Funded by Bhutan Foundation

Field Manual for Medicinal Plants Survey, Inventory & Geospatial Mapping

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

FIRST EDITION
2026

SORIG RESEARCH AND INNOVATION DIVISION

PUBLISHER

Sorig Research and Innovation Division
National Centre for Traditional Medicine Services
Ministry Of Health
PO Box: 297
www.health.gov.bt

LAYOUT & COVER PAGE DESIGN

Sonam Dorji, Menpa, NTMH, NCTMS, MoH, Thimphu

E-MAIL

tchogyal@health.gov.bt
dendupt@health.gov.bt
nlhendup@health.gov.bt
namgyelwangchuk@health.gov.bt
sonamd@health.gov.bt

Printed at Quality Fablab, Thimphu, Bhutan

ISBN: 978-99980-45-23-1

FOREWORD

Bhutan is endowed with rich biological diversity and a wealth of medicinal plant resources that form the foundation of Bhutanese Traditional Medicine (BTM) and contribute significantly to the health, livelihoods, and cultural heritage of the nation. These medicinal resources, distributed across diverse ecological zones ranging from subtropical forests to alpine meadows, represent an invaluable national asset that requires systematic documentation, sustainable management, and long-term conservation.

Recognizing the importance of medicinal plant resources and the growing need for reliable baseline information, the National Centre for Traditional Medicine Services has developed this *Manual for Conducting Field Surveys of Medicinal Plants in Bhutan*. The manual serves as a practical guide for survey coordinators, supervisors, field enumerators, botanists, forestry personnel, local guides, and other stakeholders involved in the mapping and documentation of medicinal plant resources throughout the country.

The manual provides standardized procedures and methodologies for planning and conducting field surveys, collecting ecological and geographical data, documenting species occurrence and abundance, and ensuring data quality and consistency. By adopting a uniform approach, the survey teams will be able to generate credible and comparable information that can support evidence-based decision-making, sustainable harvesting practices, conservation planning, and resource management.

It is our hope that this manual will strengthen national efforts to establish a comprehensive inventory of medicinal plant resources and contribute to the preservation of Bhutan's unique traditional medical heritage and biodiversity for future generations. We extend our sincere appreciation to all individuals and institutions whose expertise and commitment have contributed to the development of this manual.

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

ACKNOWLEDGEMENT

The Sorig Research and Innovation Division, National Centre for Traditional Medicine Services (NCTMS), would like to express its sincere appreciation and gratitude to the Department of Forest & Park Services; Ministry of Energy & Natural Resources; National Land Commission Secretariat; National Biodiversity Centre; National Soil Services Centre; Ministry of Agriculture and Livestock for their support and guidance in developing the *National Guidelines for Geospatial Mapping & Inventory of Medicinal Plants*.

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.

Core working group

1. Norbu Wangdi, Principal Forest Officer, Department of Forest and Park Services
2. Sonam Jamtsho, Range Officer, Lingshi Range, JDNP, Department of Forest and Park Services.
3. Kezang Wangchuk, Biodiversity Officer, National Biodiversity Centre
4. Kuenzang Om, Survey Engineer, Department of Survey and Measurement, National Land Commission Secretariat
5. Drungtsho Yeshi Gyeltshen, Traditional Medicine Advisor, MSPCL
6. Tashi Dorji, Sr. Menpa, Wangdichoeling Hospital, Bumthang
7. Sonam Dorji, Menpa, NTMH
8. Tenzin Dorji, Menpa, NTMH
9. Dendup Tshering, Dy. Chief Program Officer, NCTMS

Reviewer

1. Tandin Chogyel, Program Analyst, SRID, NCTMS, MoH
2. Namgyel Wangchuk, Dy. Chief Program Officer, NCTMS
3. Namgyal Lhuendup, Program officer, NCTMS

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1. INTRODUCTION

Medicinal resources are fundamental to the Bhutanese Traditional Medicine System and play an important role in biodiversity conservation, ecosystem health, cultural heritage and rural livelihoods. Bhutan possesses rich medicinal plant diversity distributed across varied ecological zones ranging from subtropical forests to alpine ecosystems. However, increasing pressure from habitat degradation, overharvesting, infrastructure development, climate variability and unsustainable land-use practices has raised concerns regarding the conservation and sustainable management of medicinal resources in the country. Therefore, systematic assessment, inventory and scientific documentation of medicinal resources are essential to support evidence-based conservation planning and sustainable utilization.

