



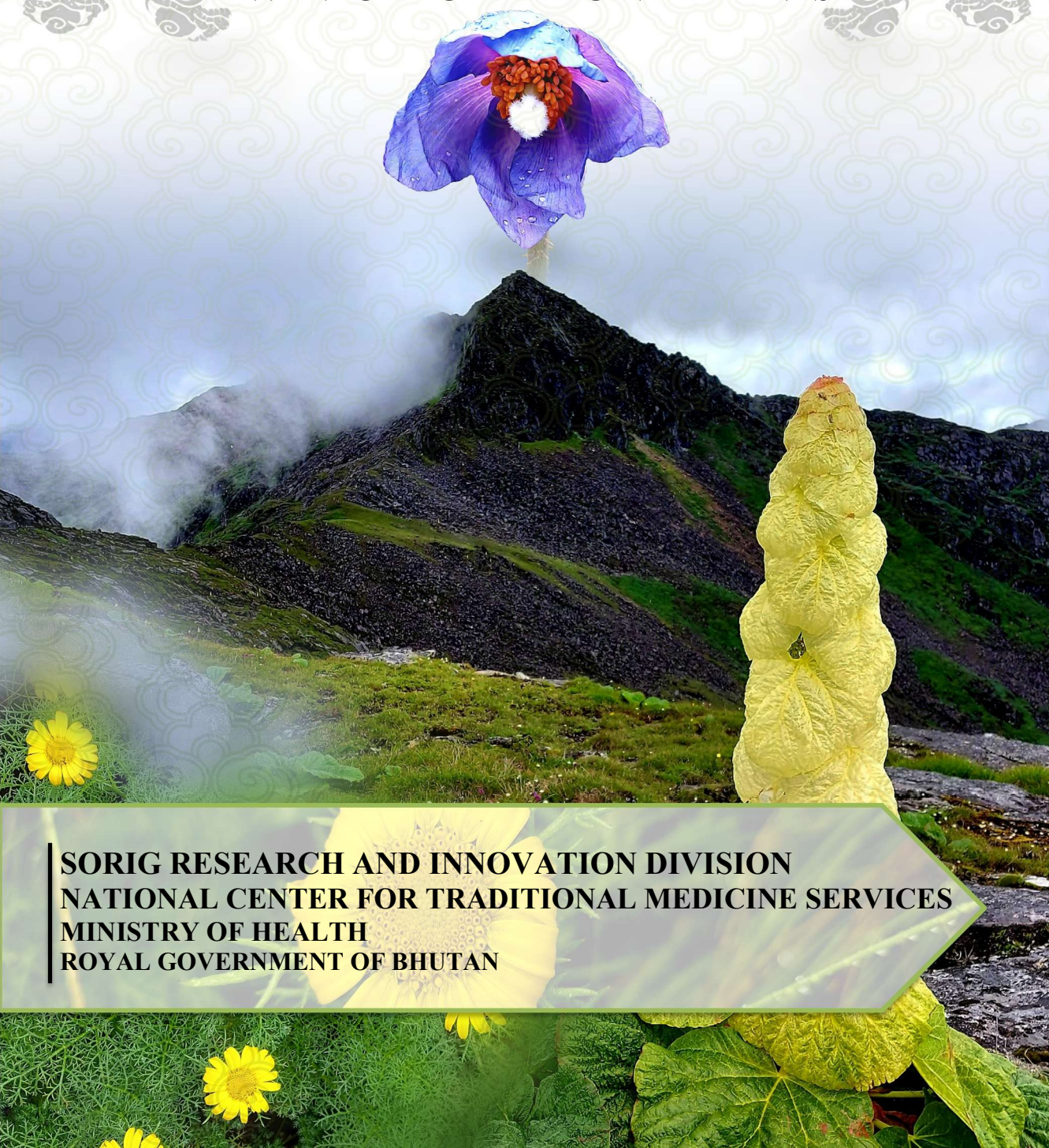
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NATIONAL GUIDELINE FOR GEOSPATIAL MAPPING & INVENTORY OF MEDICINAL PLANTS



**SORIG RESEARCH AND INNOVATION DIVISION
NATIONAL CENTER FOR TRADITIONAL MEDICINE SERVICES
MINISTRY OF HEALTH
ROYAL GOVERNMENT OF BHUTAN**

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FOREWORD

Medicinal plants constitute one of the most important natural resource bases for Bhutanese Traditional Medicine, biodiversity conservation, community livelihoods and future research and product development. The sustainability of traditional medicine services depends greatly on the proper identification, conservation, monitoring and responsible use of medicinal plant resources across the country.

Recognizing the need for a standardized and scientifically robust system, these Guidelines for Inventory and Geospatial Mapping of Medicinal Plant Resources have been developed to provide a practical framework for field assessment, ecological documentation and spatial mapping of medicinal plant populations. The guidelines are intended to support consistent methodologies, strengthen evidence generation, improve resource planning and inform conservation and cultivation interventions.

These guidelines are intended to assist program officials, researchers, field enumerators and partner institutions in generating reliable data for sustainable harvesting, habitat management, cultivation planning and policy decision-making. The document also emphasizes ethical engagement with communities, careful handling of sensitive species data and the importance of integrating field ecology with modern GIS-based resource information systems.

It is hoped that this manual will serve as a valuable technical reference for building a national medicinal plant geo-database and for strengthening the long-term resilience of traditional medicine resources in Bhutan.



Specialist Head

National Centre for Traditional Medicine Services

ACRONYM AND ABBREVIATION

MoH	Ministry of Health
NCTMS	National Centre for Traditional Medicine Services
SRID	Sorig Research and Innovation Division
MoENR	Ministry of Energy and Natural Resources
DoFPS	Department of Forest and Park Services
NBC	National Biodiversity Centre
JDNP	Jigme Dorji National Park
MoAL	Ministry of Agriculture and Livestock
NSSC	National Soil Services Centre
NLCS	National Land Commission Secretariat
NTMH	National Traditional Medicine Hospital
FoTM	Faculty of Traditional Medicine
MSPCL	Menjong Sorig Pharmaceutical Corporation Limited
LG	Local Government
LCG	Local Community Group
BTM	Bhutanese Traditional Medicine
GIS	Geographical Information System
GPS	Global Positioning System
QGIS	Quantum Geographic Information System
SW Map	Softwel Map
WRB	World Reference Base
EDP	Economic Development Policy
QA	Quality Assurance
QC	Quality Control
CRS	Coordinate Reference System
DD	Decimal Degrees
Masl	Meters Above Sea Level
RICBL	Royal Insurance Corporation of Bhutan Limited
NGOs	Non-Government Organizations
mm	Millimeter
m	Meter



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The successful development of this guideline was made possible through the collective efforts, commitment, and collaborative of the core working group members, whose knowledge and experience greatly enriched the content and quality of the document. Their contributions have laid a strong foundation for the systematic mapping, inventory, conservation, and sustainable management of medicinal plant resources in Bhutan.

The Division gratefully acknowledges the time, effort, and professionalism demonstrated by all members throughout the drafting process and extends its heartfelt thanks for their continued support in advancing research and evidence-based management of medicinal resources.

