
30	2.5 x 5.0	800 seedlings
31	3.0 x 3.0	1,111 seedlings
32	3.0 x 3.5	952 seedlings
33	3.0 x 4.0	833 seedlings
34	3.0 x 4.5	740 seedlings
35	3.0 x 5.0	666 seedlings
36	3.5 x 3.5	816 seedlings
37	3.5 x 4.0	714 seedlings
38	3.5 x 4.5	634 seedlings
39	3.5 x 5.0	571 seedlings
40	4.0 x 4.0	625 seedlings
41	4.0 x 4.5	555 seedlings
42	4.0 x 5.0	500 seedlings
43	5.0 x 5.0	400 seedlings
44	5.0 x 6.0	333 seedling

8.4.10.5 Bio-Engineering/Land Management Activities

Bio-engineering techniques include use of live vegetation either alone or in conjunction with civil engineering structures and non-living material. It is carried out to reduce velocity of water flow, control soil erosion and enhance siltation of soil on slopes (Soil Erosion Control Manual, NSSC). These techniques are used as a protective measure to stabilize the erosion prone/eroded areas and gullies by constructing check dams and planting of grasses, shrubs and trees. Field offices intending to take up bioengineering work has to carefully examine whether this intervention shall bring any tangible impact and are cost effective in land reclamation.

Table 8.17 Unit cost estimates for bio-engineering/land management works

Sl. no	Items	Qty	Unit	Rate
1	**Cutting**			
1.1	Cutting and collection of 5-10 cm dia and 1-meter length live cuttings from forest and siding			
1.1.1	Thorn less	1	No	Nu. 4.00
1.1.2	Thorny species	1	No	Nu. 5.00
1.2.1	Manual carriage of cuttings from forest to road head within 1 km distance	1	No	Nu. 2.00
1.2.2	Planting of cuttings including making of crowbar hole	1	No	Nu. 2.00
2.	**Bamboo Rhizome**			
2.1	Uprooting, packing in gunny bags and siding of bamboo rhizomes			

2.1.1	Small bamboo	1	No	Nu. 25.00
2.1.2	Large bamboo	1	No	Nu. 100.00
2.2.	Manual carriage of bamboo rhizome from forest to road head within 1km distance			
	Small bamboo	1	No	Nu.12.00
	Large bamboo	1	No	Nu. 50.00
	Manual carriage of bamboo rhizome from road head to planting site within 1km distance			
2.2.1	Small bamboo	1	No	Nu. 12.00
2.2.2	Large bamboo	1	No	Nu. 50.00
2.2.3	Digging pit of 40 cm dia x 50 cm depth for bamboo rhizome planting	1	No	Nu. 25.00
2.2.4	Planting of Bamboo Rhizome	1	No	Nu. 17.00
3.	**Grass slip**			
	Collection of grass- 5 kg/bundle	1	Bundle	Nu.100.00
	Carriage of grass within 1km distance	1	Bundle	Nu.10.00
	Planting of grass	1	Bundle	Nu.10.00
3.1	Collection of grass slip of 30cm x 30 cm	1	Sq.ft	Nu. 10.00
3.2	Carriage of grass slips within 1km distance	1	Sq.ft	Nu. 10.00
3.3	Making of hedgerows and planting grass slips.	1	Sq.ft	Nu. 10.00
4.	**Wildlings**			
4.1	Uprooting, wrapping in gunny bags and collection	1	No	Nu. 5.00
4.2	Manual carriage of wildings from forest to road head and from road to site within 1km distance	1	No	Nu. 2.00
5.	**Check Dams**			
5.1	Dry rubble stone check dam			
5.2	Collection of stones of 1 m^3 within 15m-20m distance	1	M^3	Nu. 1,000.00
5.3	Carriage of stones 1 m^3 within 15m-20m distance	1	M^3	Nu. 1,000.00
5.4	Construction of check dam of 1 m^3	1	M^3	Nu. 1,000.00
5.5	Construction of check dam with dressed stone of 1 m^3 (**Case study from NRDCL)**	1	M^3	Nu. 2,000.00
6	**Log check dams**			
6.1	Cutting and collection of logs	1	M^3	Nu. 1,500.00
6.2	Carriage of logs within 1 km	1	M^3	Nu. 2,000.00
6.3	Construction of log check dams of 1 m^3	1	M^3	Nu. 3,000.00
6.4	Construction of live check dam	1	No	Nu. 1,500.00
7	**Construction of large structures stone, log and live check dams for large scale and land management campaigns**			
7.1	Mechanical transportation of any materials required for bio engineering			As per prevailing rate
8	Cost of cuttings/bamboo rhizome/grass slip if it's to be purchased			-do-
9	Royalty for wilding, post, poles, stones and etc.			-do-

8.4.10.6 Creation of Fireline

The Royal Government of Bhutan invests huge amount of money for establishment and management of forest nurseries and plantations every year. Forest fire causes major damage to both natural and planted forests. Therefore, appropriate preventive measures such as fireline shall be adopted to protect plantations from fires.

The implementing agencies shall undertake precautionary measures by creating or maintaining fire lines around the plantations to protect from fire damages.

1. Make fireline creation a regular activity
2. Keep adequate budget provision for making fire lines in fire prone areas
3. Prepare estimates for fire line creation and maintenance based on the norms
4. Create/regularly maintain fire line before the start of drought and fire season
5. Procure basic firefighting tools and equipment
6. Keep budget provision for training staff and local communities (for those areas which falls in high fire hazard areas).

Table 8.18 Unit cost required for fireline (Average width 5 meters)

Sl. No	Items of work	Quantity	Unit	Rate	Remarks
1	Creation of fire line in broadleaf zone with an average width of 5 meters	1	m^2	Nu. 5.00	New
2	Creation of fire line in Conifer Zone with an average width of 5 meters	1	m^2	Nu. 3.00	New
3	Maintenance of fire line construction in broad leaf zone with an average width of 5 meters	1	m^2	Nu. 3.00	Maintenance
4	Maintenance of fire line in conifer zone (average width 5 meters)	1	m^2	Nu. 2.00	Maintenance

8.4.10.7 Fencing

Biotic interference like livestock grazing and wildlife causes extensive damage to plantations. Therefore, it is essential to fence the plantation areas to prevent it from grazing and browsing damages. Fencing is a high cost component among the activities associated with creation of forest plantation and nurseries. Therefore, the implementing agency shall always be mindful in estimation of materials for fencing.

Alignment of fencing is another factor which determines the cost. Wrong judgment during the alignment shall increase the cost unnecessarily. The field staff involved in survey work shall use broken, dead or inferior trees which fall in the alignment as natural supports. These can be used as fencing posts. If the alignment passes through steep or rocky areas from where animals cannot enter the plantation area, such portion can be excluded from fencing cost estimate.

Cost of fencing using other materials may be based on actual field situation. Requirement of fencing materials like barbed wire, fencing poles, U nails shall be based on the actual perimeter of the plantation sites and not on the theoretical calculated tables.

Barbed Wire Fencing

While preparing the estimates, the implementing agency shall select the relevant activity from the Table 8.19. It is also necessary to decide the spacing of posts and number of barbed wire strands to be provided. The quantity of fencing material requirement including pit digging shall depend on shape and size of the plantation area. Thus, calculation of fencing material requirement must be done based on the actual perimeter measured on the ground. Calculation of estimates for natural barriers which serves as

fencing shall be avoided. Eg. Cliff, river, deep/steep gully, etc. The implementing agency intending to use GI fencing post shall provide proper justification for using iron posts instead of wooden.

Table 8.19 Unit cost estimates for barbed wire fencing

Sl. No	Items of work	Qty	Unit	Rate
1	**Royalty for fencing**	1	No	6
2	Felling, cross cutting, collection, debarking and carriage of fencing post (2m long,12-15 cm dia) from source to road point within 1km distance.	1	Post	Nu.83.00
	Purchase of fencing post from NRDCL/Community/ Private Forest.	1	Post	Nu. 45.00
	Purchase of Iron Post/Cement fencing post.	1	Post	As per prevailing rate
3	Dressing of post	1	Post	Nu. 10.00
4	Application of preservative	1	Post	Nu. 10.00
5	Mechanical transportation of fencing post, barbed wire and U Nails from source to plantation sites. One truck load carry 250 numbers of post.	1	T/L	As per prevailing rate
	Loading and unloading of fencing post including siding	1	T/L	Nu. 500.00
	Manual carriage of fencing post from road head to pit site (within 1km distance)	1	No	Nu. 25.00
6	Pit digging and erection of posts with pit size of 45cm deep x 20cm dia.	1	No	Nu. 25.00
7	Fixing and stretching of barbed wire including carriages up to working sites and putting U Nails.			
	100 meters 4 strand (9 inch apart)	1	M	Nu. 25.00
	100 meters 5 strands	1	M	Nu. 30.00
	100 meters 6 strands	1	M	Nu. 35.00
8	Manual carriage of barbed wire and U Nails (within 1 km distance)	1	kg	Nu.3.00
	Cost of barbed wire	1	Kg	
	Cost of U Nail	1	Kg	
	Cost of Nails	1	Kg	
	Cost of preservatives (coal tar, brush etc)	1	Kg	

Fencing Using Other Materials (Tree guard, bamboo mat enclosures, etc.)

Avenue plantations are created for recreational and aesthetic purposes in towns and cities, roadsides, in the premises of Dzongs, offices and other structures. Such plantation requires extra care and entails additional activities such as bigger pit size, construction of concrete structures (cubicles), making of tree guard or bamboo mat enclosures for fencing, regular watering, etc.

Table 8.20 Unit cost estimate for fencing using other materials

Sl. No	Items	Unit	Qty	Rate	Remarks
1.	Making tree guard in pyramidal/desirable shapes with collection of sticks	Plant	1	Nu. 100.00	
2	Making of enclosure with bamboo mats excluding the materials – 10 plants	Plant	1	Nu. 50.00	
	The tree guard and bamboo mat enclosures are provided in places where barbed wire fencing is not feasible or uneconomical and where individual plant requires protection Eg. Avenue, Micro-site, Patch plantation. In case concrete structures are to be constructed for avenue, the cost estimated by Regional/Dzongkhag engineer shall be followed				
	Note: Any activities not covered in this norm shall be taken up through special approval				

Table 8.21Requirement of fencing materials (3 strands)

Sl. No	Perimeter (meter)	Barbed wire	2 meter spacing		2.5 meter spacing	
			Post No.	Unail/Kg	Post No.	Unails/Kg
1	100	47.00	50.00	2.00	40.00	1.00
2	200	94.00	100.00	3.00	80.00	3.00
3	300	141.00	150.00	5.00	120.00	4.00
4	400	188.00	200.00	6.00	160.00	5.00
5	500	235.00	250.00	8.00	200.00	6.00
6	600	283.00	300.00	9.00	240.00	8.00
7	700	330.00	350.00	11.00	280.00	9.00
8	800	377.00	400.00	12.00	320.00	10.00
9	900	424.00	450.00	14.00	360.00	11.00
10	1000	471.00	500.00	15.00	400.00	12.00

Table 8.22 Requirement of fencing materials (4 strands)

Sl.no	Perimeter (meter)	Barbed wire (Kg)	2 meter spacing		2.5 meter spacing	
		Post	Post No.	Unail/Kg	Post No.	Unails/Kg
1	100	79.00	50.00	3.00	40.00	2.00
2	200	157.00	100.00	5.00	80.00	4.00
3	300	235.00	150.00	8.00	120.00	6.00
4	400	314.00	200.00	10.00	160.00	8.00
5	500	392.00	250.00	13.00	200.00	10.00
6	600	471.00	300.00	15.00	240.00	12.00
7	700	549.00	350.00	18.00	280.00	14.00
8	800	628.00	400.00	20.00	320.00	16.00
9	900	706.00	450.00	23.00	360.00	18.00
10	1000	785.00	500.00	25.00	400.00	20.00

Table 8.23 Requirement of fencing materials (5 strands)

Sl. No	Perimeter (meter)	Barbed wire (Kg)	2 meter spacing		2.5 meter spacing	
			Post No.	Unail/Kg	Post No.	Unails/Kg
1	100	63.00	50.00	2.00	40.00	2.00
2	200	126.00	100.00	4.00	80.00	4.00
3	300	188.00	150.00	6.00	120.00	5.00
4	400	251.00	200.00	8.00	160.00	7.00
5	500	314.00	250.00	10.00	200.00	8.00
6	600	377.00	300.00	12.00	240.00	10.00
7	700	440.00	350.00	14.00	280.00	12.00
8	800	502.00	400.00	16.00	320.00	13.00
9	900	565.00	450.00	18.00	360.00	15.00
10	1000	628.00	500.00	20.00	400.00	16.00

Table 8.24 Requirement of fencing materials (6 strands)

Sl. no	**Perimeter (meter)**	**Barbed wire (Kg)**	**2 meter spacing**		**2.5 meter spacing**	
			Post No.	**Unail/Kg**	**Post No.**	**Unail/Kg**
1	100	94.00	50.00	3.00	40.00	3.00
2	200	188.00	100.00	6.00	80.00	5.00
3	300	283.00	150.00	9.00	120.00	8.00
4	400	377.00	200.00	12.00	160.00	10.00
5	500	471.00	250.00	15.00	200.00	12.00
6	600	565.00	300.00	18.00	240.00	15.00
7	700	659.00	350.00	21.00	280.00	17.00
8	800	754.00	400.00	24.00	320.00	20.00
9	900	848.00	450.00	27.00	360.00	22.00
10	1000	942.00	500.00	30.00	400.00	24.00

STANDARDS:

1	Barbed wire (12 gauge) per kg	6 meters
2	“U” Nail (8 gauge) 5 cm per kg	100 nos (standard)
3	3.75 cm per kg	125 nos
4	Fencing post truck load	200 nos
5	Barbed wire truck load (DCM)	4.5 tons
6	Sand truck load	8 cubic meter
7	Leaf mould truck load	8 cubic meter
8	Manual transportation of truckload of leaf mould within 1 km	Nu.6650.00

Root Balling

Generally, large size saplings are rarely raised in the forest nurseries. During adhoc landscaping activities, plants are usually root balled from the forest for instant greening. It is recommended to carry out rootballing activities before the sprouting of new leaves.

For pole size trees, it is advisable to root ball the plants and keep it in the same pit for a season to get hardened. Intensive care must be taken to keep the root ball soil intact during handling. All this process shall ensure achieving higher success rate (Figure 8.5).