This Field Survey Manual has been developed to provide practical guidance for conducting nationwide field surveys, mapping and documentation of medicinal resources in Bhutan. The manual outlines standardized methods and approaches to ensure consistency, reliability and scientific accuracy in data collection and ecological assessment across different regions and habitats. It serves as a reference document for surveyors, researchers, forestry personnel, traditional medicine professionals and relevant stakeholders engaged in medicinal resource surveys.

The manual describes the scope and objectives of the nationwide survey, including habitat assessment, species identification, population estimation, regeneration status, ecological documentation and geospatial mapping of medicinal plant resources. It provides detailed guidance on survey design, habitat stratification, sampling methods, transect and plot establishment, specimen collection, photography, GPS recording and data management procedures. The manual also highlights the tools and equipment required for field surveys, including GPS devices, measuring instruments, data sheets, field guides and digital applications.

In addition, the manual defines the roles and responsibilities of surveyors and survey teams to ensure coordinated and systematic implementation of field activities. Emphasis is placed on maintaining national standards for data

collection, documentation and reporting to enable comparability and long-term monitoring of medicinal resources. The information generated through these surveys will support conservation prioritization, sustainable harvesting practices, policy formulation and the continued development of Bhutan's traditional medicine system.

2. PURPOSE OF THE SURVEY MANUAL

The purpose of a field survey manual is to provide standardized guidance for planning and conducting field surveys in a systematic, accurate, and consistent manner. It serves as a practical reference for survey teams by outlining the objectives, methods, tools, procedures, and standards to be followed during data collection and documentation.

In the context of mapping and documenting medicinal resources, the manual helps ensure reliable identification, recording, classification, and conservation of medicinal plants and related traditional knowledge. It also promotes uniform data collection, proper use of survey instruments, ethical practices, safety measures, and quality control, enabling the generation of credible information for research, conservation, sustainable utilization, and policy planning.

3. SCOPE OF THE SURVEY MANUAL

This Field Survey Manual is designed to provide standardized procedures and guidance for the nationwide mapping and documentation of medicinal resources in Bhutan, covering both high-altitude and low-altitude ecosystems.

The manual is intended for use by a wide range of personnel involved in field-based data collection and coordination, including field surveyors, survey supervisors, and survey coordinators. It also serves as a key reference for expatriate and technical experts such as botanists, foresters, and other subject specialists, as well as local field guides who contribute indigenous knowledge and on-ground navigation support.

The scope of the manual encompasses all stages of the field survey process, including planning, species identification, data collection, documentation, georeferencing, and preliminary validation of medicinal plant resources. It ensures consistency in methods and standards across different teams and geographic regions.

Geographically, the manual covers the entire country of Bhutan, addressing medicinal resources found across diverse ecological zones from subtropical and temperate regions to alpine and high-altitude environments. It supports the systematic recording of species distribution, habitat characteristics, and associated traditional uses across these varied landscapes. Overall, the manual provides a unified framework to ensure accurate, reliable, and comparable data collection for effective conservation, research, and sustainable utilization of Bhutan's medicinal plant resources.

4. GUIDING PRINCIPLES

All fieldwork should be carried out according to the following principles: scientific validity, practicality, accuracy, conservation sensitivity, ethical engagement, confidentiality, inter-sectoral collaboration, and adaptive learning. These principles mean that the team must collect reliable data with minimal ecological disturbance, respect local knowledge and permissions, and produce records that can be checked, reproduced, and used for decision-making.

a. Use standardized methods and codes across all survey teams.
b. Avoid unnecessary destructive sampling or disturbance to rare or vulnerable species.
c. Protect confidential species locations and restricted traditional knowledge.
d. Integrate ecological observation, spatial recording, and careful documentation every day.

5. STANDARD SURVEY WORKFLOW

The recommended workflow is: desk review, site selection, permissions and logistics, reconnaissance survey, habitat stratification, track/transect and polygon planning, plot/quadrat sampling, species and voucher documentation, daily review, office validation, GIS mapping, and final reporting.

Field surveys shall initially be conducted through a reconnaissance survey to verify tracks, polygons, and survey areas. Subsequently, GPS Garmin devices/SW Maps / QField / EpiCollect5 may be used to navigate verified features and support consistent recording of tracks, polygons, and species observations.