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Table of Contents	Page
FORWARD.....	i
ACRONYM AND ABBREVIATION.....	ii
ACKNOWLEDGEMENT.....	iii
1 INTRODUCTION.....	1-2
2 POLICY AND LEGAL LANDSCAPES.....	3
3 RATIONALE.....	4
4 PURPOSE OF THE GUIDELINE.....	5-6
5 SCOPE AND APPLICABILITY.....	6-8
6 OBJECTIVES.....	8-9
7 GUIDING PRINCIPLES.....	9-10
8 INSTITUTIONAL ARRANGEMENTS AND GOVERNANCE.....	10-15
9 RECOMMENDED FIELD TEAM COMPOSITION.....	15
10 DEFINITIONS AND KEY TERMINOLOGY.....	15-17
11 SURVEY TYPES AND APPROACHES.....	17-19
12 PRE-SURVEY PLANNING AND PREPARATION.....	20-23
13 SELECTION OF TARGET SPECIES AND SURVEY AREAS.....	24
14 SURVEY DESIGN AND SAMPLING FRAMEWORK.....	25-26
15 OVERALL SURVEY WORKFLOW.....	27
16 DATA MANAGEMENT, QUALITY ASSURANCE / QUALITY CONTROL & VALIDATION.....	28-30
17 DATA ANALYSIS AND INTERPRETATION.....	30
18 REPORTING REQUIREMENTS AND OUTPUTS.....	31
19 SAFETY, ETHICS AND RISK MANAGEMENT.....	31-32
20 EQUIPMENT AND LOGISTICS.....	32
21 REVIEW AND REVISION OF THE GUIDELINES.....	32-33
22 CONCLUSION.....	34
REFERENCES.....	35-36



1. INTRODUCTION

Bhutan is renowned for its exceptional biodiversity, with more than 11,248 documented species recorded across its diverse ecosystems. Among these, 637 species have been identified as medicinal plants, reflecting the country's rich natural heritage. Of the medicinal plant species documented in Bhutan, approximately 250–300 is currently used in the production of 110 essential traditional medicines and more than 25 health supplements.

Medicinal plants in Bhutan are broadly classified into two categories: *Sngosmen*, which refers to high-altitude medicinal plants found above 2,000 meters above sea level, and *Khrog-smen*, which includes low-altitude medicinal plants occurring between 600 and 2,000 meters above sea level. Together, these resources form the foundation of Bhutanese Traditional Medicine (BTM), which relies heavily on medicinal ingredients collected from diverse ecological zones throughout the country.

This strong dependence on locally available biodiversity underscores the importance of sustainable resource management. The long-term viability of BTM and its ability to provide equitable, holistic healthcare services depends on the effective identification, conservation, monitoring and sustainable utilization of medicinal plant resources. However, increasing demand driven by population growth and the expansion of traditional healthcare services has placed growing pressure on these resources. At the same time, overharvesting, habitat degradation and the impacts of climate change are contributing to the decline of many wild medicinal plant populations, posing significant challenges to the future sustainability of the traditional medicine system.

Despite these concerns, Bhutan has significant opportunities to strengthen the resilience of its traditional medicine sector through strategic and sustainable resource management. Promoting ethical harvesting practices, establishing alternative collection areas and expanding the cultivation and domestication of medicinal plants can help reduce pressure on wild populations while ensuring a reliable supply of raw materials. Beyond its role in healthcare, BTM has broader national significance. It contributes to environmental conservation and forest protection, supports rural livelihoods through income-generating opportunities and holds considerable potential for economic development through nature-based industries and wellness initiatives.

Given the increasing pressure on medicinal plant resources, there is an urgent need to better understand the factors driving resource depletion and to identify opportunities for conservation, regeneration and cultivation. While a number of localized and small-scale mapping exercises have been conducted over the

years, Bhutan has yet to undertake a comprehensive, nationwide assessment of its medicinal plant resources using standardized scientific methods. As a result, there is a clear need for a coordinated national initiative to systematically inventory, map, and document medicinal plant resources across the country.

Establishing a standardized national inventory and integrated data management system is critical for the sustainable management of these resources. Such a system requires clear technical guidelines and appropriate tools for surveying, documenting and mapping medicinal plant populations. A robust geospatial and ecological database would provide valuable information on species distribution, abundance, habitat requirements, population dynamics and emerging threats. This evidence base would support informed decision-making for conservation planning, cultivation programs, habitat restoration and sustainable harvesting practices.

These guidelines have therefore been developed to provide a comprehensive technical framework for field surveys, ecological inventories, GPS-based data collection, GIS mapping, and database development. They are intended for application across Bhutan's diverse ecological landscapes, including forests, alpine meadows, shrublands, riparian ecosystems and other habitats that support medicinal plant diversity. By promoting standardized approaches to data collection and resource assessment, the guidelines aim to strengthen the sustainable management and long-term conservation of Bhutan's medicinal plant resources for future generations.



2. POLICY AND LEGAL LANDSCAPES

The Bhutanese Traditional Medicine (BTM) system is guided by the Constitution of the Kingdom of Bhutan, particularly Articles 4 and 9, which mandate the protection of cultural heritage, environmental conservation, and the promotion of public health and well-being. This constitutional mandate is strengthened by the National Health Policy (2011), which supports the integration of traditional medicine into the national healthcare system and emphasizes the sustainable supply and management of medicinal resources to ensure the system's long-term viability.

Furthermore, a range of national laws and policies govern the survey, inventory, and geospatial mapping of medicinal plant resources, providing direction on biodiversity conservation, sustainable resource use, protection of traditional knowledge, land use planning, environmental safeguards, and access to biological resources. Together, these legal and policy frameworks form the foundation for the planning, implementation, and governance of medicinal plant resource assessment and management in Bhutan.

The relevant sections of the following legislative tools of the Royal Government of Bhutan will directly or indirectly impact traditional medicine resource mapping and inventory.

- 2.1. Medical and Health Council Act, 2002 of the Kingdom of Bhutan
- 2.2. The University of Medical Sciences Act 2012
- 2.3. Bhutan Medicines Rules and Regulation 2025
- 2.4. Medicine Act of the Kingdom of Bhutan 2003
- 2.5. Biodiversity Act of Bhutan 2022
- 2.6. The Climate Change Policy of the Kingdom of Bhutan 2020
- 2.7. The Bhutan Medicines Rules and Regulation 2019
- 2.8. Health Services Rules and Regulations 2025
- 2.9. Bhutan's Economic Development Policy (EDP) 2016
- 2.10. The Biosecurity Policy of Bhutan 2010
- 2.11. Geo – Information Policy 2018
- 2.12. Land Act of Bhutan, 2007

3. RATIONALE

The rationale for geospatial mapping and inventory of medicinal plants is to systematically understand, record, and manage medicinal plant resources so they can be conserved and used sustainably. The key reasons include:

3.1. Conservation of biodiversity

Medicinal plant surveys help identify rare, threatened, and overharvested species, supporting strategies to protect them and prevent loss of biodiversity.

3.2. Sustainable use of resources

Inventory and Mapping provide information on distribution and abundance, helping to ensure that harvesting practices do not deplete natural populations.

3.3. Knowledge preservation

Systematic documentation of medicinal plant resources contributes significantly to the preservation of traditional medicine (Sowa Rigpa) and scientific knowledge. It facilitates the recording of species diversity, local names, traditional uses, ecological characteristics, and habitat information, thereby safeguarding indigenous knowledge (oral tradition) systems for future generations. In addition, documented information serves as an important reference for research, education, policy formulation, and sustainable management interventions.