Table 8.25 Root Balling and Live Cuttings Rates for Plantations

Sl. No	Items of work minimize	Nos	Unit	Unit-Cost
1	**Trees root balling and collection.** All unit cost includes extraction, packing, manual carriage to road head, loading and unloading			
	Trees size (1.1m to 2.4m height x 1 to 2.4 inch girth at breast height)	1	No	Nu. 500.00
	Trees size (2.5 to 2.9m height x 2 to 2.5 inch girth at breast height)	1	No	Nu. 1000.00
	Trees size (3 to 4m height x 2.6 to 4 inch girth at breast height)	1	No	Nu. 1,500.00
	Cost of hassen cloth per square meter	1	M^2	Nu. 40.00
	Cost of soothly rope	1	Kg	Nu. 90.00
	Cost of jute rope per per kilogram	1	Kg	Nu. 140.00
	Machanical transportation of root balled trees. One truckload carry-15 trees (sizes of 1.5 to 4 m height and 1 to 4 inches dia.).	1	T/L	Depending on local transportation rate as per the distance.
2.	**Planting root balled trees.**			
	Pit digging (Pit size 80 x 80 x 80cm)			
	Hard soil	1	Pit	Nu. 84.00
	Soft soil	1	Pit	Nu. 42.00
	Planting of root ball trees include manual carriage of root ball from road head to plantation sites; Application of manure, back filling of soil and making of 'Thallies' (2m dia) for watering.	1	Pit	Nu. 63.00
	Providing materials like bamboo and sticks for the prop breast height.	1	No	Nu. 20.00
	Making prop with bamboo and sticks at 2 to 3 meters long.	1	No	Nu. 10.00
	Manure such as top fertile soil and leaf mould as per the existing market rate.	1	T/L	
	All sizes (Manual carrying beyond 300ft uphill and 600ft downhill of motorable road for plantation)	1	No	Nu. 225.00
3.	**Bush root balling collection**			
	Bush sizes (0.5 to 0.9 m height)	1	No	Nu. 125.00
	Bush sizes (1 to 1.4 m height). All men days includes extraction, packing and manual carriage to road head, loading and unloading.	1	No	Nu. 250.00

	Transportation = 60 nos bushes = one truckload as per existing transportation rate.			
4	**Bush root balling plantation**			
	Pit digging (40 x 40 x 40 cm)			
	Hard soil	1	Pit	Nu. 42.00
	Soft soil	1	Pit	Nu. 21.00
	Bush plantation includes manual carriage of root ball from road head to plantation site; application of manure, back filling of soil and making of thallies (1m dia) for watering. Manual carriage and planting of all sizes bush within 300ft uphill and 600ft downhill of motorable road.	1	No	Nu. 50.00
5	**Willow cutting**			
	Cutting, collection, carriage, pit digging and planting of Salix cutting of 8ft length and 5 Inches and above girth.	1	Feet	Nu. 33.00
	Machanical transportation of Salix cutting One truck load=350 Salix cuttings. Transportation cost shall depend on prevailing rate.	1	T/L	

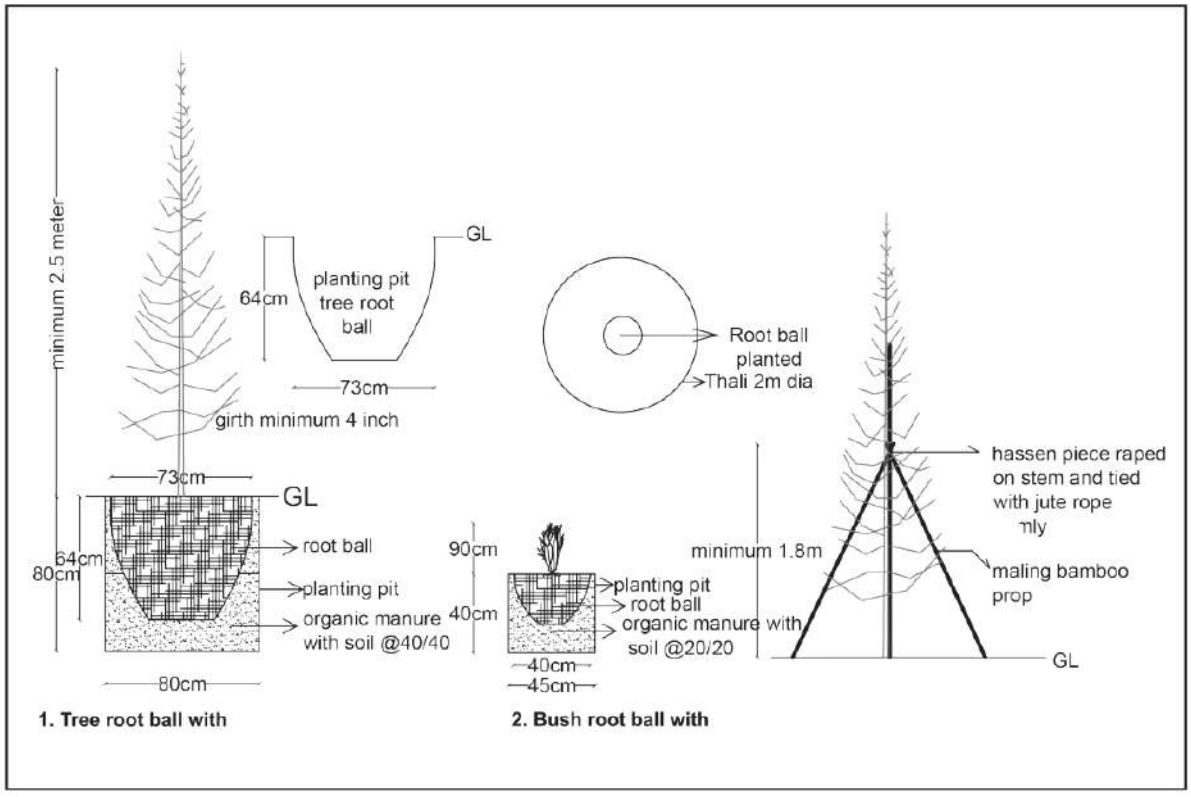


Figure 8.5 Guidelines for root balling plantation of trees and bushes

8.5. Monitoring and Evaluation (M & E)

Monitoring and Evaluation (M&E) is one of the essential components in the plantation program to measure the overall output or progress and achievement of the implementing agencies through assessment of the survival rate of seedlings. It also enables identifying constraints, issues and lessons to be learnt on regular basis and offer alternative rectifying measures for improvement. Periodic field evaluation also facilitates in validating plantation database.

8.5.1 Objective

Plantation shall be created with clear objectives and long-term purposes. The general objectives of plantation and nursery M&E are to:

- verify whether the plantations and nurseries are raised as per the technical estimates and specifications;
- evaluate the status and survival percentage of the plantations and nurseries;
- provide recommendations/rectifications for improvement; and
- update the plantation and nursery record of Bhutan on annual basis for future reference.

8.5.2 Periodicity

All forest plantations and nurseries are subjected to M&E at different period of establishment at two levels. Monitoring of the plantation starts from planting the seedling till it established depending upon ecological sites.

- At the implementing level, the concerned implementing agencies shall conduct M&E annually by forming a team from different stakeholders. The implementing agencies at the field levels are field offices, GBCL, NRDCL and other field implementing agencies/stakeholders. The annual M&E report for plantation and nursery shall be submitted to DoFPS.
- At the Department level, the entire plantation and nursery; irrespective of the agencies responsible for creation shall be subjected to M&E by SFED every 2-3 years.

Box 8.2 Prerequisite for Plantation/Nursery Monitoring and Evaluation

Prerequisite for Plantation/Nursery Monitoring and Evaluation

- Monitoring standard (objective, methods, expected outcome, etc),
- Work plan with time line,
- Geo-reference points,
- Shape file and location map,
- Plantation/Nursery Journal,
- Tools and equipment,
- Recording format,
- Notebook,
- Pen/Pencil,
- Eraser,
- GPS,
- Measuring tape,
- Calculator,
- Camera,
- Manpower

8.5.3 Methodology and Approaches for M&E

8.5.3.1 Sampling Methods and Intensity

The systematic and random sampling method shall be used for monitoring and plantation survival.

At least 2% and 5 % of the plantation area shall be surveyed for annual & mid-term and final evaluation respectively. Mid-term evaluation shall be done at the end of 2nd year from the year of creation of the plantation while the final evaluation shall be done at the end of fifth year.

However, for any plantation, the minimum number of plots for survival assessment is provided in Table 8.26.

Table 8.26 Sampling intensity for evaluation of plantation

Area (ha)	No. of sample		Area (ha)	No. of sample	
	Annual (2%)	Final evaluation (5 %)		Annual (2%)	Final evaluation (5 %)
1	1	2	31	28	69
2	2	4	32	28	71
3	3	7	33	29	73
4	4	9	34	30	76
5	4	11	35	31	78
6	5	13	36	32	80
7	6	16	37	33	82
8	7	18	38	34	84
9	8	20	39	35	87
10	9	22	40	36	89
11	10	24	41	36	91
12	11	27	42	37	93
13	12	29	43	38	96
14	12	31	44	39	98
15	13	33	45	40	100
16	14	36	46	41	102
17	15	38	47	42	104
18	16	40	48	43	107
19	17	42	49	44	109
20	18	44	50	44	111
21	19	47	51	45	113
22	20	49	52	46	116
23	20	51	53	47	118
24	21	53	54	48	120
25	22	56	55	49	122
26	23	58	56	50	124
27	24	60	57	51	127
28	25	62	58	52	129
29	26	64	59	52	131
30	27	67	60	53	133

Two sampling methods are recommended for the survival assessment of the plantations

Line transect and plot sampling

Line transect sampling offers an efficient way to monitor many species. Using the principles of line transect, design a line transect of variable length[1] For the plantation survival assessment, a line transects of variable length spaces at 50m, 100m, 200m, 300m, 400m and 500m depending on the area of the plantation.

[1] Line is not used for analysis of data and it is used only to aid to locate the plots

For each line transect, randomly layout a first 15m x 15m square plot from the edge of the boundary of plantation (similar to regeneration survey in FMUs) (Figure 8.6). The subsequent plots shall be established after every 70 meters in same direction. The line spacing between two transect should be 70 m.

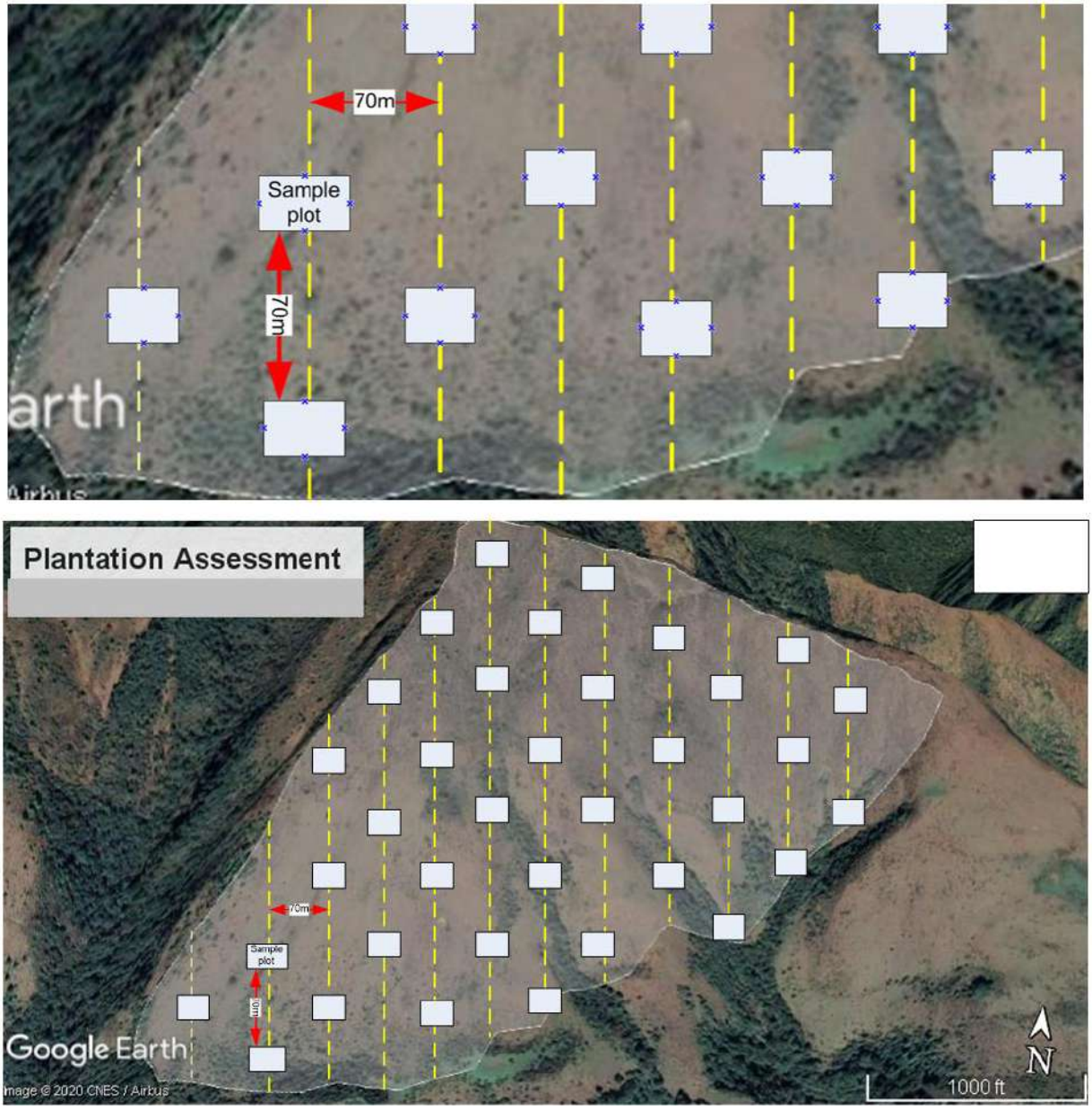
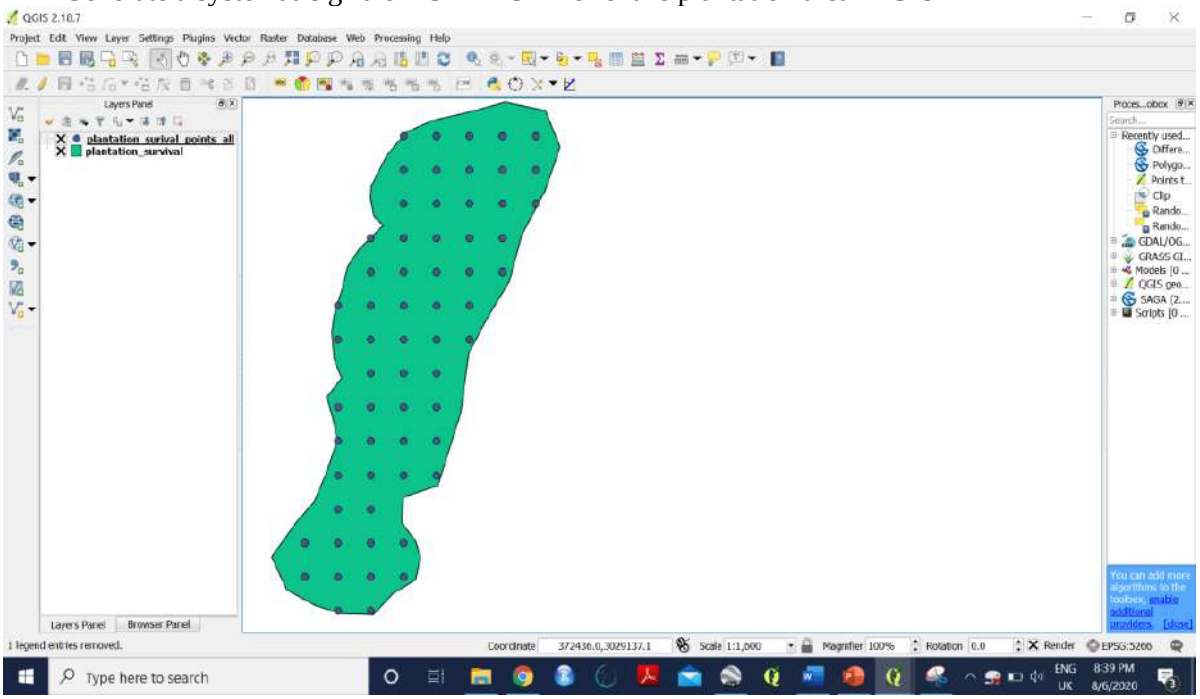


Figure 8.6 Laying of transect

The surviving seedling in each plot shall be counted and recorded in the data collection sheet (Table 8.27).

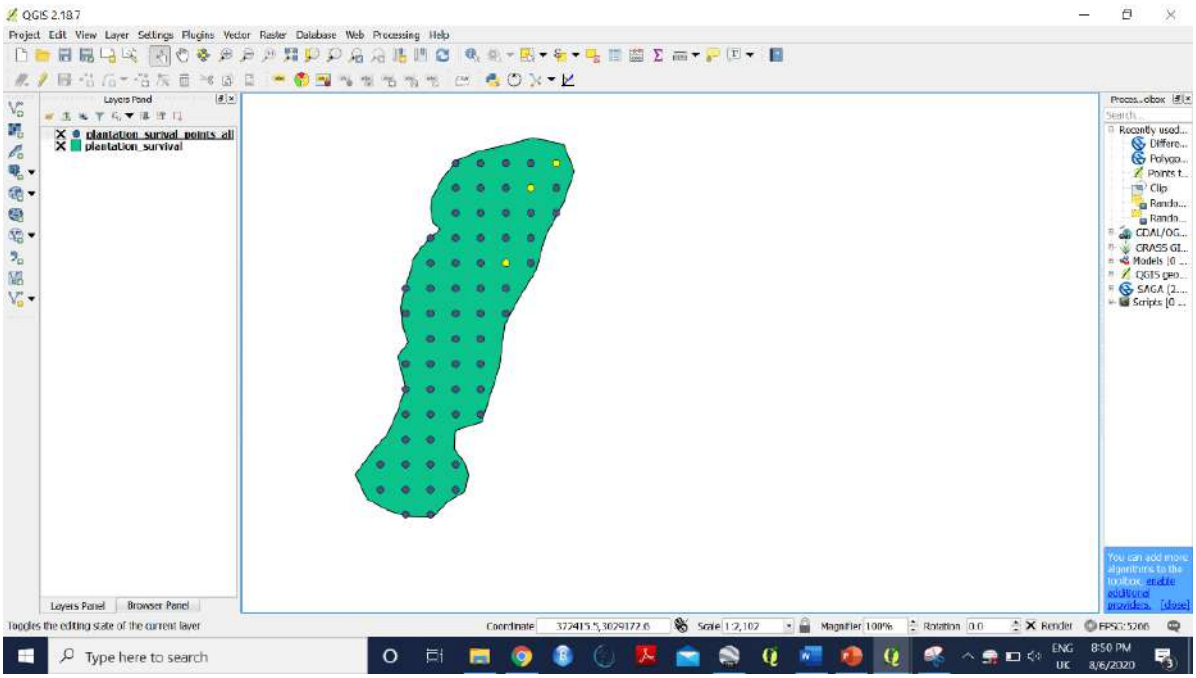
Systematic grid and random plot sampling

- Generate a systematic grid of 15m x 15 m for entire plantation area in GIS

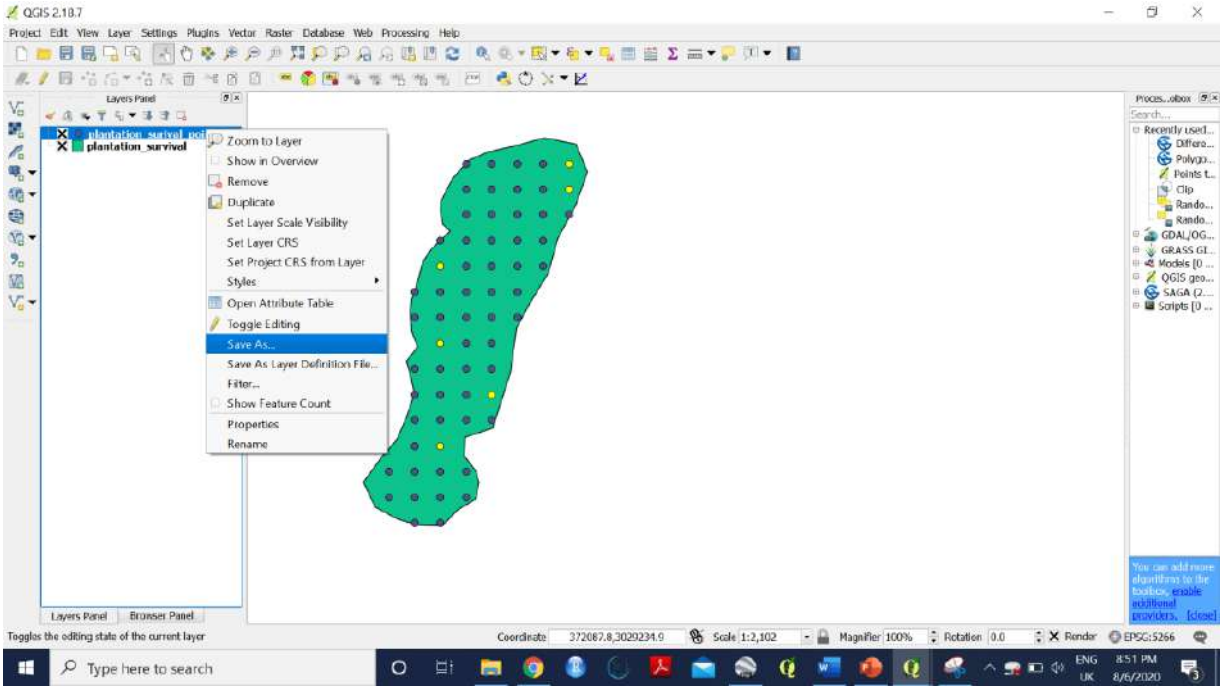


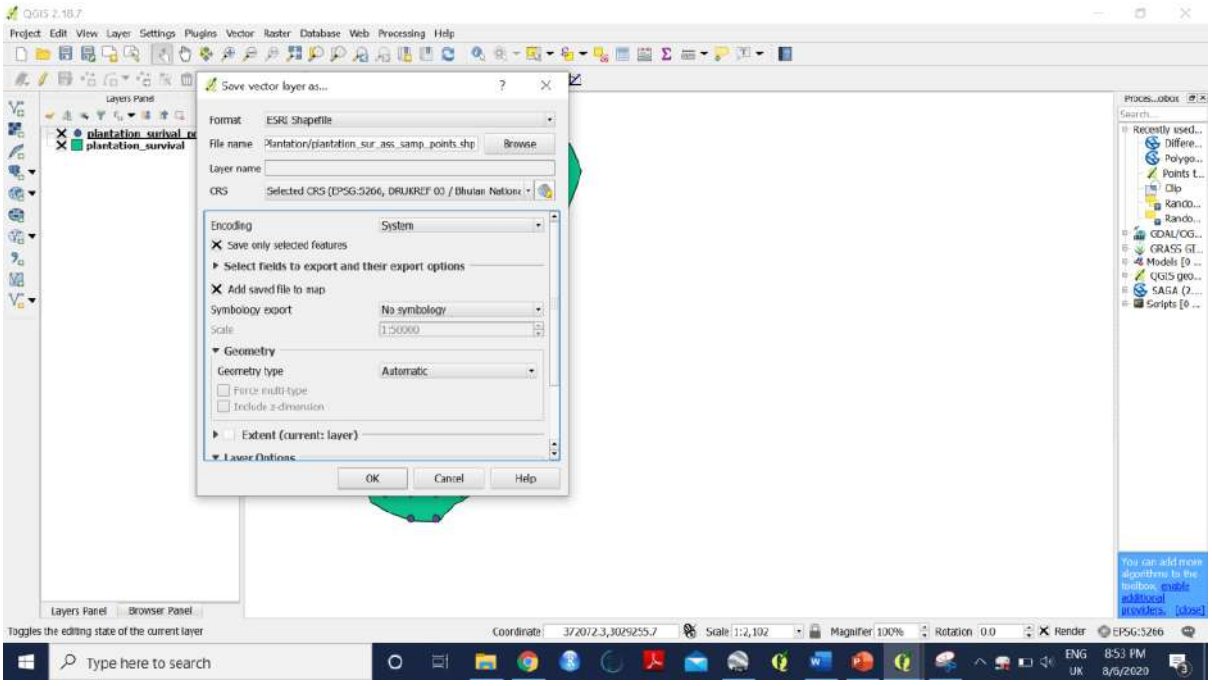
- Determine the number of plots required for survival assessment based on the area of the plantation (sampling intensity of 2% or 5 % as prescribed in Table 8.26)

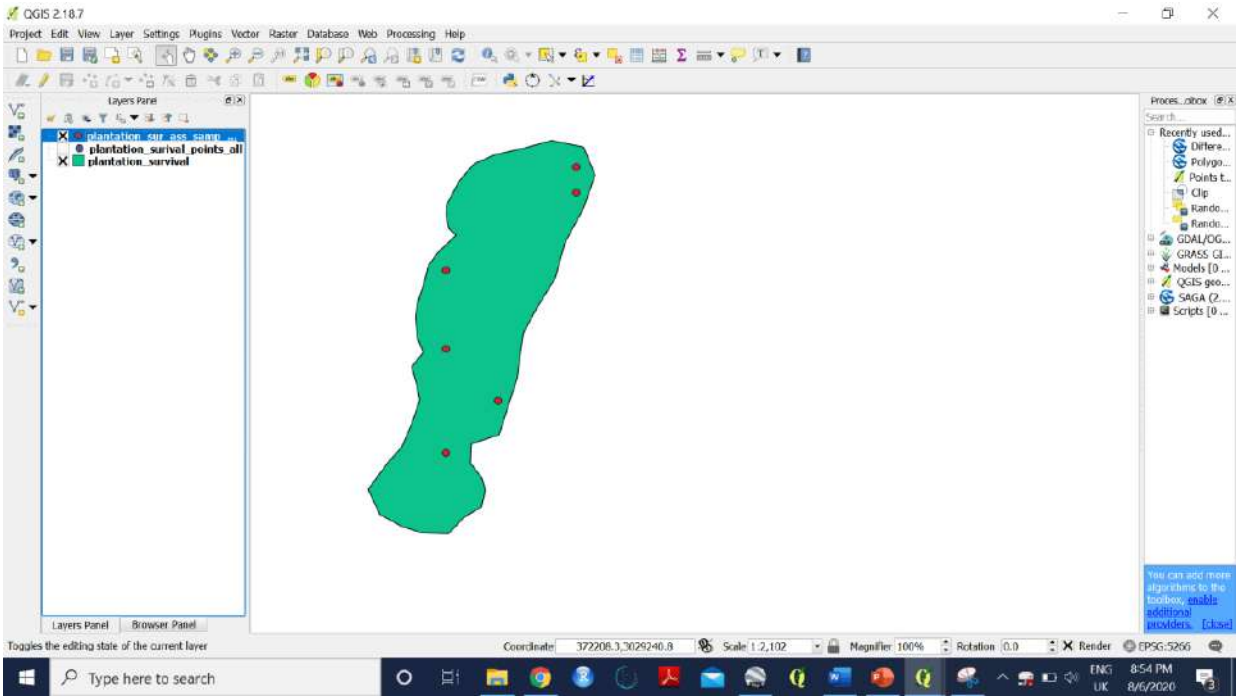
- Select on random point from the grid (either using GIS or random number generator in the excel). For example, select three plots or six plots