3.4. Support for research and healthcare

Accurate records of medicinal plants support pharmacological research, drug development, and integration of traditional medicine with modern healthcare systems.

3.5. Resource management and planning

Geospatial mapping and inventory data enables relevant authorities and stakeholders to make informed decisions regarding integrated land use and spatial planning, habitat protection, conservation prioritization, medicinal plant management, and resource allocation. The information generated also supports the identification of conservation, cultivation areas, sustainable harvesting sites, and evidence-based policy formulation for long-term resource sustainability.



3.6. Economic and livelihood benefits

Proper identification, inventory, and geospatial mapping of medicinal plant resources can enhance sustainable harvesting, cultivation, domestication, and value addition initiatives. This, in turn, enhances livelihood opportunities for local communities through income generation, enterprise development, market linkages, and community-based natural resource management while ensuring long-term sustainability of the resource base.

3.7. Creation of a Geo-database

Creation of a geo-database for medicinal plants involves systematically collecting, mapping, and storing spatial and ecological data on plant species using GIS tools. It enables accurate documentation of distribution, supports conservation planning, facilitates sustainable harvesting, and provides a foundation for research, monitoring, and informed policy decision-making over time.

4. PURPOSE OF THE GUIDELINES

The purpose of these Guidelines is to establish a nationally standardized framework for the systematic survey, inventory, and geospatial mapping of medicinal plant resources in Bhutan. Specifically, the Guidelines aim to:

4.1. Standardize field survey methodologies for medicinal plant inventory, ecological assessment, habitat characterization, and population monitoring to ensure consistency and reliability in data collection across different ecological zones and administrative regions.

4.2. Establish uniform protocols for field data collection and GIS mapping, including field data collection, spatial analysis and habitat mapping to support accurate and consistent spatial documentation of medicinal plant resources.

4.3. Improve the scientific quality, reliability, and comparability of medicinal plant data through standardized sampling designs, inventory parameters, species identification, and quality assurance and quality control (QA/QC) measures.

4.4. Provide standardized field formats, survey tools, and data standards for both paper-based and digital data collection systems to



facilitate efficient recording, storage, verification, and management of inventory information.

4.5. Support the establishment and maintenance of a national medicinal plant geo-database and decision-support system to enable evidence-based planning, conservation prioritization, sustainable harvesting, ecological monitoring, research, and informed policy formulation.

4.6. Strengthen conservation and sustainable management efforts by generating reliable baseline information on species distribution, abundance, regeneration status, habitat condition, and harvesting pressures, particularly for rare, threatened, endemic, and commercially important medicinal plant species.

4.7. Promote inter-agency coordination and data harmonization by providing common technical standards and methodologies for government agencies, Non-Government Organizations (NGOs), protected area managers, forestry professionals, researchers, local communities, and other stakeholders involved in medicinal plant resource assessment and management.

4.8. Facilitate long-term monitoring and adaptive management of medicinal plant resources to assess ecological changes, climate-related impacts, and trends in resource availability over time.

5. SCOPE AND APPLICABILITY

These Guidelines provide a standardized framework for the survey, inventory, ecological assessment, and geospatial mapping of medicinal plant resources across Bhutan. They are intended to guide government agencies, research institutions, protected area managers, forestry professionals, local communities, and other stakeholders engaged in medicinal plant resource assessment, conservation, sustainable management, and planning.

The Guidelines shall apply to the following areas and activities:

5.1. National and Dzongkhag-Level Medicinal Plant Resource Assessments

The Guidelines shall be used for conducting systematic medicinal plant resource assessments at national, regional, and Dzongkhag levels to establish baseline information on species distribution, abundance, habitat conditions, conservation status, and resource potential. Such assessments shall support national resource planning, policy formulation, and strategic conservation interventions.

5.2. Baseline Surveys in Wild Collection Areas

The Guidelines apply to baseline surveys conducted in natural habitats and wild medicinal plant collection areas, including alpine meadows, forest ecosystems, rangelands, and high-value collection zones. These surveys shall provide essential information on resource availability, harvesting pressure, habitat conditions, and regeneration potential to support sustainable utilization and management.

5.3. Species-Specific Ecological and Population Studies

The Guidelines shall support detailed ecological studies and population assessments of priority medicinal plant species, including rare, threatened, endemic, commercially important, and overharvested species. Such studies may include population dynamics, habitat preferences, regeneration patterns, phenology, ecological interactions, and sustainable harvesting thresholds.

5.4. Habitat and Landscape-Level Medicinal Plant Mapping

The Guidelines shall be applied for habitat characterization and landscape-level geospatial mapping of medicinal plant resources using GIS and remote sensing technologies. This includes species distribution mapping, habitat suitability assessment, ecological zoning, hotspot identification, and monitoring of habitat changes over time.

5.5. Conservation, Restoration, and Sustainable Management Planning

The Guidelines shall inform conservation prioritization, habitat restoration, ecological restoration, and sustainable resource management planning. The information generated through surveys and inventories shall support the identification of critical habitats, threatened populations, conservation areas, restoration priorities, and sustainable harvesting practices.

5.6. Community-Based Resource Assessment

The Guidelines shall support participatory medicinal plant resource assessments involving local communities, community forests, local institutions, and traditional (customary) resource users. Community-based assessments shall integrate local ecological knowledge and strengthen participatory monitoring, sustainable harvesting practices, and community stewardship of medicinal plant resources.

5.7. Suitability analysis for medicinal plant cultivation and Domestication

Where linked to wild resource assessments, the Guidelines shall support studies related to suitability analysis for medicinal plant cultivation, domestication potential, and habitat matching for priority medicinal plant species. Such assessments shall help identify suitable ecological zones for cultivation, reduce harvesting pressure on wild populations, and support livelihood and enterprise development initiatives.

5.8. Support for Research, Monitoring and Decision

The Guidelines also serve as a technical reference for academic research, ecological monitoring, climate impact assessments, medicinal plant databases, and evidence-based decision-making. The standardized methodologies outlined herein shall facilitate consistency, comparability, and long-term tracking of medicinal plant resources across time and landscapes.

6. OBJECTIVES

- 6.1. To establish a scientifically robust and standardized system for surveying, inventorying, documenting and geospatially mapping medicinal plants.
- 6.2. Identify medicinal plant species in selected ecological zones and collection landscapes.
- 6.3. Record the geographic distribution and elevation range of target species.
- 6.4. Assess abundance, density, population structure and regeneration status.
- 6.5. Document habitat characteristics and ecological associations.
- 6.6. Identify harvesting pressure, habitat disturbance and other threats.



- 6.7. Capture geo-referenced data for GIS analysis and national database development.
- 6.8. Generate maps and reports to guide conservation, sustainable harvesting and cultivation.

7. GUIDING PRINCIPLES

The implementation of these guidelines shall be based on the following principles:

7.1. Scientific validity:

Methods must be consistent, documented and repeatable.

7.2. Practicality:

Methods should be realistic under any geographic conditions.

7.3. Accuracy:

Data must be carefully recorded, checked and validated.

7.4. Conservation sensitivity:

Minimize ecological disturbance and avoid unnecessary destructive sampling.

7.5. Ethical engagement:

Implementation shall respect local communities, traditional knowledge holders, and customary resource-use practices. Prior informed engagement and appropriate recognition of indigenous and local knowledge shall be encouraged.