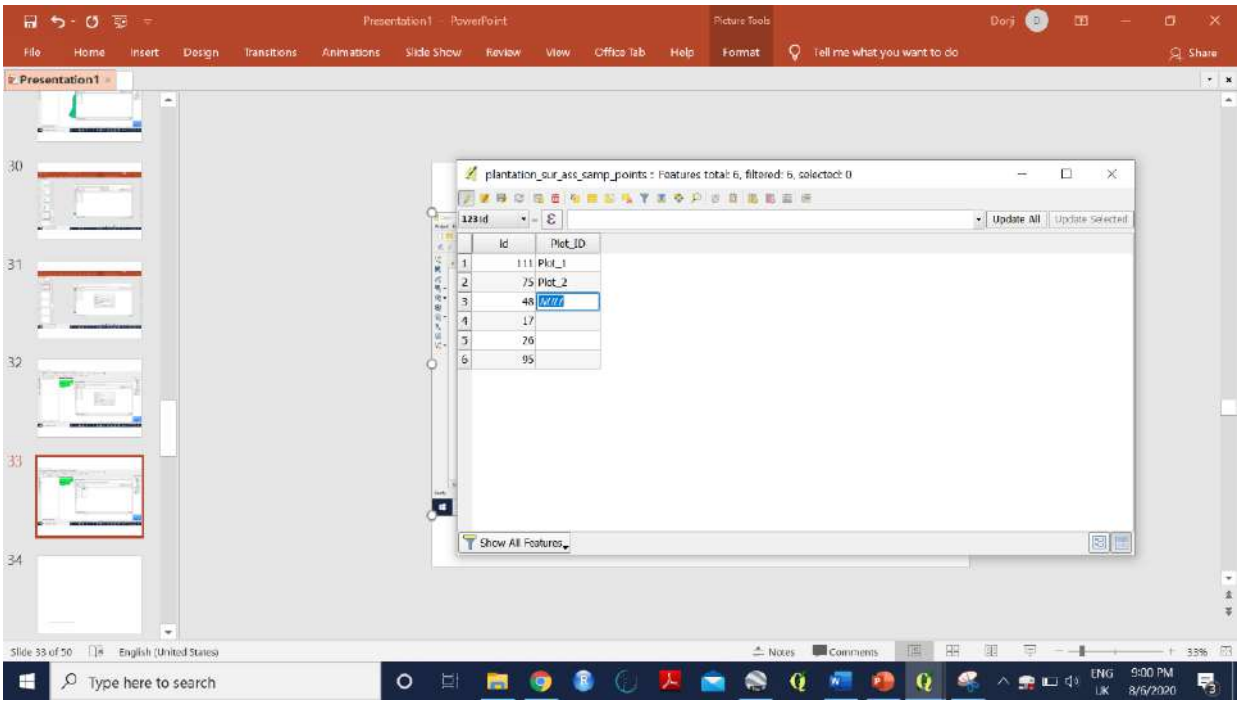
- Save the randomly selected number of plots as shapefile (in QGIS right click on the existing layer, select save as, name the file, select features only, then click Ok)



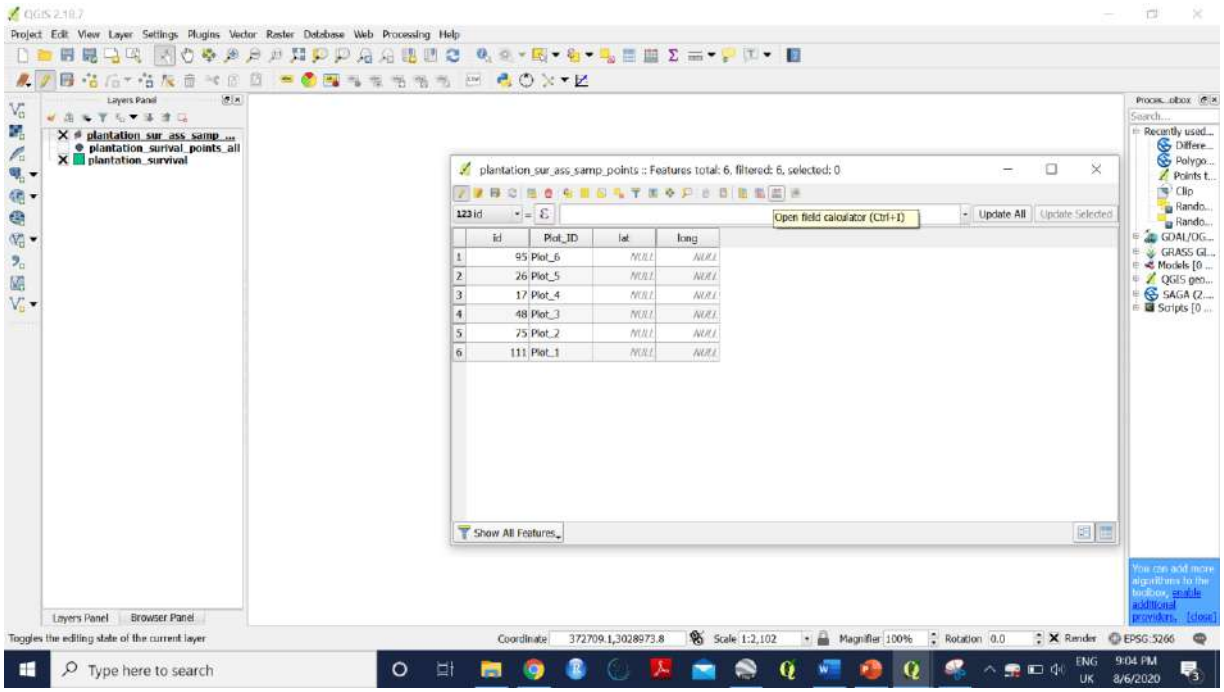


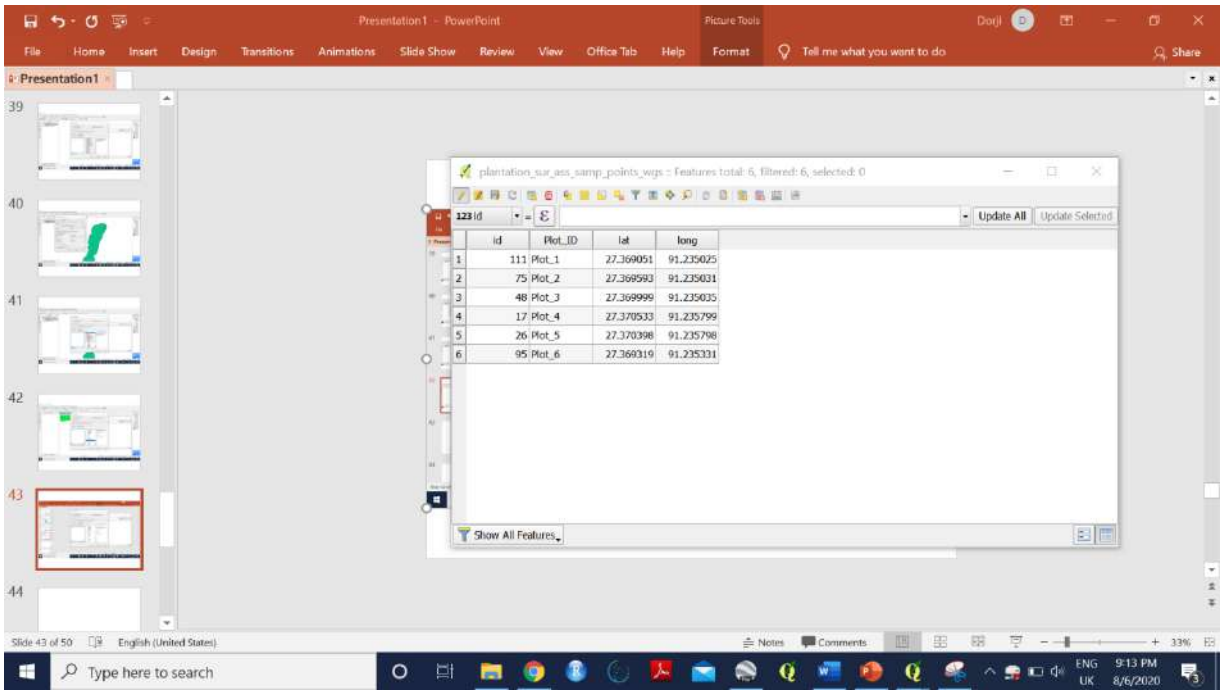


- Assign plot number to newly created point shapefile (load the point layer, open attribute file and assign the plot number by adding new field and using field calculator in QGIS or type manually)



Add lat and long attribute to attribute table by adding field and generate coordinates by using field calculator.





- Export the plot in GPS format and upload on the GPS for locating the plot. In the QGIS, right click on the layer, click on the save as and in the file format, select GPS format and save the layer.
- Use GPS to locate the plots and the coordinate of the GPS shall be used as one corner of the plot. From that corner measure 15m to north and 15m to east to form rectangular plot
- Collect the data and record in the table

Table 8.27 Plantation Survival Assessment

Plantation Survival Assessment			
Division Office:		Plantation Location Name:	
Range Office:		Plantation area (ha):	
Beat Office:		Plantation Year:	
Monitoring Team (Name):		Plantation spacing:	
Monitoring Date:		Plot Area:	
Sl. No	**Plot No.**	**Species**	**Count**
Total			

8.5.3.2 Basis for Calculating number of Sample Plots

2% sampling intensity in 1hectare area. = 10000m^2 (1 hectare) = 2% of 10000m^2 = 200m^2 = 200/sample plot area of 15mx15m = 200/225 (number of sample plots in 1 hectare) = 0.89 (equivalent to 1 sample plot)	OR	2% sampling intensity in 1hectare area. = 10000m^2 (1 hectare) = 225m^2 (15x15m sample plot) = 10000/225 (number of sample plots in 1 hectare) = 44.44 plots in 1 hectare = 2% of 44.44 sample plots = 0.89 (equivalent to 1 sample plot)

8.5.3.3 Formula to Calculate Survival Percentage

$$\text{No. of seedlings in a plot} = \frac{\text{Size of plot}}{Plant\ to\ Plant\ distance} \quad (12)$$

$$\text{No. of seedlings in a plot } = \frac{No.\ of\ surviving\ seedling\ in\ plot}{No.\ of\ seedling\ in\ a\ plot}\ x\ 100 \quad (13)$$

$$Average\ survival\ \%\ of\ the\ site\ = \frac{Sum\ of\ surviving\ \%}{Number\ of\ plots\ surveyed} \quad (14)$$

8.5.3.4 Grading of Plantation Performance based on Survival Percentage

Grading of plantation performance based on survival percent			
Sl. No	Survival percentage	Ranking code	Grade
1	Above 76	A	Very Good
2	51-75	B	Good
3	26-50	C	Satisfactory
4	Below 25	D	Poor/Failure

8.5.3.5 Quick references to survival percentage based on plant to plant spacing in15 by 15meter sampling plot

1.5 by 1.5 meter		2 by 2 meter		2.5 by 2.5 meter		3 by 3 meter		3.5 by 3.5 meter		4 by 4 meter	
Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent
0	0	0	0.0	0	0.0	0	0	0	0	0	0
1	1	1	1.8	1	2.8	1	4	1	5.6	1	7.1
2	2	2	3.6	2	5.6	2	8	2	11.1	2	14.3
3	3	3	5.4	3	8.3	3	12	3	16.7	3	21.4
4	4	4	7.1	4	11.1	4	16	4	22.2	4	28.6
5	5	5	8.9	5	13.9	5	20	5	27.8	5	35.7
6	6	6	10.7	6	16.7	6	24	6	33.3	6	42.9
7	7	7	12.5	7	19.4	7	28	7	38.9	7	50.0
8	8	8	14.3	8	22.2	8	32	8	44.4	8	57.1
9	9	9	16.1	9	25.0	9	36	9	50.0	9	64.3
10	10	10	17.9	10	27.8	10	40	10	55.6	10	71.4
11	11	11	19.6	11	30.6	11	44	11	61.1	11	78.6
12	12	12	21.4	12	33.3	12	48	12	66.7	12	85.7
13	13	13	23.2	13	36.1	13	52	13	72.2	13	92.9
14	14	14	25.0	14	38.9	14	56	14	77.8	14	100.0
15	15	15	26.8	15	41.7	15	60	15	83.3		
16	16	16	28.6	16	44.4	16	64	16	88.9		
17	17	17	30.4	17	47.2	17	68	17	94.4		
18	18	18	32.1	18	50.0	18	72	18	100.0		
19	19	19	33.9	19	52.8	19	76				
20	20	20	35.7	20	55.6	20	80				
21	21	21	37.5	21	58.3	21	84				

1.5 by 1.5 meter		2 by 2 meter		2.5 by 2.5 meter		3 by 3 meter		3.5 by 3.5 meter		4 by 4 meter	
Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent
22	22	22	39.3	22	61.1	22	88				
23	23	23	41.1	23	63.9	23	92				
24	24	24	42.9	24	66.7	24	96				
25	25	25	44.6	25	69.4	25	100				
26	26	26	46.4	26	72.2						
27	27	27	48.2	27	75.0						
28	28	28	50.0	28	77.8						
29	29	29	51.8	29	80.6						
30	30	30	53.6	30	83.3						
31	31	31	55.4	31	86.1						
32	32	32	57.1	32	88.9						
33	33	33	58.9	33	91.7						
34	34	34	60.7	34	94.4						
35	35	35	62.5	35	97.2						
36	36	36	64.3	36	100.0						
37	37	37	66.1								
38	38	38	67.9								
39	39	39	69.6								
40	40	40	71.4								
41	41	41	73.2								
42	42	42	75.0								
43	43	43	76.8								
44	44	44	78.6								

1.5 by 1.5 meter		2 by 2 meter		2.5 by 2.5 meter		3 by 3 meter		3.5 by 3.5 meter		4 by 4 meter	
Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent
45	45	45	80.4								
46	46	46	82.1								
47	47	47	83.9								
48	48	48	85.7								
49	49	49	87.5								
50	50	50	89.3								
51	51	51	91.1								
52	52	52	92.9								
53	53	53	94.6								
54	54	54	96.4								
55	55	55	98.2								
56	56	56	100.0								
57	57										
58	58										
59	59										
60	60										
61	61										
62	62										
63	63										
64	64										
65	65										
66	66										
67	67										

1.5 by 1.5 meter		2 by 2 meter		2.5 by 2.5 meter		3 by 3 meter		3.5 by 3.5 meter		4 by 4 meter	
Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent
68	68										
69	69										
70	70										
71	71										
72	72										
73	73										
74	74										
75	75										
76	76										
77	77										
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79	79										
80	80										
81	81										
82	82										
83	83										
84	84										
85	85										
86	86										
87	87										
88	88										
89	89										
90	90										

1.5 by 1.5 meter		2 by 2 meter		2.5 by 2.5 meter		3 by 3 meter		3.5 by 3.5 meter		4 by 4 meter	
Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent	Count of surviving seedling, sapling	Percent
91	91										
92	92										
93	93										
94	94										
95	95										
96	96										
97	97										
98	98										
99	99										
100	100										

8.5.3.6 Seasonal Calendar for Plantation Monitoring and Evaluation

MONITORING SEASONAL CALENDAR FOR CREATION OF PLANTATION											Responsible
SN	Activity	1st Year		2nd Year		3rd Year		4th Year		5th Year		
		Jan Aug	Dec Jan	May Aug	Dec Jan	May Aug	Dec Jan	May Aug	Dec Jan	Jan Aug	Dec Jan	
1	Site clearance											CFO, RO, GFO, Unit I/C
2	Alignment and stacking											
3	Spacing maintained											
4	Pit size as per technical sanction											
5	Type of seedlings											
6	Quality of seedlings											
7	Fencing post											
8	Barbed wire strand maintained											
9	Information maintained											
	a). Plantation Journal											
	b). Work measurement book											
	c) Sign board											
10	Others (specify)											
	a).											
	b).											
	c).											
	d).											