7.6. Confidentiality:

Protect sensitive species locations and restricted knowledge.

7.7. Inter-sectoral collaboration:

Coordination among different sectors involved including concerned local governments and Dzongkhags.

7.8. Adaptive learning:

Survey methodologies, software, protocols, and management approaches shall be periodically reviewed and refined based on field experience, technological advancement, scientific findings, and emerging conservation and management needs.

8. INSTITUTIONAL ARRANGEMENTS AND GOVERNANCE

Effective implementation of these Guidelines requires strong institutional coordination, clear roles and responsibilities, and multi-sectoral collaboration among agencies involved in medicinal plant conservation, traditional medicine, forestry, research, and local governance. Institutional arrangements ensure scientific rigor, operational efficiency, data consistency, and long-term sustainability of medicinal plants assessments.

8.1. Lead Institution

The National Centre for Traditional Medicine Services (NCTMS) shall serve as the **lead institution** responsible for coordinating the national survey, inventory, documentation, and geospatial mapping of medicinal plant resources in Bhutan.

As the principal agency for traditional medicine and medicinal plant utilization, NCTMS shall provide overall strategic guidance and ensure that survey and inventory efforts align with national priorities for traditional medicine, biodiversity conservation, sustainable utilization, and resource security.

The lead institution shall work in close coordination with relevant government agencies, technical institutions, Dzongkhags, local governments, research organizations, and community stakeholders to ensure harmonized implementation and effective information sharing.

8.1.1. Roles and Responsibilities of the Lead Institution

The lead institution shall be responsible for the following:

- a. Provide strategic leadership and technical oversight for the planning, coordination, and implementation of medicinal plant surveys and inventories.
- b. Approve survey plans, methodologies, and technical protocols, including sampling designs, field procedures, and geospatial standards.



- c. Coordinate partner institutions and stakeholders to ensure effective collaboration, information sharing, and institutional alignment.
- d. Develop and standardize field tools, data collection formats, and technical standards for inventory, ecological assessment, Geospatial mapping, and database management.
- e. Mobilize financial, technical, and human resources required for field implementation, capacity building, and data management.
- f. Facilitate necessary permits, administrative clearances, and inter-agency coordination required for field surveys and specimen collection.
- g. Facilitate data management, quality assurance, and validation, including species verification, GIS quality control, and database maintenance.
- h. Establish and maintain a centralized medicinal plant geo-database and information management system to support long-term monitoring and evidence-based planning.
- i. Review, endorse, and approve survey outputs, technical reports, maps, and final recommendations prior to dissemination and official use.
- j. Promote research, knowledge sharing, and capacity development related to medicinal plant conservation, sustainable utilization, and cultivation.
- k. Collaborate with RICBL for safeguarding personnel against field-related risks and unforeseen incidents, all field staff shall be covered under an appropriate insurance scheme.
- l. High altitude allowance:
- m. First Aid:



8.2. Technical and Operational Partners

- 8.2.1. Department of Forest Park Services (DoFPS) (MoENR)
- 8.2.2. National Biodiversity Centre (NBC) (MoAL)
- 8.2.3. National Soil Services Centre (NSSC) (MoAL)
- 8.2.4. National Land Commission Secretariat (NLCS)
- 8.2.5. Menjong Sorig Pharmaceutical Corporation Limited (MSPCL)
- 8.2.6. Faculty of Traditional Medicine (FoTM)
- 8.2.7. Local Government (LG)
- 8.2.8. Local Community Groups (LCG)

8.2.1. Department of Forest Park Services (DoFPS) (MoENR)

The Department of Forest and Park Services shall play a key role in the planning, coordination, and implementation of field activities related to the survey, inventory, and mapping of medicinal plants within the assigned jurisdiction.

8.2.1.1. Roles and Responsibilities

- a. Assist in the identification, survey, and inventory of medicinal plant species in the field.
- b. Coordinate and facilitate field activities, including mobilization of field staff, local communities, and relevant stakeholders.
- c. Guide the survey team in locating medicinal plant habitats and ensure proper coverage of sampling sites.
- d. Record field observations, ecological characteristics, habitat conditions, and distribution patterns of medicinal plant species.
- e. Support geo-referencing, mapping, and spatial documentation of medicinal plant resources using mobile based GIS applications.
- f. Ensure accurate collection, verification, and maintenance of field data in accordance with prescribed survey protocols and standards.
- g. Facilitate consultations with local communities and resource users to gather indigenous knowledge/*local* and information related to medicinal plants.
- h. Monitor field logistics, safety, and adherence to approved methodologies during field survey
- i. Assist in specimen collection, tagging, photography, and documentation for species verification where required.



- j. Assist in preparing field reports and submit survey findings, challenges, and recommendations to the concerned authority in a timely manner.
- k. Ensure compliance with relevant rules, regulations, and permit requirements related to biodiversity conservation and medicinal plant resource assessment.

8.2.2. National Biodiversity Centre (NBC) (MoAL)

8.2.2.1. Roles and Responsibilities

- a. Taxonomic Identification of medicinal plants
- b. Maintaining herbarium specimens and reference collections
- c. Digitizing biodiversity information systems (herbarium data)
- d. Policy and Institutional coordination (NBSAP, Biodiversity Act)

8.2.3. National Soil Service Centre (NSSC) (MoAL)

8.2.3.1. Roles and Responsibility

- a. Soil description
- b. Collect soil samples
- c. Determination of soil chemical and physical properties
- d. Laboratory interpretation and recommendation

8.2.4. National Land Commission Secretariat (NLCS)

8.2.4.1. Roles and Responsibilities

- a. Assist in defining survey boundaries and study area extents using existing spatial datasets.
- b. Support habitat stratification by generating elevation zones, slope, aspect, and vegetation layers.
- c. Ensure spatial accuracy
- d. Generate thematic maps, including:
 - Species distribution maps
 - Habitat association maps
 - Elevation range maps
 - Abundance and density maps
 - Threat hotspot maps
 - Conservation priority maps



- e. Perform spatial analysis such as:
 - Species richness mapping
 - Overlay analysis (species vs habitat vs disturbance)
 - Hotspot identification
 - Habitat suitability mapping (where applicable)
- f. Ensure interoperability with national systems (e.g., land, forestry, biodiversity databases).
- g. Standardize spatial data formats for long-term storage and sharing

8.2.5. Menjong Sorig Pharmaceutical Corporation Limited (MSPCL)

8.2.5.1. Roles and Responsibilities

- a. Assist in identifying and authenticating species with Sowa Rigpa nomenclature in the field
- b. Connect the survey team with a community group to get real time information on plant distribution and abundance.
- c. Engage in surveying and mapping the medicinal plants
- d. Share information and other technical expertise
- e. Support to record the species and engage in developing herbariums, compiling pictorial or descriptive guidebooks for future references
- f. Provide list of rare and endangered medicinal plant species
- g. Resources sharing/cofinancing on some surveys and others
- h. Help collecting some data while collecting medicinal plants by MSPCL every year
- i. Identifying alternative resources sourcing

8.2.6. Faculty of Traditional Medicine (FoTM)

8.2.6.1. Roles and Responsibilities

- a. Support/Lead in technical expertise on identification and classification of species and medicinal plants.
- b. Information dissemination of research results (medicinal plant survey)
- c. Support in data analysis, report preparation and publication
- d. Integrate mapping and documentation within their curriculum.
- e. Rare or endangered species replacement research (lead)



8.2.7. Local Government (LG)

8.2.7.1. Roles and Responsibilities

- a. Coordinate local permissions and logistics
- b. Mobilize local communities and guide
- c. Ensure coordination with local authorities

8.2.8. Local Community Groups (LCG)

8.2.8.1. Roles and Responsibilities

- a. Share indigenous/local knowledge
- b. Help identify medicinal plants and locations
- c. Support field movement and local guidance
- d. Encourage local communities to engage in the survey in providing the required information.

9. RECOMMENDED FIELD TEAM COMPOSITION

A standard field team should include:

- 9.1.** Team Leader / Principal Investigator
- 9.2.** Botanist / Taxonomist
- 9.3.** Traditional Medicine Professionals
- 9.4.** Ecologist / Forester
- 9.5.** GIS Officer/Survey Engineer/Surveyor
- 9.6.** Field Enumerators
- 9.7.** Community Liaison / Local Guide
- 9.8.** Soil surveyor/expert

10. DEFINITIONS AND KEY TERMINOLOGY

For standardization, the following terms should be used:

- 10.1. Medicinal Plant:** A plant species used for therapeutic, preventive and pharmacological research purposes in the traditional medicine system.
- 10.2. Species:** A group of plants that share common characteristics and can interbreed to produce fertile offspring under natural conditions.
- 10.3. Occurrence Point:** A geo-referenced record confirming the presence of a species.



- 10.4. Transect:** A linear survey path used to observe ecological change or species occurrence.
- 10.5. Quadrat/Plot:** A fixed sampling unit used to assess species abundance and habitat variables.
- 10.6. Regeneration:** The presence of younger classes (seedlings, juveniles, saplings) indicating population renewal.
- 10.7. Voucher Specimen:** A physical, permanently preserved sample of an organism (such as a plant, insect, or tissue) deposited in a recognized scientific repository, like a natural history museum or herbarium for taxonomic verification, future study and data validation.
- 10.8. Habitat Patch:** A spatially distinct area with similar vegetation and ecological conditions.
- 10.9. Threat Hotspot:** A site or cluster of sites showing elevated harvesting or habitat disturbance pressure.
- 10.10. Kobo Toolbox:** is an open-source digital data collection and management platform designed for field surveys, monitoring, and assessments, particularly in remote or resource-limited environments. It enables users to design forms, collect field data using mobile devices, manage, analyze, and export data in real time or offline.
- 10.11. GIS (Geographic Information System):** is a computer-based system used to collect, store, manage, analyze, and visualize spatial or geographic data. It enables the integration of field observations with geographic coordinates to map, analyze, and interpret the distribution and relationships of natural resources across landscapes.
- 10.12. GPS (Global Positioning System):** is a satellite-based navigation system used to determine the precise geographic location of a point on the Earth's surface. It provides location coordinates such as latitude, longitude, altitude, and elevation, enabling accurate positioning and spatial data collection.
- 10.13. Epicollect5:** is a free mobile and web-based data collection platform developed for field surveys, ecological studies, biodiversity assessments, and participatory research. It allows users to create



customizable digital forms and collect geo-referenced data using smartphones or tablets, with both online and offline functionality.

10.14. SW MAP: refers to a software-based mapping tool or workflow used to digitally record, visualize, and analyze spatial data collected during field surveys.

10.15. Inventory: refers to the systematic process of identifying, recording, and cataloging resources or assets within a defined area. It involves collecting detailed information about the type, quantity, location, and condition of items such as medicinal plants, habitats, or other natural resources.

10.16. Polygon: Closed geometric shape used in Geographic Information Systems (GIS) to represent spatial areas such as habitats, land parcels, forest types, lakes, or administrative boundaries. It is formed by connecting multiple coordinate points in a continuous line, where the first and last points are the same, creating a closed boundary that encloses an area.

10.17. Qfield: mobile Geographic Information System (GIS) application that works directly with QGIS. It is designed for field data collection, map viewing, and spatial editing on smartphones and tablets.

11. SURVEY TYPES AND APPROACHES

The choice of survey approach depends on the objective, terrain, species and available resources.

11.1. Rapid Reconnaissance Survey

A Rapid Reconnaissance Survey of medicinal plants is a quick, preliminary field assessment carried out to obtain an overall understanding of medicinal plant resources in a specific area within a short period of time. The main purpose of this survey is to:

- a. Provide a quick overview of medicinal plant diversity and availability
- b. Identify priority areas for conservation or detailed study
- c. Guide the planning of more comprehensive ecological or species-specific surveys



- d. Support early decision-making in resource management and planning

This approach is used for:

- a. Broad landscape screening,
- b. Presence/absence confirmation,
- c. Locating collection zones,
- d. Preliminary site selection

11.2. Detailed Ecological Survey

A systematic and comprehensive field study conducted to document medicinal plant diversity, distribution, abundance, habitat characteristics, and regeneration within a defined area. The survey uses standardized methods such as systematic random sampling and Transact method, GIS mapping, and vegetation sampling to assess ecological conditions, including soil, climate, altitude, moisture, and human impacts affecting the growth and sustainability of medicinal plants.

This approach is used for:

- a. Density estimation,
- b. Regeneration analysis,
- c. Habitat Association,
- d. Conservation planning.

11.3. Species-Specific Survey

A focused field study conducted to collect detailed information on a specific medicinal plant species, including its distribution, population status, habitat preference, regeneration, phenology, and threats within a defined area. The survey uses targeted methods such as systematic random sampling and Transact method, direct observation, GIS/remote sensing mapping, and local knowledge to ensure accurate identification and documentation.

This approach is used for:

- a. Rare or threatened species,
- b. High-demand species,
- c. Species under overharvesting pressure,
- d. Species identified for cultivation.



11.4. Habitat-Based Survey

A Habitat-Based Survey of medicinal plants is a systematic ecological assessment that focuses on identifying, documenting, and evaluating the habitats where medicinal plants naturally occur, rather than only listing the species themselves.

It involves studying different habitat types (such as forests, grasslands, wetlands, or alpine areas) to understand:

- a. The distribution and abundance of medicinal plants,
- b. The environmental conditions that support their growth (soil, climate, altitude, moisture), and
- c. The ecological status and threats affecting those habitats.

This approach is used for:

- a. Medicinal plant-rich habitats,
- b. Alpine meadows,
- c. Riparian zones,
- d. Forest understories,
- e. Specific ecological niches.

11.5. Participatory Community Resource Survey

A community-based assessment approach that actively involves local people in identifying, documenting, and assessing medicinal plant resources. It integrates traditional knowledge with field observations and participatory tools such as group discussions, mapping, field walks, and local consultations to document species availability, distribution, uses, and harvesting practices. The main purpose of this survey is to:

- a. Document locally known medicinal plants and their uses
- b. Understand availability, abundance, and harvesting patterns
- c. Identify areas of importance for conservation and sustainable use
- d. Strengthen community involvement in managing medicinal plant resources

This approach is used for:

- a. Local collectors or healers hold important location knowledge,
- b. Historical abundance trends are needed,
- c. Participatory mapping is appropriate.