MONITORING SEASONAL CALENDAR FOR MAINTENENCE OF PLANTATION												
1	Weeding											CFO, RO, GFO, Unit I/C
2	Cleaning											
3	Fencing repair											
4	Casualty replacement											
	a). Quantity of seedlings											
	b). Types of species											
	c). Quality of seedlings											
5	Others (specify)											
	a).											
	b).											
	c).											
	d).											

8.5.3.7 Seasonal Calendar for Plantation Evaluation

SEASONAL CALENDAR FOR PLANTATION EVALUATION				
SN	Activity	Midterm Assessment 3rd Year	Final Evaluation 5th Year	Responsible
		Nov-Feb	Nov-Feb	
1	Survival rate			SFED, Field Office, GBCL, NRDCL, and Funding Agency
2	Growth information			
3	Biotic pressure			

4	Maintenance (weeding and cleaning)			
5	Casualty replacement			
6	Need for fencing repair			
7	Choice of species			
9	Pest and diseases			
10	Plantation journal			
10	Others (specify)			
	a).			
	b).			
	c).			
	d).			
	e).			
	f).			
	g).			

Use seasonal calendars for strategic planning, execution, timely monitoring and evaluation of the plantation and nursery program.

8.5.3.8 Report Writing for Plantation Monitoring and Evaluation

Summary

Index

1. Background (introduction, objectives)
2. Achievement and discussions
    - 2.1. Plantation Creation
        - Brief write-up based on reporting format 4 for plantation creation.
    - 2.2. Plantation Maintenance
        - Brief write-up based on reporting format 5 for plantation maintenance.
    - 2.3. Plantation Survivability Assessment a- Brief write-up based on reporting format 6 for plantation evaluation.
3. Problems and constraints
    - Problems and constraints observed and received during the process of implementation.
4. Lessons learnt and feedback
    - Lessons learnt and feedbacks from the implementation.
5. Recommendations
    - Way forward suggestions and recommendations.
6. Conclusion

8.5.4 Monitoring template

The Methodology and Approaches for M&E shall be used to conduct M&E. The detailed process of M& E shall be conducted using the forms and templates for M & E explained in this section.

8.5.4.1 General Information

The general information which could be filled in from the technical sanctions, estimates and document shall be done prior to field visit in the format below:

Table 8.28 General information on Plantation

<table>
<tr><td colspan="4">General Information Sheet</td></tr>
<tr><td colspan="4">Name of Plantation:</td></tr>
<tr><td colspan="4">Objectives of plantation:</td></tr>
<tr><td rowspan="2">Creation Year (DDMMYYYY):</td><td colspan="3">Area (hectare):</td></tr>
<tr><td colspan="3">Altitude:</td></tr>
<tr><td>Financial Year:</td><td colspan="3">Aspect:</td></tr>
<tr><td>Division/PA:</td><td colspan="3">Slope percent:</td></tr>
<tr><td>Range/PA name:</td><td colspan="3">Soil types:</td></tr>
<tr><td>Dzongkhag:</td><td colspan="3">Fund source:</td></tr>
<tr><td>Gewog:</td><td colspan="3">Expenditure (Nu.):</td></tr>
<tr><td>Type of plantation:</td><td rowspan="2">Point reference with plantation area map</td><td>Northing:</td></tr>
<tr><td>Location name:</td><td>Easting:</td></tr>
<tr><td colspan="4">Existing forest types in the surrounding area:</td></tr>
<tr><td colspan="4">Species planted:</td></tr>
<tr><td colspan="4">Brief description of the plantation site:</td></tr>
<tr><td colspan="4">Remarks on new plantation:</td></tr>
</table>

The printed or scanned copy of this information sheet can be used as check list while monitoring and evaluation of the plantation. Always make a copy and use background information during field visit and assessment of the plantation.

8.5.4.2 Regular Monitoring, Evaluation and Reporting

All implementing field offices and relevant stakeholders shall carry out regular M&E of the plantation creation and maintenance works (Table 8.29). The focus of this exercise shall be to assess, verify and ensure that the following inputs/criteria are delivered in the afforestation and reforestation programmes as per the technical regulations.

- Selection/identification of feasible plantation and nursery sites,
- Site clearance including weeding and cleaning,
- Quality of seedlings and planting pits,
- Choice of species and composition,
- Casualty replacement,
- Fencing and replacement of fencing materials,
- Survival percentage,
- Growth information and condition of species planted, Biotic and abiotic interference and suggestive measures, any unforeseen problems, etc.

Table 8.29 Regular Plantation Monitoring and Evaluation

Format-2: Regular Plantation Monitoring and Evaluation

Regular Plantation Monitoring and Evaluation Sheet					
Year of plantation maintenance (tick)	1st [ ]	2nd [ ]	3rd [ ]	4th [ ]	5th [ ]
Date of visit (DMY)	:	:	:	:	:
Species planted/ casualty replacement:					
General observations (tick or mark Yes or No	Excellent	Very Good	Good	Poor	Very Poor
1. Overall survival					

2. Fencing repair					
3. Weeding/ cleaning					
4. Seedling/Casualty refilling					
5. Anthropogenic pressure					
6. Cattle pressure					
7. Others (specify)					
i).					
ii).					
iii).					
iv).					
Any human wildlife conflict:					
Any feedback received from the implementers:					
Comments/suggestion for improvement:					
Monitoring team members:					

Name and signature of the monitoring team leader

8.5.4.3 Midterm and Long-term Plantation/Nursery Evaluation and Reporting

Monitoring and evaluation of plantation shall be either synchronized with monitoring of activities of any areas-based management plan or shall be done as and when deemed necessary by SFED for areas falling outside any management regimes.,

- All respective Field Offices shall conduct midterm and final evaluation (survival assessment) of the plantations as per Table 8.30.
- The evaluation team along with the implementing agencies shall judge the success of plantation/nursery (annual/midterm evaluation) and further recommend if any remedial measures are required,
- The annual/midterm and final evaluation reports shall be submitted to the Department/SFED (Table 8.31, Table 8.32 and Table 8.33)
- The evaluation reports which require technical intervention shall be presented to the Technical Advisory Committee (TAC) of the Department for further review and strategic planning and implementation by SFED.
- This information shall be updated in FIRMS and/or electronic excel sheet database and update information after every field visit and report to the Department/SFED.

Table 8.30 Midterm and Long-term Plantation Evaluation Sheet

Format 3. Annual/ Midterm and Long-term Plantation Evaluation Sheet									
Date: (DMY)	Name of plantation	Location name	Area (hectare)	Plant to plant spacing	No. of live seedling in the sampling plot		Survival percent	Outcome	Impact	Source of verification
					Plot 1			Plantation outcome observed, or result obtained from the implementation of plantation, any differences made in the forest/ environment	Field data, Long-term effect of the plantation or special changes in the environment/ forest through practice of plantation forest management	Field data collection, Annual M&E report 20182019
					Plot 2					
					Plot 3					
					Plot 4					
					Plot 5					
					Plot 6					
					Plot 7					
					Plot 8					
					Plot 9					
Total										
Average										
Justification if survival percentage is below 30 percent:										

Any critical remarks and recommendations (*Reason for failure of plantation (eg., forest fire,pest and diseases, other natural disasters etc., and probable wayforward*) :
Evaluation team members: (1) …… (2) …….. (3) …… (4) …….. (5) …… (6) …… _____

Name and signature of the evaluating team leader:				

8.5.4.4 Reporting Structure for Monitoring and Evaluation of Plantation

Table 8.31 Reporting for Plantation Creation

Format 4. Reporting for Plantation Creation														
Division/ PA	Dzongkhag	Gewog	Name of plantation	Location Name	Range/PA Name	Type of Plantation	Area (ha.)	Creation Cost (Nu.)	Fund Source	Creation Year (DMY)	Implementer	Remarks	Point Reference	
													Northing	Easting

Table 8.32 Reporting for Plantation Maintenance

Format 5. Reporting for Plantation Maintenance												
Division/ PA	Dzongkhag	Gewog	Name of plantation	Location Name	Range/PA Name	Type of Plantation	Area (ha.)	Maintenance Cost (Nu.)	Fund Source	Maintenance Year (DMY)	Implementer	Remarks

Table 8.33 Reporting for Plantation Evaluation

Format 6. Reporting for Plantation Evaluation												
Division/PA	Dzongkhag	Gewog	Location Name	Range/PA Name	Type of Plantation	Area (ha.)	Creation Year (DMY)	Assessment Year (DMY)	Survival Percent	Outcome	Impact	Remarks

8.6. Bibliography

SFED. (2020), *Norms and Standards for Nursery and Plantation-2020*, Social Forestry and Extension Division, DoFPS, MoAF

SFED. (2019), *Guidelines for Monitoring and Evaluation of Plantation and Forest Nursery 2019*, Social Forestry and Extension Division, DoFPS, MoAF

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9. Agroforestry Interventions

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9 Agroforestry Interventions

9.1 Management Context

9.1.1 Background

This *Code* outlines how a proponent should proceed to establish agroforestry sites in their private land or in State Reserve Forest Land (SRFL). Agroforestry systems and practices are multifunctional and provide a wide range of economic, sociocultural and environmental benefits. These systems are primarily categorized into agri-silviculture, agri-horticulture, agri-horti-silviculture, hortipastoral and specialized systems in different agroclimatic regions (Dhyani et al., 2015). In the context of climate change, agroforestry practices as a land use option can help build resilience of small-scale farming communities. The integrated approach to farming can reduce the risk of economic failure by increasing the diversity of production within a farming system.

It can be particularly important for Bhutanese farmers because it generates diverse products and services on a small land holding and it can also create opportunities for small-scale forest-based enterprises. Many of the constraints that farmers face on farm are potentially amenable to agroforestry-based solutions. Agroforestry technologies can not only help reduce land degradation but can also be used to reduce Human Wildlife Conflict and rural poverty by improving household income through increased on-farm production and employment opportunities.

Traditional mixed farming practices in Bhutan are common agroforestry practices as shown in Figure 9.1.

Most of the farmlands are located in close vicinity of natural forests, which are abundant in natural resources essential for livelihood, food and farming. The practice of agroforestry by farmers is likely to depend on two main factors: need and profit (Hocking and Wangdi, 2000).

Some of the notable/traditional agroforestry practiced in Bhutan include:

1. Planting shrubs/trees along the agriculture field boundaries to meet fuel wood and improve soil fertility.
2. Fodder trees planted for livestock and as live fences.
3. Fruit trees planted near homesteads.

Figure 9.1 Traditional Agroforestry site, Dagana

9.1.2 Objectives

Understanding what agroforestry actually is, helps in deriving the purpose of establishing an agroforestry system.

Agroforestry is a land use that involves deliberate retention, introduction of mixture of trees or other woody perennials in crop/animal production fields to benefit from the resultant ecological and economic interactions

The general objective to develop agroforestry systems and practices is to generate diverse products and services on a small land holding. However, depending on the site, multiple benefits can be derived:

- Integration of agriculture, livestock and forestry sector to provide maximum positive interaction through an interdisciplinary approach to sustainable farming
- Ecological stabilization of mountainous terrain and protection of the watersheds
- Restoration of degraded farmland
- Socio economic development of rural communities
- Implement ecosystem-based adaptation to climate change

Figure 9.2 Agroforestry intervention for soil and water conservation

9.2 Roles and Responsibilities

The Department of Forests and Park Services (DoFPS) houses the National Agroforestry program. The Department, in close consultation with other relevant stakeholders, provides the necessary strategic directives and road map for agroforestry practices in the country. Social Forestry and Extension Division (SFED) shall take the lead and coordinate the program activities.

Table 9.1 Roles and Responsibilities

Agency	Roles and responsibilities
SFED	• Process technical clearance (TC) for the establishement of agroforestry sites (Refer Sectione 9.3.1 for details). • Provide strategic directives and develop policies and guidelines relevant to agroforestry in the country • Provide technical guidance in establishing agroforestry sites in the country. • Consolidate information on the traditional agroforestry practices • Monitor the success of the intervention.
Ugyen Wangchuck Institute of Conservation and Environment Research (UWICER)	• Conduct research on agroforestry • Pilot agroforestry sites
Field Offices	• Receive application/proposal for establishement of agroforestry sites • Submit the field assessment report to SFED for TAC approval • Facilitate establishment of agroforestry sites and provide technical support in the sites • Monitor the success of the intervention.
Local Government	• Facilitate the establishment of agroforestry within the local communities, fund mobilization, etc. • Monitor the success of the intervention.

9.3 Citeria

Agroforestry practices can be small, medium and large scale. The categories would primarily depend on the land holding size and not on the number of farmers involved. The categories are primarily developed to ease in clearance processes, guide management priorities and for the equitable distribution of government resources (particularly technical assistance).

Table 9.2 Criteria for Agroforestry sites

Scale	Land Size	Ownership
Small	Upto 2 ha	Individual/Institutions
Medium	2 to 8 ha	Individual/Community groups/ Cooperatives/ Mega farms/ Large scale landholdings/ Institutions
Large	More than 8 ha	Individual/Community groups/ Cooperatives/ Mega farms/ Large scale landholdings/ Institutions

9.3.1 Establishing Agroforestry Sites

The need to establish an agroforestry system could be due to various reasons depending on the benefits. It could be a watershed management prescription to conserve soil and water in the mountainous terrain, reduce human wildlife conflict and at the same time, generate multiple ecological and economic benefits.

Agroforestry sites can be established by different stakeholders such as Private individuals or Government institutions. Agroforestry sites may be established in private registered land by individuals while agroforestry sites shall be established on SRFL only by Government Insitutions for research and education purposes. Agroforestry sites have been established in the country as sites for research, demonstration and pilot sites to understanding the ecological and economic benefit.