12. PRE-SURVEY PLANNING AND PREPARATION

12.1. Desk Review

A desk review for a medicinal plant survey is the process of collecting and analyzing existing information on medicinal plants from published and unpublished sources before conducting fieldwork (Krug & Milliken, 2008). It involves reviewing materials such as ethno-botanical studies, herbarium records, scientific journals, traditional medicine texts, biodiversity reports, maps, area boundaries, policy documents, and databases to understand what is already known about medicinal plant species in the study area. The purpose of this desk review is to:

- a. Identify known medicinal plant species and their uses
- b. Understand their distribution, habitat, and conservation status
- c. Detect knowledge gaps and priority areas for field investigation
- d. Help design efficient and focused field survey methods

12.2. Define Survey Questions

Survey questions for a medicinal plant survey are a structured set of carefully designed questions used to collect information related to medicinal plants from communities, practitioners, or field observations.

These questions are developed to gather reliable data on aspects such as types of medicinal plants used, local names, parts used, preparation methods, availability, habitat, harvesting practices, and perceived medicinal uses. They may include:

- a. Closed-ended questions (e.g., whether a plant is available or not, frequency of use) for quick analysis
- b. Open-ended questions (e.g., local uses, preparation methods, traditional knowledge) to capture detailed indigenous knowledge

The purpose of these survey questions is to ensure systematic documentation of ethno-botanical knowledge and ecological information, which supports medicinal plant conservation, sustainable use, and further scientific research. Basically, it is crucial to reflect on the following questions; -

- a. Where do the priority medicinal plants occur?
- b. What is their abundance and regeneration status?
- c. Which sites are under greatest harvest pressure?



- d. Which habitats are most suitable for conservation or cultivation?
- e. Which species require urgent intervention?

12.3. Select Priority Species

Select Priority Species for a medicinal plant survey refers to the process of identifying and choosing specific medicinal plant species that will be given focused attention during the survey and subsequent study or conservation work. This selection is based on clear criteria such as: -

- a. Medicinal importance (widely used or highly valued in traditional medicine)
- b. Threat status (rare, endangered, or declining species)
- c. High market demand or overharvesting pressure
- d. Ecological significance (indicator or keystone species)
- e. Endemic or restricted distribution (found only in limited areas)
- f. Declining regeneration,
- g. Potential for cultivation or domestication

The purpose of selecting priority species is to focus limited time and resources on the most important or vulnerable plants, ensuring that the survey produces relevant data for conservation planning, sustainable use, and further research.

12.4. Select Survey Areas

Selection of Survey Areas for a medicinal plant survey refers to the process of identifying and choosing specific geographical locations where the survey will be conducted to study medicinal plant diversity and distribution. These areas are selected based on factors such as:

- a. High diversity or richness of medicinal plants
- b. Different habitat types (forests, grasslands, wetlands, alpine zones, etc.)
- c. Known traditional use areas where medicinal plants are commonly collected
- d. Accessibility and safety for fieldwork
- e. Representation of ecological zones to ensure comprehensive coverage
- f. Presence of threatened or important species
- g. Community knowledge on the medicinal plant species



The purpose of selecting survey areas is to ensure that the study covers ecologically and culturally important sites, allowing researchers to gather representative and meaningful data on medicinal plant resources for conservation, sustainable use, and management planning.

12.5. Permissions and Approvals

Permissions and Approvals in a medicinal plant survey refer to the process of obtaining official consent and authorization from relevant authorities and stakeholders before conducting fieldwork or collecting information on medicinal plants. This step ensures that the survey is carried out legally, ethically, and with respect to local communities and biodiversity regulations. It typically involves securing approval from:

- a. Government agencies or ministries responsible for forestry, agriculture, environment etc.
- b. Local administrative authorities (e.g., District or Community Leaders)
- c. Protected area management authorities if the survey is within national parks or conservation areas
- d. Community consent, especially where traditional knowledge or resource use is involved
- e. Specimen collection permit

The purpose of obtaining permissions and approvals is to:

- a. Ensure compliance with national laws and biodiversity regulations
- b. Promote ethical research practices and respect for indigenous knowledge
- c. Facilitate smooth field access and cooperation from local stakeholders
- d. Prevent illegal collection or misuse of medicinal plant resources

12.6. Training and Standardization

Training and Standardization in a medicinal plant survey refers to the process of preparing the survey team with the required knowledge and ensuring that all members follow uniform methods and procedures during fieldwork. Training involves building the capacity of enumerators, researchers, and field assistants so they can correctly:



- a. Identify medicinal plant species (including local and scientific names)
- b. Use Web and mobile based field tools such as GPS, field, EpiCollect5, SW Map, field quadrats, transect lines, and data sheets
- c. Conduct interviews with local knowledge holders
- d. Record ecological and ethno-botanical information accurately
- e. Follow ethical guidelines when collecting information
- f. Adhere to standardized photo protocols when documenting medicinal plants
- g. Understands and apply essential safety skills during fieldwork
- h. Follow voucher specimen collection protocols

Surveyors are trained through classroom sessions on objectives, species identification, and survey tools, followed by hands-on practice with modern web and mobile based field tools such as Qfield, Epicollect5, SW map, Kobo Toolbox. Role-plays and pilot field surveys reinforce skills. Trainers emphasize ethical conduct, data quality, and standardized methods, with supervision and feedback ensuring consistency and accuracy in data collection.

Standardization ensures that all team members collect and record data in the same way, so the results are consistent and comparable. This includes:

- a. Using standard definitions and survey formats
- b. Applying the same sampling methods and measurement techniques
- c. Following uniform protocols for interviews and observations
- d. Ensuring consistent recording of plant names, habitat descriptions, and quantities

The main purpose of training and standardization is to:

- a. Improve accuracy and reliability of data
- b. Reduce errors and bias in data collection
- c. Ensure consistency across different survey teams and sites
- d. Enhance the quality and scientific credibility of the medicinal plant survey



13. SELECTION OF TARGET SPECIES AND SURVEY AREAS (if required)

13.1. Based on Prioritization

Generally, we target all the medicinal plants that are used in traditional medicine production, but selection of specific targets may have to apply in case of the following situation.

- a. Rarity (ICIMOD, 2006)
- b. Demand in TM,
- c. Collection pressure,
- d. Regeneration condition,
- e. Habitat sensitivity,
- f. Conservation value,
- g. Cultivation feasibility.
- h. Endemic species of medicinal plants.

13.2. Habitat Stratification

Habitat stratification is a method of dividing a study area into distinct ecological or environmental zones (called “strata”) based on habitat characteristics such as altitude, vegetation type, soil, moisture, slope, or climate. In simpler terms, it means grouping similar habitats together before conducting a survey so that data collection is more organized and representative. This method is used to: -

- a. Ensures all habitat types are properly represented in a survey
- b. Improves accuracy of sampling and data collection
- c. Helps compare species distribution across different environments

Survey areas should be stratified by:

- a. Elevation zone,
- b. Forest type,
- c. Aspect,
- d. Moisture regime,
- e. Disturbance class,
- f. Land-use category,
- g. Protected / non-protected area



14. SURVEY DESIGN AND SAMPLING FRAMEWORK

The survey design for medicinal plant assessment is based on a stratified ecological approach to ensure representative and systematic coverage of diverse habitats. The study area is first divided into homogeneous strata using key environmental and management variables such as elevation zones, forest types, slope aspect, moisture regimes, disturbance intensity, land-use categories, and protection status (protected and non-protected areas). This stratification helps capture ecological variability and improves the accuracy of species distribution assessment.

Within each stratum, a probability-based sampling framework is applied, preferably using stratified random sampling to reduce bias and ensure equal representation of habitat types. Sampling units are established in the form of plots, quadrats, or transects depending on terrain conditions and vegetation structure. The size and number of sampling units are determined based on habitat heterogeneity, accessibility, and available resources.

Standardized field protocols are followed for data collection, including recording species composition, abundance, habitat characteristics, and geographic coordinates using available web and mobile based modern GIS technology. Photographic documentation and specimen collection (where permitted) support accurate identification and verification. Surveyors are trained to ensure consistency in data recording and adherence to methodological standards.

Finally, all spatial and field data are compiled into a geo-referenced database, enabling spatial analysis, mapping, and long-term monitoring of medicinal plant resources. This framework ensures scientifically robust, repeatable, and policy-relevant survey outcomes for conservation and sustainable utilization planning.

Recommended Standard Framework

- a. Desk review and site screening
- b. Reconnaissance survey
- c. Stratification by habitat/elevation
- d. Transect establishment
- e. Plot/quadrat sampling



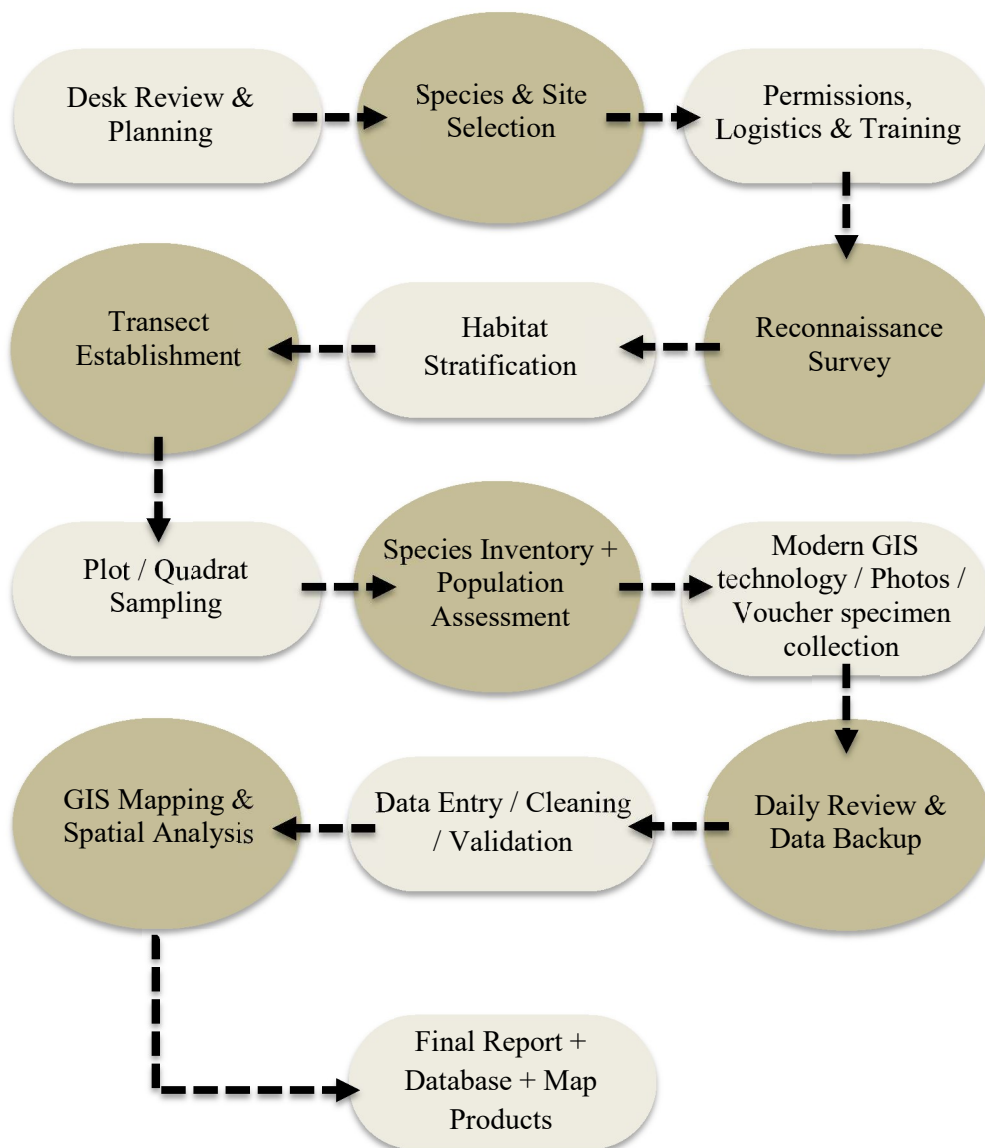
- f. Opportunistic observation
- g. Geospatial data capture
- h. Validation and analysis

The choice of sampling design shall therefore be determined by ecological, geographical, biological, and operational variables that influence medicinal plant occurrence and detectability. The following sampling methods are to be considered while surveying the medicinal plants:

- a. Random Sampling
- b. Systematic Sampling
- c. Stratified Sampling
- d. Quadrat Sampling
- e. Transect Sampling
- f. Cluster Sampling
- g. Purposive Sampling
- h. Opportunistic Sampling
- i. Species-Specific Sampling



15. OVERALL SURVEY WORKFLOW



16. DATA MANAGEMENT, QUALITY ASSURANCE / QUALITY CONTROL AND VALIDATION

16.1. Daily Field Quality Assurance

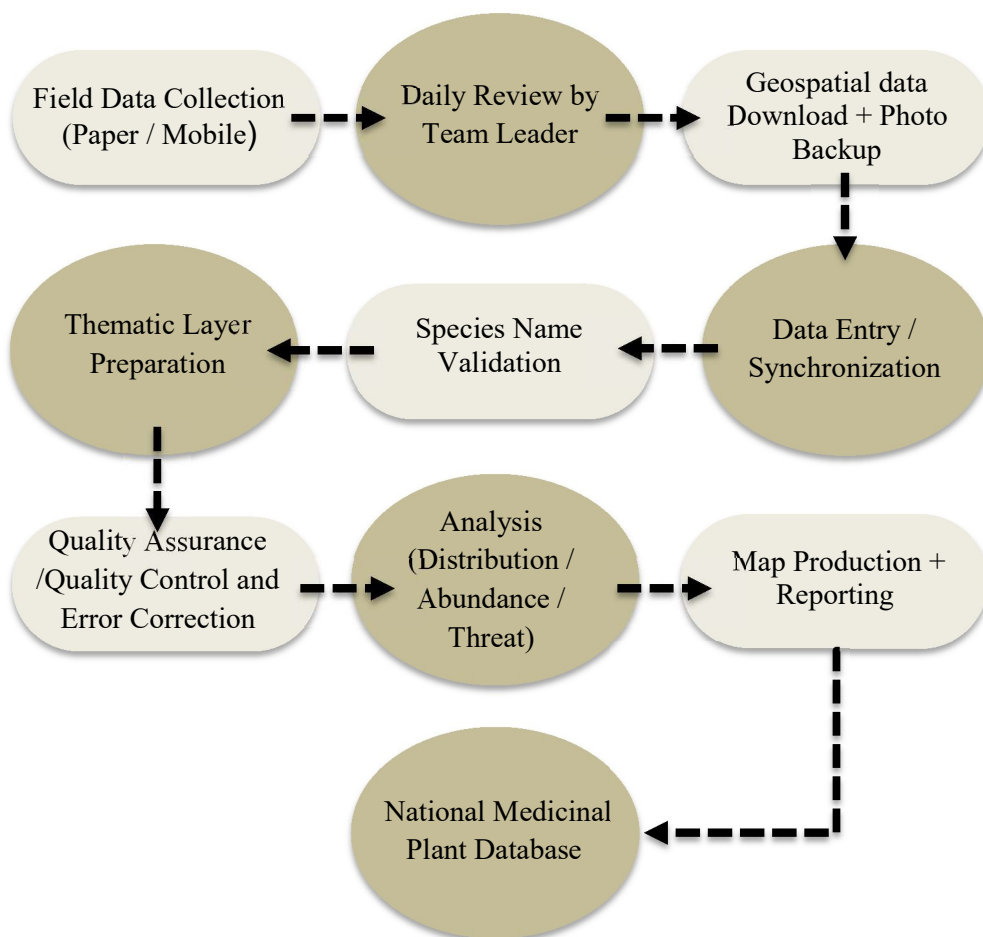
At the end of each field day, all survey forms should be reviewed for completeness, geospatial points verified and saved, photos backed up, voucher specimens properly labeled, and any uncertainties noted for verification the following day.