This guideline provides the step-by-step procedure on developing agroforestry systems and practices

9.3.1.1 Technical Clearance:

Private individuals may apply for technical clearance if they require technical support and assitance from the Department. The process for availing TC by the is described in Figure 9.3. The proponent shall initiate the first step with the submission of the required documents. The proponent is the interested party seeking to establish agroforestry sites in the country. The field office shall carry out the second step and the last step shall be completed by SFED in consultation with relevant agencies.

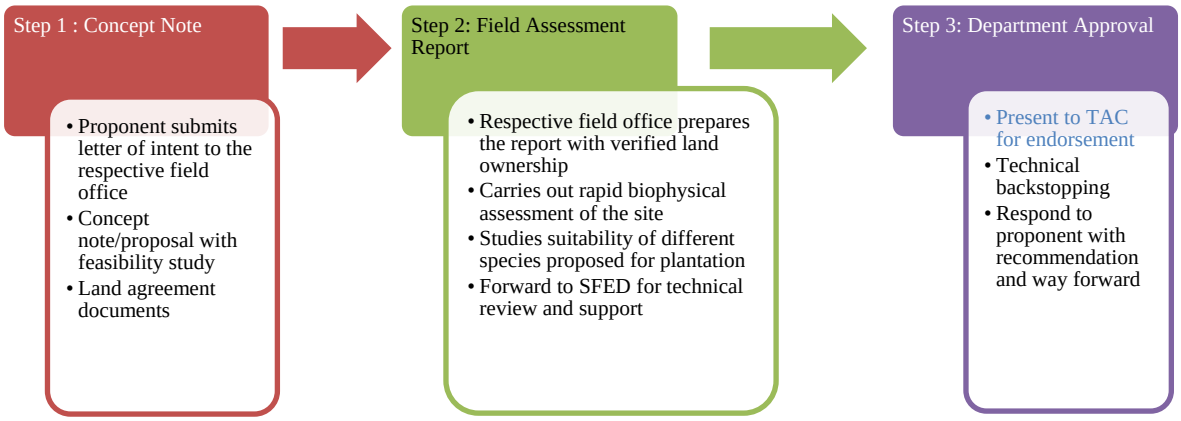

Figure 9.3 Technical Clearance process for the establishing for agroforestry sites

9.3.1.2 Department Endorsement

Apart from the change in policy and policy directives from the Department and Ministry, the following lists are some important basis for the Department to consider during endorsement;

1. If the proposed site is already listed as an existing agroforestry site;
2. If it has been recommended in other area-based management plans; and
3. If previous projects were implemented in the proposed site. (*The previous projects do not necessarily have to be specifically linked to agroforestry. Agroforestry could be one of the land uses options in any other land use plan.)*

As reflected in the field assessment report submitted by the field office, SFED shall seek assistance from FRMD to develop the map showing the different area-based management plans in the agroforestry site or in its vicinity. The following table shall be compiled in the process.

Table 9.3 Land Characteristics of proposed agroforestry site

Management Category	**Area (Ha)**	**% of total area**
Community Forest		
Forest Management Unit		
Local Forest Management Areas		
Etc., (list other management Regimes, if any)		
Other SRFL		
Grand total		100%

9.3.1.3 Management Priorities

Priority for technical assistance in establishing an agroforestry site and other management interventions shall be provided to proposals originating from farmer groups/community groups and not restricted to the

size of the farm. And priority shall also be given to medium and large-scale agroforestry farms. Individual proposals for small-scale farms shall be recommended for formation of groups in the same proximity.

The Department shall encourage the formation of agroforestry groups, especially for small-scale farms in close proximity to create a medium or large-scale agroforestry site. This initiative shall be encouraged through the Local Government. This shall encourage individual farmers in close proximity to work together for a landscape level intervention through agroforestry practices.

9.4 General Procedures in Establishing an Agroforestry Site

The development of an agroforestry site is voluntary. In the event, the proponent requires any technical support, the Department shall provide the necessary technical guidance to design, adapt and establish agroforestry systems in the country as per the roles, responsibilities and criteria provided in this guideline.

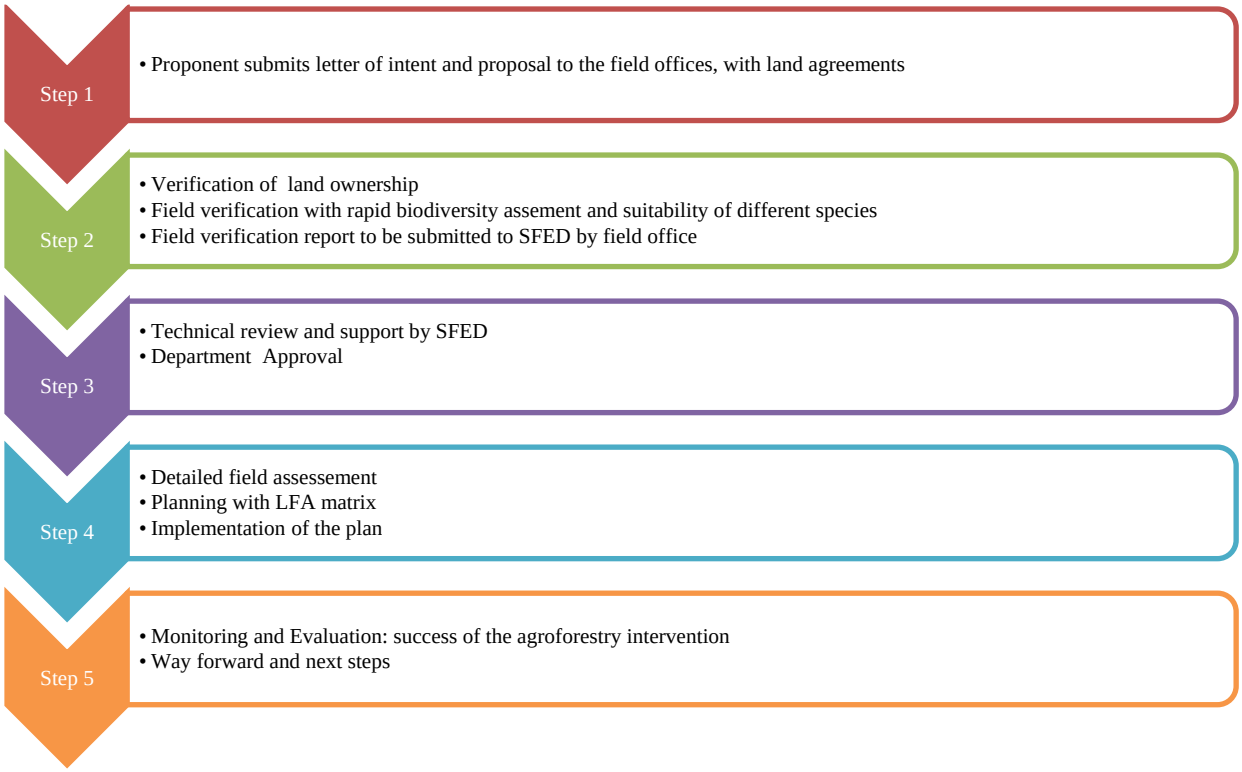

Figure 9.4 Step by step process for establishment of Agro Forestry Site

This procedure is an elaborated version of the TC procedure as outlined in the previous section. While all agroforestry sites proposed in the SRF by Government institutions should follow all the steps mentioned in Figure 9.4, agroforestry sites proposed in private registered land may follow Step 4 and Step 5 for effective management of the site.

While Step 1 through 3 is explained, the remaining steps (Step 4&5) are elaborated further in the following sections and shall be required for the sustainable management of all agroforestry sites in the country. A good preliminary assessment and analysis shall save a lot of time and resources in the planning process. The information that are gathered and analyzed here can be further improved and changed to suit the planning and management purposes. The identification of the gaps shall help in providing the terms and reference for the next step.

9.5 Management Planning Process

The following steps shall provide the necessary technical guidance in developing a Management plan for an agroforestry site in the country. It is the elaborated version of Step 4 in establishing an agroforestry site in the country. Although there is no need to follow a traditional management planning process, the following steps shall help make informed decisions and reduce the unintended consequences during

implementation. The development of a timeline in the plan shall help maximize the chances of success of the agroforestry practice, as landowners can better envision how to successfully integrate agroforestry practices in their farm.

A management action plan is important to have but not a mandatory requirement for all agroforestry sites in the country. It is especially important for medium and large-scale agroforestry sites. However, management action plans for agroforestry sites in SRFL is required and shall be the basis for monitoring and evaluation of the sites for the next approval cycle. The time frame of the action plan shall be of 5 years cycle. Figure 9.5 shows the different steps involved in management planning process and are elaborated in the following sections.

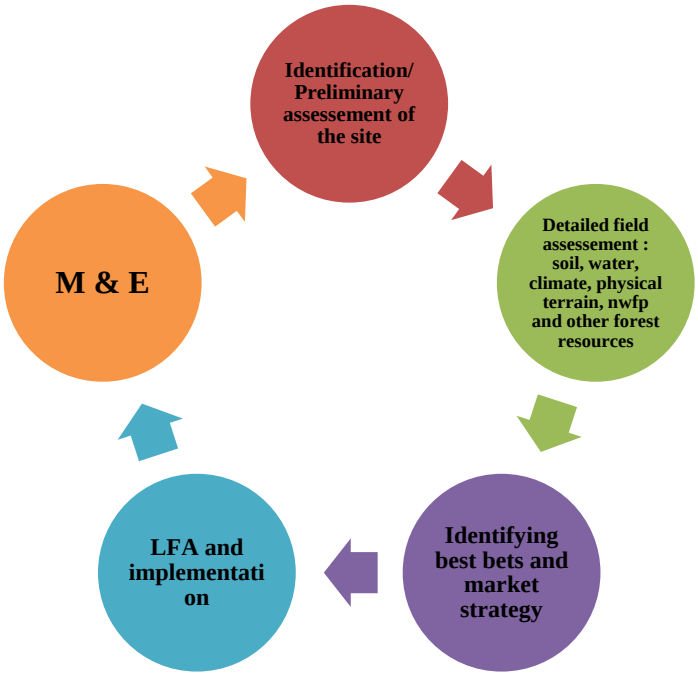

Figure 9.5 Managment Planning process

9.5.1 Identification of Potential Agroforestry Sites and Preliminary Assessment

The first step in establishment of any agroforestry site is the selection or identification of the site. The potential agroforestry sites can be in private land or in SRFL. It can be leased commercial agricultural lands, mega farms, institutional agricultural lands and other permanent research sites.

The proponents shall submit a request to the field offices for establishment of an agroforestry site. The letter of intent with a preliminary feasibility study and concept note/proposal shall be submitted with relevant supporting documents to the respective field office, which shall be one of the conditions for the Department to approve the proposal. The preliminary assessment shall include the initial objective and priorities of the agroforestry site with land lease agreements. Upon receipt of proposal from the proponent, the concerned field offices shall check whether;

1. the proposed site is listed as an existing agroforestry site;
2. it has been recommended in other area-based management plans; and
3. previous projects were implemented in the proposed site. (*The previous projects do not necessarily have to be specifically linked to agroforestry. Agroforestry could be one of the land use options in any other land use plan*).

The application for TC with endorsement of the Department is then processed. So, the first step in the management planning process takes into account the first three steps of Figure 9.4.

The following tools shall also be used for the detailed field assessment but are key steps to follow during the identification of potential agroforestry sites:

1. Conduct a transect walk along the agricultural landscapes to understand land utilization patterns, land holding size, terrains, agro ecological conditions, climate and hydrogeology and adjoining communities etc. Additional information can be gathered during focus group discussions. It shall also help in availing the derivative goals and objectives of establishing the agroforestry system.
2. Using PRA tools, develop a detailed land use and resource map of the proposed area. A detailed Land Use Land Cover (LULC) map using GIS is required. At the later stage, during monitoring and evaluation of the proposed site, it can help in establishing a baseline for evaluation. It can also help in identifying the management interventions.
3. Participatory Rural Appraisal (PRA) tools such as Key Informant Interviews (KII) shall be conducted to understand the socio-economic condition of landowner/communities within the proposed site. Understanding the land ownership and tenure rights and responsibilities is important.
4. During these discussions, agro ecological conditions, climate and hydrogeology conditions of the landscape shall also be recorded in order to understand the soil and water conservation needs in the landscape. This shall additionally help derive the purpose of establishing an agroforestry system.

At this stage a good land use map should be available with the preliminary assessments. However, the land use map can still be improved as the detailed field assessments are carried out in the following steps.

Resource Mapping

Topographic maps can be used to interpret information on the land characteristics such as the average slope, latitude, drainage pattern, watershed and sub watershed boundaries and variations in landforms. Today though topographic maps are outdated, it is still considered a good resource for planning purposes. However, maps can be readily generated through ArcGIS. Other maps that include administrative boundary, land use distribution, soil maps, biophysical and socio-economic maps can be derived from information provided by the National Statistical Bureau (NSB). The latest LULC maps provided by National Land Commission Secretariat (NLCS) is an important data source. If there is sufficient financial support for obtaining aerial maps and satellite imageries, it will help in comparing and contrasting the change that has occurred in the landscape. It is also very important resource in the planning process.

9.5.2 Detailed Field Assessment

A landscape approach to seeking collective solutions is advised. World Agroforestry (Minang et al. 2015) highlights three essential interactive aspects that define a landscape, namely functional interactions, negotiated spaces and multiple scales. Ecological, economic and social processes in a landscape interact shaping the functional interactions. Landscapes typically have a diverse set of stakeholders with different perspectives, interests, power and ambitions which conflict with each other. Therefore, collective decisions that shape the landscape is paramount, making it a negotiated space. Landscapes oftentimes contain institutions, private sector and community-based organizations, creating a heterogeneous biophysical and socio-economic dimension. Through a landscape approach, better collective solutions are explored rather than individual sector-specific solutions. The approach looks into a complete set of options, avoiding solutions that are narrow and oftentimes have high potential of causing conflict and helps us find smart trade-offs between objectives. This shall include the current land use mapping, climate assessment, soil assessment, physical features (terrain, hydrogeological survey and identifying water recharge areas) and inventory of the non-wood forest products in the respective watershed.

Box 9.1 General tools in carrying out detailed field survey

General tools in carrying out detailed field survey in an agroforestry site

Key Informant Interviews

Key informants are individuals who because of their position within the community or specialized knowledge of a specific issue can provide either a broad overview of the local social structures and farming systems, or specific information and insights on particular aspects of the local biophysical and socio-economic environment. They are major sources of information for those conducting in depth investigations or for those interviewing under time constraints.

They can provide useful information on a wide range of topics including:

- Normative information and variability
- Features common to the community (marketing prices, general constraints)
- Community organization and power structure
- Local units of measurement
- Changes in farming practices over time, perception of soil erosion

Focus Group Discussion

Focus Group discussions with the community members can yield quick understanding of household situations. The group is deliberately chosen with diverse age group & gender. When smaller, homogeneous group of people are naturally assembled during the field visits, this type of interviewing is appropriate to gain in depth information on particular issues. It is also used to obtain a consensus of opinions from a group of local professionals (RNR staff, LG).

Questions in these interviews are highly focused on a few key issues. This type of interview is generally not useful at an early exploratory stage, before the general features of the farm household system are understood.

Topographic Transects

These are longitudinal or transverse section of a particular area that show the relationship between the use and the bio-physical characteristics (soil type, drainage, slope, landform, etc) of each land unit. They are particularly useful where there is a strong relationship between land use and topography, such as in mountainous areas. Wherever possible, such transects should be undertaken as a participatory exercise with the planning team members and farmers walking the transect (walk through the landscape) together. Such transects are useful in discussions with communities to clarify local variations in land conditions and the corresponding differences in land management. A series of transect diagrams can be used to show major shifts in land use or land management over time.

Resource Mapping

This technique involves asking a community representative to help in constructing a map, often by drawing it on a large paper on the ground, showing the main features of the community and its surrounding areas. Later, this information can be recorded permanently on paper. This approach can be very helpful in giving information about the village and in certain situation could provide a useful way of drawing up a sampling frame for use in selecting farmer/fields for trails or for more detailed surveys.

Direct Observation

The planning team, while moving through the planning area observes the farmers' fields, practices, circumstances, homes, and household activities. Such observations can be used for checking the validity of information obtained through farmer interviews. In this regard, the experience of individual team members shall be critical in identifying the underlying causes of

observable and stated problems. This information often suggest follow up questions to reconcile any inconsistencies between farmers' statements and the teams' observations. Through direct observation, major land utilization forms may become apparent. Buildings and other assets can serve as indicators of the wealth of a family. Never the less, cautions need to be exercised, because direct observation is subjective and may not consider the spatial and temporal changes.

Learning by Working

Physically working with farmers and doing what they do can greatly facilitate the exchange of information between technical specialist and farmers. As a result, it can lead to very meaningful collaboration. Working with farmers in their fields shall often encourage details a planner would not normally consider. Most farmers generally take their role as teacher very conscientiously. Learning by working can prompt changes in attitude by the technical 'experts'. For instance, would soil conservation technicians be ever ready to recommend terracing if they had to do the construction themselves with only hand tools?

Field offices shall carry out detailed field assessments of the proposed site with:

a. Biophysical site assessment: soil, climate & water
b. Biodiversity Assessment: flora, fauna & aquatic
c. Socio-economic assessment: community
d. Forest Resource Inventory in and around the agroforestry sites (buffer)Timber and Non-timber in the watershed
e. Crop and Livestock Inventory

The following checklist shall help keep track of information gathered for the site. The following box encompasses field tools and techniques in gathering information in the field.

Table 9.4 Checklist for Detailed Field Assessment

Background	❖ Settlement history ❖ Important events ❖ Land use history
Administrative Location	❖ Region and district in which the site is located with GPS coordinates
Cultural characteristics of rural household within the watershed	❖ Indigenous/religious affiliations of the various households within the community (eg. Moenpa community) ❖ Locally important customs, traditions and religious festivals
Land tenure and user rights	❖ Legal land status (agricultural land/ grazing rights/ SRFL/FMU, protected areas/leased land) ❖ Security of user right of individual land holdings ❖ Informal land leasing/sharing agreement ❖ User rights of common property resources (grazing area, community, forest area)
Basic statistics including trends	❖ Total area ❖ Population total density and growth rate ❖ Different land users groups ❖ Number of rural households engaged in small-scale farm and/or forestry activities within watershed ❖ Average household size and composition ❖ Typical farm size and range of sizes ❖ Crops and area under crop ❖ Livestock number ❖ Key non-farm land use enterprises
Climate	❖ Rainfall total, distribution, reliability and intensity ❖ Seasonal maximum and minimum temperature

	❖ Risk of drought and other climate hazards (eg. Typhoon) ❖ Length of cropping season
Land Resources	❖ Land management unit ❖ Soil type, fertility level ❖ Land forms, terrain and dominant slopes ❖ Land capability
Biodiversity (vegetation and wildlife)	❖ Status of pasture areas ❖ Natural vegetation and wildlife ❖ Ecologically and socioeconomically valuable plants and animals ❖ Rare, threatened, endangered species
Hydrology	❖ Stream flow ❖ Peak floods ❖ Sediment yield ❖ Quantity/ quality of water available for domestic, livestock, irrigation purposes
Agriculture crops (annual and perennial)	❖ Major and minor crops grown ❖ Recommended crops husbandry practices ❖ Average yields and range of yields ❖ Crop prices ❖ Crop production problems
Livestock	❖ Range of animal kept ❖ Percentage of households with livestock and average herd size ❖ Animal husbandry practices ❖ Type, sources and seasonal availability of feeds. ❖ Other inputs ❖ Livestock product and value ❖ Livestock production problem
Food	❖ Household nutritional requirements ❖ Preferred foods ❖ Production strategies ❖ Degree of household self sufficiency
Timber and non-timber forest products	❖ Source of fuel wood and poles ❖ Existing tree planted and rented on farm holdings and product obtained from them. ❖ Official tree planting programs ❖ Recommended tree species and availability ❖ Exploitation / management of forest resources ❖ Important minor forest products
Soil and water conservation	❖ Severity, extent and type of land degradation ❖ Recommended conservation practices ❖ Level of adaptation and awareness ❖ Indigenous conservation / land husbandry practices
Support services	❖ Government Department extension support services for crop and livestock production, forestry, agro forestry and reforestation, soil and water conservation ❖ Extension support services provided by separate development projects and NGOs ❖ Credit facilities ❖ Marketing and input supply channels
Community organization and structure	❖ Traditional authorities and other community leaders ❖ Community based organization
National, regional and local policies	❖ Development thrusts ❖ Price for input and marketed produce ❖ Credit ❖ Land rights

	❖ Conservation / watershed protection ❖ Irrigation ❖ Upland agriculture development ❖ Afforestation ❖ Resource utilization
Other land uses and users	❖ Downstream water users ❖ Recreational facilities ❖ Experimental and similar projects ❖ Hydropower generation

Note: This is the first technical guideline to establish Agroforestry sites in the country. As and when, new information and experiences are acquired, this guideline shall be improved.

Table 9.5 Soil characteristics

Aspect (South or North Facing)				
Terrain (Slope, Steepness, Gullies)				
Soil Type				
Parent Material				
Effective Depth				
Soil Color				
Structure and Consistence				
Texture	Topsoil		Sub soil	
Chemical properties	PH		O.M%	
	N%		P ppm	
	K meq		C.E.C	
	Base Saturation		Salinity/ Toxicity	

Note: Soil sample shall be colleted from the field site and the assessment of chemical properties of soil shall be carried out at soil laboratory.

Table 9.6 Water Quantity resources (Quality can be explored but not required at this stage)

Box 9.2 Perennial surface water resources		Reliability*	
Seasonal surface water resources		Reliability*	
Ground water resources		Reliability*	

*Months of the year when the quantity of water available from this source was adequate to meet local needs.

Table 9.7 Pest and diseases (type and effect)

Pest and diseases of agricultural crops	
Pest and diseases of forest species	
Pest and diseases of livestock	
Pest and diseases of tree crops	
Human environmental health hazards	

Table 9.8 Land degradation

Extent and severity of existing soil erosion	Sheet erosion	
	Rill erosion	
	Gully erosion	
	Stream bank erosion	
	Mass movement (type, status and severity)	
Erosion hazards		
Other forms of soil degradation		
Degradation status of forest/ woodland areas		
Degradation status of grassland areas		
Degradation status of water resources		

Table 9.9 Data: Attributes, methods and analysis

Attributes	**Possible uses in planning**	**Data Analysis**	**Possible methods of collection**
Area	Land use location	Landforms and geomorphology Topography Geology and soil profile Existing soil impacts within and around the management area (eg. Dredging, excavation, filling, mining, contamination, soil amendment)	Field measurements, planimetry, GIS, other map measurement techniques
Slope (mean slope, slope classes)	Assessment of erosion potential suitability, selection, design and evaluation of alternative land use and practices		Field measurements, map measurements, GIS, existing maps
Elevation (mean elevation, elevation classes)	Assessment of erosion potential suitability, selection, design and evaluation of alternative land use and practices		Field measurements, map measurements, existing maps
Soil (texture, erosion potential, depth, N, P, K, pH, organic matter content)	Assessment of fertility/ productivity, land suitability, erosion potential, selection, design and evaluation of alternative land use and practices.		Soil survey / analysis, existing information / maps.
Climate (rainfall amount, intensity and distribution, written period of maximum and minimum rainfall events, wettest and driest month, number of rainy days, maximum, minimum and mean air temperature, sunshine duration, wind velocity)	Assessment of land suitability, erosion potential and land productivity, prediction of assessment of future hydrologic events, selection and design of land use and practices, assessment of impact of proposed land use and practices	Brief current and historic climate patterns Precipitation Temperature Other climatic parameters if available Potential implications of climate change	Field measurement, record at DHMS and other existing observation stations nearby, local knowledge

Hydrology (quality and quantity of stream flow, siltation rate, surface runoff, evapotranspiration)	Appreciation of hydrologic behavior of a watershed, assessment of land suitability, erosion potential, impact of proposed land use and practices	Site specific wetland hydrology including information on surface water and ground water and their interaction (depth to ground water through soil profile) Key catchment characteristics, processes and existing issues Existing water quality Existing hydrological modifications (drainage lines, water tapping)	Field measurement, existing record, local knowledge.
Vegetation (species composition, distribution, structure, volume density, percentage canopy and ground cover and ethno botanic value of plants)	Assessment of land suitability, erosion potential and productivity, selection, design and evaluation of land use and practices.	Vegetation Survey Methodology Significant, threatened and endangered ecological community Existing impact on the vegetation and flora within the wetlands management area	Field measurement, existing records, research and academic institutions, local knowledge
Wildlife (species composition, distribution, threatened, endangered and rare species, habitat and food sources, socio-economic value of wildlife)	Assessment of land suitability, erosion potential, design, and selection of appropriate land use and practices.	Fauna Survey Methodology Significant, threatened and endangered community Significant pests (human wildlife conflict) Faunal habitat and their significance Existing impact to the fauna within the wetlands management area	Field measurement, existing records, research and academic institutions, local knowledge.
Land use (extent of existing and historical land use, major practices, productivity).	Selection and design of appropriate biodiversity conservation measures and practices, assessment of impact of proposed		Remote sensing imaginary, GIS technology, PRA Tools

	land use and practices		
Ecological Disturbances	Existing ecological linkages within and around the management area Ecological linkage values	Disease presence and disturbance (e.g. dieback, pine rust) Existing impact caused by diseases	Research papers and management plans.
Cultural Significance	Community based ecotourism	Cultural heritage Community use Existing management Existing use – recreational (active and passive trends) educational, scientific, resource based, landscape amenity/aesthetics Existing community involvement Existing access within and around the management area Existing facilities within and around the management area. Existing impacts within and around the management area (garbage, prohibited access tracks)	Trabnsect walk and PRA Tools

Box 9.3 Field Assessment

Field Assessments

a. Biophysical Site Assessment

This information is needed to determine the biophysical constraints and potentials relevant to identifying designing, developing to implement the later proposed strategies in order to maintain the overall watershed health. The biophysical characteristics of the site can be described in terms of geology, landforms, hydrology, soil, vegetation, fauna, type of ecosystem and ecosystem values, natural hazards. Though a comprehensive database is usually recommended to reduce the cost of acquiring information, the team can limit the biophysical characterization to land use planning and decision-making. Comprehensive research and data mining can be proposed as strategic activities in designing solutions and interventions.

b. Soil Edaphic Features

Soil features greatly influence the soil infiltration capacities of the watershed, hence also affecting the nature of subsequent run off, ground water recharge and other processes. These features assist in assessing the suitability of an area for the production of agricultural crops and forest vegetation. The basic essential soil features are soil depth, soil texture and the origin of the parent material. Other information, that are required for agricultural yield and for land use interventions, the following features can be also collected: soil structure, permeability, soil erosion condition, soil PH, soil fertility (plant nutrients and organic matter content)

General information on the soil can be obtained from NSSC, however, the detailed soil survey would have to be carried out in collaboration with the concerned agency. Thus then the interdisciplinary of planners can be identified from NSSC or any soil scientist can be hired as a specialist.

f. Climatic Information

Climate has an overwhelming influence on the different biophysical and socio-economic features and processes within a watershed. Rainfall and air temperature greatly determine the types of plants and animals that thrive in a watershed. They also influence the nature of land uses and practices in watersheds. The hydrologic processes such as surface run-off, stream flow, infiltration and ground water recharge are under the strong influence of rainfall, air temperature and other climatic factors. These features are therefore important in assessing land suitability, soil erosion potential and impacts of proposed land uses and practices. Hence the quantitative description and continuous monitoring of climatic variables are important for planning and management purposes.

An initial overview of the climatic condition of the area can be obtained from agencies such as National Center for Hydro Metrological Services (NCHMS), web portals and most probably at local hydro metrological stations that might have been set up through prior donor funded projects. Some information can also be collected at community schools. Usually metrological stations are found scattered throughout the country but hydrological stations are found focused only at river outlets. Thus stream discharge is usually not available. Hence this gap in information could suggest the team to set up strategic hydro metrological stations to provide data during the planning an implementation period or hereafter. Usually, the climatic information includes precipitation, solar radiation, wind direction and discharge measurements of streams and rivers.

Where a weather station does not exist within the watershed, inferences may be drawn from climatic data obtained from the nearest weather station. Climatic data may also be available from some academic or research institutions. Partial or inconsistent climate data recordings should not be discounted. They can at least give an indication of variance with official recording sites. Likewise,

local people can usually describe the climate in their locality and should be considered a viable source of information. If resources permit, it may be important to consider establishing a weather station within the watershed during the management phase to generate a local climatic database. At bare minimum, such a weather station should have a rain gauge and a maximum/minimum thermometer to regularly monitor rainfall and extremes of air temperature. However, where possible, a more elaborate weather station taking a wider range of measurements is more preferable. Detailed discussion of procedures, instrumentation, and climatic data processing can be found in many available references.