16.2. Office Data Quality Assurance

After fieldwork, species names should be standardized, coordinates and voucher records verified, missing values checked, duplicates removed, photo IDs cross-checked, and outliers in elevation or habitat carefully inspected.



16.3. Data Flow Diagram



16.4. Surveying / Geospatial Standards

To ensure consistency, interoperability, spatial accuracy, and long-term usability of geospatial information collected during medicinal plant surveys, all survey teams and partner institutions shall adhere to standardized geospatial data recording protocols.

The following minimum geospatial standards shall apply to all spatial data collection, mobile based GIS application observations, mapping activities, and geo-referenced survey records conducted under these Guidelines.



Sl. No.	Parameter	Required Standard
1	Geodetic Datum	WGS84
2	Coordinate Format	Decimal Degrees (DD)
3	Preferred Positional Accuracy	≤10 meters
4	Device for coordinate recording	Mobile based GIS application (Qfield, Epicollect5, GPS, SW Maps)
5	Spatial File Format	GIS compatible Format (Shapefile, xml,etc)
6	Coordinate Reference System (CRS)	EPSG:4326 (WGS84)
7	Elevation Unit	Meters above Sea Level (masl)

17. DATA ANALYSIS AND INTERPRETATION

17.1. Minimum Analyses Required

Each survey should include assessments of species richness, frequency of occurrence, density and abundance, regeneration status, elevation range, habitat association, threat hotspots, and priority ranking.

17.2. Priority Ranking Matrix (Recommended)

Criterion	Score 1	Score 2	Score 3
Rarity	Common	Localized	Rare / restricted
Harvest pressure	Low	Moderate	High
Regeneration	Good	Fair	Poor
TM importance	Moderate	High	Critical
Habitat threat	Low	Moderate	Severe

Higher total score = higher priority for conservation and/or cultivation intervention



18. REPORTING REQUIREMENTS AND OUTPUTS

18.1. Minimum Report Structure

Each completed survey report should include an executive summary, background and objectives, survey area description, methodology, target species and habitats, findings, thematic maps and spatial analysis, priority species and site rankings, recommendations, and annexes containing survey records and supporting data.

18.2. Required Map Outputs

At minimum, the survey should include maps of the survey area, and transects, species occurrence, elevation distribution, habitat association, threat hotspots, conservation priority zones, and potential cultivation suitability where applicable.

19. SAFETY, ETHICS AND RISK MANAGEMENT

19.1. Field Safety

Field teams should conduct pre-departure briefings, carry first aid kits, use communication devices, avoid solo movement in remote terrain, continuously monitor weather and environmental risks such as landslides, wildlife encounters, and exposure to toxic or allergenic plants, and keep local authorities informed of field routes and schedules. To safeguard personnel against field-related risks and unforeseen incidents, all field staff shall be covered under an appropriate insurance scheme, including accident, medical, disability, and emergency evacuation coverage for the duration of field operations.

19.2. Environmental Ethics

Field activities should minimize disturbance by reducing trampling, avoiding unnecessary collection of rare species, rehabilitating disturbed areas where possible, and protecting sensitive locations.



19.3. Knowledge Ethics

Prior informed consent should be obtained, restricted knowledge must not be recorded without approval, sensitive information should be kept confidential, and exact locations of highly vulnerable species should not be published without clearance.

20. EQUIPMENT AND LOGISTICS

Ensure that all essential field survey equipment and tools are available by verifying them against the logistics checklist.

- a. Travel and Field Logistics
- b. Communication and Safety Preparedness
- c. Survey Equipment and Materials

21. REVIEW AND REVISION OF THE GUIDELINES

These guidelines shall be reviewed every three (3) to five (5) years, or earlier if deemed necessary based on evolving technical, ecological, institutional, or regulatory requirements.

The review and revision process shall take into consideration, but not be limited to, the following factors:

21.1. Field implementation experience:

Lessons learned, operational challenges, feedback from field teams, and practical experiences arising from implementation of the guidelines.

21.2. New ecological evidence:

Emerging scientific findings updated ecological assessments, species distribution data, habitat changes, and improved understanding of medicinal plant ecology and regeneration.

21.3. Taxonomic updates:

Revisions in species nomenclature, classification, identification standards, and newly documented medicinal plant species based on accepted botanical references.



21.4. Changes in Traditional Medicine (TM) species priorities:

Inclusion of new priority species shifts in procurement demand, conservation status, or changes in medicinal plant utilization under traditional medicine systems.

21.5. Advancements in digital data collection tools and technologies:

Integration of improved survey technologies, mobile data collection platforms, GIS applications, remote sensing tools, and data management systems to enhance field efficiency and data quality.

21.6. New conservation, legal, or policy requirements:

Updates in national legislation, biodiversity policies, access and benefit-sharing provisions, protected species regulations, or international commitments relevant to medicinal plant management.

The review process shall be coordinated by the lead institution concerned in consultation with relevant technical agencies, field practitioners, biodiversity experts, traditional medicine institutions, and other key stakeholders to ensure that revisions remain practical, scientifically robust, and aligned with national priorities.

Revised versions of the guidelines shall be formally endorsed and disseminated to all implementing agencies to promote standardized and consistent application across medicinal plant resource management programs in Bhutan.



22. CONCLUSION

A standardized system for the survey, inventory, and geospatial mapping of medicinal plant resources is essential for ensuring sustainable management, conservation, and evidence-based decision-making. Consistent implementation of these guidelines will improve the quality and reliability of field data, strengthen conservation and sustainable harvesting, support cultivation and restoration planning, enhance procurement and supply systems, and promote the integration of ecological and geospatial information for informed resource management. These guidelines are intended to serve as both a practical field manual and a technical reference framework for institutions engaged in medicinal plant resource assessment, conservation, and management in Bhutan.



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Note: *The following references were consulted for background information but not directly cited in the text (1, 5, 6, 7,10)*