Following is an enumeration and brief description of the significance of the different climatic variables that must be described during the planning process. The basic climatic data essential for planning purposes are: rainfall distribution, maximum air temperature, and minimum air temperature. Other useful data if available should include: total amount of rain, rainfall intensity, extreme rainfall events, mean air temperature, wind speed, relative humidity, solar radiation and soil temperature.

g. Hydrology

Geo-morphological features of a watershed influences the amount and velocity of water moving over land surfaces, hence these features are essential in assessing the soil erosions and land sustainability for various land uses. This in turn helps in designing the management practices. Area of the watershed slope and elevation are the most important process, however, basin length, elongation ratio, relief ratio, stream order, stream length, drainage pattern and stream densities can be measured. Though these information are not required directly for management planning, it provides insights for the planners into the hydrologic and other physical behaviors of the watershed.

Stream flow quantity, quality and pattern are excellent indicators for assessing the health of a watershed, its responses to human interventions and the suitability and impacts of management activities on the watershed. For planning and implementation, a description of the long-term behavior and continuous monitoring of stream flow is extremely useful, and is essential for watershed management. Data on the following features are commonly needed: Stream flow rate, Stream flow quality, Surface run-off volume and Evapo-transpiration rates.

Long term streamflow records for big rivers are commonly available at DHMS. Small watersheds, long-term streamflow data are usually not available. There is thus a need to make some quick measurements to get a general idea of the quality and quantity of stream flow. The current practice at WMD to obtain the quantity of streamflow is by using the simple float method and quality is determined by using a simple hand held PCS multiparameter tester (PH, temperature, turbidity, salinity and conductivity). Surface run-off is important because it is a major source of streamflow. It is also a major force that causes soil erosion and is highly sensitive to various land use practices. In describing surface runoff, the volume and velocity of flow are usually quantified. Runoff plots, hydrograph analysis and hydrologic models can be used to estimate surface runoff. A quick measure of surface runoff potentials of a watershed can be generated using the rational method described in many hydrology books (Brooks, et al, 1991). Local knowledge can also be a potential source of surface runoff information, particularly peak flood levels and consistency of stream flow (e.g., length of no flow periods).

h. Socio-economic data

The statistical year book from NSB and the gewog administrative office would be the prime source of information to collect data on population numbers, distribution, density, growth rates and other demographic characteristics. It can also give us information on the socio economic status of the watershed such as income lever, source of livelihood, infrastructure, etc. Other information such as agricultural productions, livestock numbers, literacy rates and access to road, electricity, health and

education (basic need) can be determined. This shall indicate the livelihood status of the watershed. Other proxy data can also be obtained from the gewog/dzongkhag's annual progress reports.

i. Cultural and spiritual significance

Through focused group discussions and individual key information on the cultural and spiritual significance of the area can be recorded in order to consider it in the planning process. Some of the historical landmarks and monasteries hold important anthropogenic records of the past that can be very informative and add value to the planning process.

j. Vegetation

Information on the composition, type and structure of plant communities, volume and density of trees, and percent ground and canopy cover in a watershed are necessary to the understanding of the roles vegetation plays in the physical processes of a watershed. The influence of plants and the impacts of utilization and harvesting of plants on such processes as soil erosion, surface flow and infiltration can be assessed accurately only if adequate vegetation analysis has been done. Database on the floristic composition of a watershed is also vital in the conservation of biodiversity. Many watersheds contain plants that are ecologically, scientifically, culturally, economically and socially valuable. The protection and conservation of these plants rest on an accurate database on their location distribution, abundance and utilization. Aerial photographs and remotely senses imageries are potential sources of vegetation distribution and quality information. Vegetation survey methodologies are sufficient for this purpose (Annexure attached).

k. Biodiversity

Referring to past reports from government agencies (Parks, Territorial Divisions, Gewogs, Dzongkhags, Central Offices, Projects) that have carried out inventories and assessments and any other management planning and developmental activities shall be useful in harnessing the past information. This is an important source to integrate other past current and proposed activities within that watershed.

To be able to properly manage the wildlife population in the watershed, the species composition, species density, species distribution/occurrence, species diversity and similarity, habitats and food sources need to be assessed carefully. Local knowledge and data from previous surveys are potential cheap sources of information on wildlife, in cases where money is limited and biodiversity is not a major problem area. Otherwise, sophisticated field methods such as direct count method, time area count method and block estimation method can be used for describing the wildlife population

9.5.3 Management Planning and Implementation

This step is crucial where a list of potential agroforestry interventions shall be identified. The 'best bets' is based on the biophysical conditions and the detailed assessment carried out in the previous step. The list shall be revised based on best market potential and objectives set for the agroforestry site.

A management plan projection (ideally 5 years) is a schedule of the work planned for the next five years to develop the agroforestry practices. Following which the next plan cycle shall be on adding value to the agroforestry site. The specific tasks and timelines are set in this process to form the basis of the yearly work plan. A detailed LFA matrix can have weekly, monthly and yearly work plan but it depends on how detailed out you can be.

Logical Framework Analysis (LFA) shall be used as a systematic procedure to identify the appropriate management interventions **(**Figure 9.6**).** Brainstorming of agroforestry interventions and 'best bets' shall be carried out in this step.

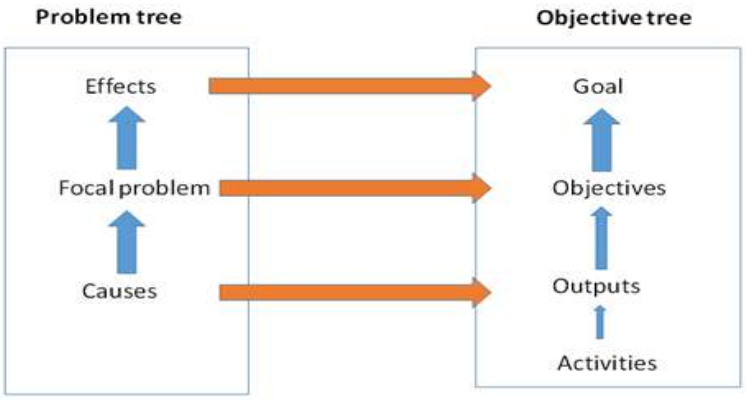

Figure 9.6 Logical Framework Analysis

a. Agroforestry Development

At this stage, a lot of information has been gathered and probably ideas for agroforestry development are already formed. Available resources and current conditions have been assessed. With the goal and objectives of the agroforestry sites there is a need to list the potential crops that can be grown in the land. The following tables shall help assess the available information.

Table 9.10 Land Use

Major kinds of land-use	**NLCS classifications (can be more detailed if resources are available)**
Land utilization types	Residential/Recreational/Grazing/Argi-paddy/Agri-dry/Agri-orchard/Pasture/CF/Wildlife area/Buffer zone (areas with some form of management)

Table 9.11 Existing Farming practices

	Current Status	**Challenges**
Natural vegetation types		
Common exotics and invasive species		
Farming Crops		
Rangeland and livestock		
Others		

After which a list of best bets should be developed whereby depending on the assessment of the existing farming practices, changes could be made or value addition can be proposed. However, the best bets have to go through several re-assessments to be aligned with the set goals and objectives of the site.

The best bets shall have to meet the requirements of the desired agroforestry system and the benefits derived from the integrated system. Market studies and potential added values shall be explored which is a major component of an agroforestry practice. This shall require market studies with demand and supply trends and available government incentives and programs. Department of Agricultural Marketing and Co-opertives (DAMC), Ministry of Agriculture and Forests (MoAF) shall take lead in market related programs and activities.

At this stage, areas with land degradation or visible signs of land degradation can also be identified, mapped and soil and water interventions can be used to mitigate or prevent further damage to the landscape.

Each crop plant listed as best bet shall require additional information. The following information shall be gathered for all the best bets:

Table 9.12 Information required for best bets

Crop Plant	Description	Estimated value (Nu.)
Input		
Shade requirement		
Soil requirement		
Water requirement		
Labor requirement		
Compatible crops		
Compatible livestock		
Harvest requirements		
Post harvest requirements		
Packaging and transportation		
Cost to grow and harvest		
Output		
Volume (Potential production)		
Grade standards in market		
Current market price		
Difference in output and input		
Profit potential		

For each best bet (all crop plants), product influences and trends with value added opportunities shall be explored.

b. Development of the Plan

Development of a plan for an agroforestry site is important for the efficient implementation of the plan. Planning with a timeline has been proven to produce a better result. ***The planning process is more important than the plan itself***, providing the opportunity to understand the landscape and prescribe best practices and appropriate agroforestry systems that can achieve on farm goals. Market opportunities shall also be explored in the process.

LFA planning is an objective-oriented approach whereby the point of departure of the planning process is the problem analysis, which leads to the objectives and finally makes it possible to choose the relevant activities. Hence, before making a plan of activities, an analysis of the problems and objectives is necessary. The main steps in the LFA process are to:

- carry out a *problem analysis;*
- carry out an *objective's analysis;*
- identify *outputs* needed to achieve the objectives;
- prepare a plan of *activities* to achieve the outputs; and
- prepare a LFA Matrix to: (i) summarize and display the entire intervention logic, (ii) identify indicators for monitoring activities, (iii) identify individuals/agencies responsible for implementation and (iv) assist with budgeting.

The process is best carried out using a goal-oriented planning workshop (a LFA workshop) to clarify *WHY* a change (why a management/action plan) is needed and to gain consensus on *WHAT* shall be done.

The LFA process shall help guide which best bets to select and what activities should be considered to manage the landscape of the entire agroforestry site.

For each development area of the entire agroforestry site, the following information shall be gathered to bring in appropriate management interventions.

Table 9.13 Information required for AGF management intervenion

	Crop Plant	**Agroforestry practice**	**Management required for best market results**
Development Area 1			
Development Area 2			
…			

Upon several consultations with the stakeholders, an elaborate implementation framework shall be developed as shown below.

Table 9.14 Implementation Framework

Logical Framework Matrix

Purpose of the Plan:

Goal:

Outputs	**Activities**	**Verifiable indicators**	**Responsible agency/person for implementation**	**Collaborating partners**	**Local area based plan**	**Budget (M Nu)**	**Timeline**
	Objective 1.						
1.1.	1.1.1.						
	1.1.2.						

The action plan can be summarized in a LFA matrix, the log frame, which brings together all the key aspects of the plan into a single matrix. The project-planning group draws up the plan of activities, with guidance from the problem analysis made by the stakeholders and based on the objective analysis. The project group usually identifies activities from the participants during planning phase. The management plan shall then be implemented as per the log frame.

During the planning process an implementation framework is derived and consented upon. Normally the landowner becomes the manager of the agroforestry site. However, if the agroforestry system is established and caters to multiple landowners, a management roles and responsibility with appropriate terms of reference shall be drawn for the management plans period.

For an agroforestry site, the following basic information is good to maintain for proper planning and implementation. This shall help keep track of the activities that might require extensive preplanning time requirements.

Table 9.15 Work plan

Agroforestry Practice	Time of the Year	Management objective	Specific Tasks	Resources (Labor, material, equipment)

9.6 Monitoring and Evaluation

The basic goal of all agroforestry system is to achieve productivity, sustainability and adaptability. M&E is conducted on farm or at a landscape level, depending on the extent of the management plan.

The monitoring and evaluation shall be carried out based on the Logical Framework Analysis Matrix. If the project has not been planned properly, with clear objectives and indicators, it shall be very difficult to succeed in achieving the objectives in the implementation phase and finally, it shall be difficult to evaluate the results.

Field Offices (DFOs and PAs) shall regularly monitor the implementation of the agroforestry interventions. The monitoring shall focus on the implementation of the planned activities, and achieved outputs. SFED shall conduct periodic monitoring of the implementation of agroforestry interventions as outlined in the management/action plan.

Evaluation shall be carried after the completion of the implementation of activities. Evaluating these outcomes is important to judge the success of the overall intervention. The management/ action plan has four main sections to conceptualize the overall operation that shall be evaluated for the renewal of the plan:

i. Area: size of the managed area
ii. Practice: agroforestry practice and the associated products (crops)
iii. Year: year the management activity was commenced
iv. Management Objective: Specific objective to be achieved.

a. Importance of M&E

The M&E of an agroforestry site is an important step that helps add value and build on information to assist in the next planning cycle. The process helps to:

i. understand whether the agroforestry intervention is resilient;
ii. recognize the shortcomings and lead to corrective measures;
iii. communicate lesson learnt;
iv. provide references for subsequent plans; and
v. enhance accountability and coordination among stakeholders

b. M&E Criteria

The following criterias are addressed:

Table 9.16 Criteria for M & E

Criteria	Description
Relevance	Value of the agroforestry intervention in relation to stakeholder needs, national priorities and international policies.
Efficiency	Efficient resource use
Effectiveness	Are the results satisfactory?
Impact (Includes social, economic and environmental effects on individuals and communities)	Intended/unintended Positive/negative
Sustainability	Continuity despite resource constraints

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1	Passang Wangchen Norbu	Specialist/ Advisor	DoFPS
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3	Kinley Dem	Dy. Chief Forestry Officer	FRMD
4	Tashi Norbu Waiba	Dy. Chief Forestry Officer	FRMD
5	Sither Wangdi	Sr. Forestry Officer	SFED
6	T.B Rai	Sr. Forest Ranger I	SFED
7	Tashi Wangchuk	Dy. Chief Forestry Officer	SFED
8	Sonam Choden	Dy. Chief Forestry Officer	SFED
9	Jigme Tenzin (PhD)	Dy. Chief Forestry Officer	WMD
10	Tshering Pem	Forestry Officer	NCD
11	R.B Mongar	Forestry Officer	FPED
12	Sherab	Specialist	UWICER
13	Sangay	Dy. Chief Forestry Officer	UWICER
14	Tshewang Dorji	Sr. Forest Ranger I	SFED
15	Ugyen Tshering	Sr. Forestry Officer	SFED
16	Arun Rai	Principle Forestry Officer	FRMD
17	Dorji Wangdi	Dy. Chief Forestry Officer	FRMD
18	Dawa Zangpo	Dy. Chief Forestry Officer	FRMD
19	Jamyang Choden	Forestry Officer	FRMD
20	Ngawang Gyeltshen	Sr. Forest Ranger I	NCD
21	Namgay Wangchuk	Sr. Forestry Officer	NCD
22	Letro	Sr. Forestry Officer	NCD