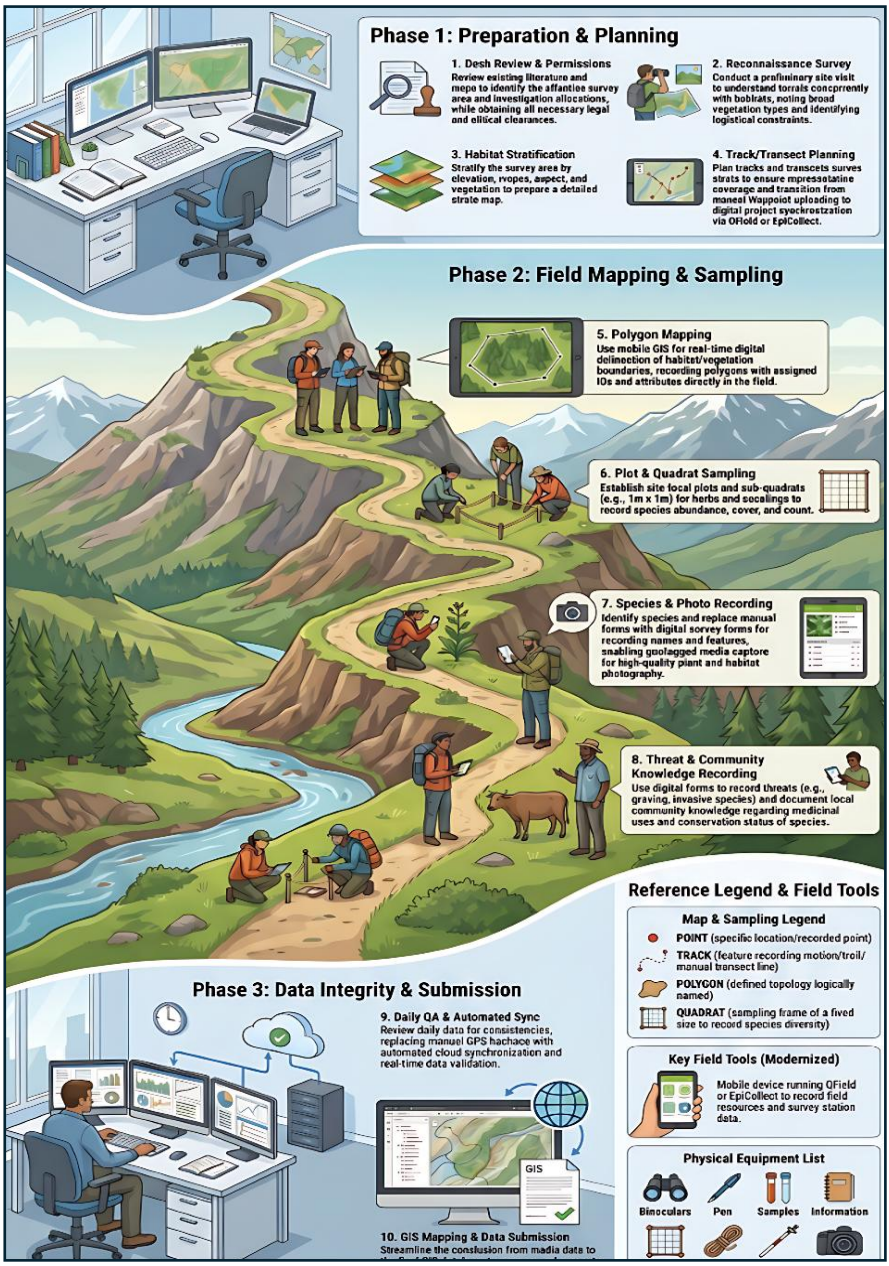

Figure 1. Workflow for medicinal plant field survey, inventory, and geospatial mapping.

6. TEAM COMPOSITION AND RESPONSIBILITIES

A complete field team should normally include a team leader or principal investigator, botanist or taxonomist, traditional

Role	Primary Responsibilities
Team Leader	Overall planning, daily supervision, field decisions, completeness review, safety oversight
Botanist /Taxonomist	Species identification, diagnostic notes, support for voucher decisions
Traditional Medicine Professionals	Sowa Rigpa identification, Sowa Rigpa usage interpretation, cross-check of useful species
GIS Officer/Survey Engineer/Surveyor	Track logging, geolocation, polygon capture, waypoint management, coordinate quality, file export, thematic map generation and analysis
Ecologist / Forester officer	Plot layout, quadrat counts, habitat recording, form completion; Track logging, polygon capture, waypoint management, coordinate quality, file export, any new method or technology, Population assessment, threat analysis, conservation planning.
Enumerators	Plot layout, quadrat counts, habitat recording, form completion
Local Guide/Liaison	Access support, route guidance, local names and usage, community coordination
Soil Expert	Provide soil descriptions, collect soil samples, determine soil properties, and deliver lab interpretations along with management recommendations.

medicine professionals, ecologist or forester, GIS/Survey Engineer/Surveyor, field enumerators, and a local guide or community liaison. This combination ensures that ecological, medicinal, taxonomic, and geospatial dimensions are all covered in the same field operation.

7. PRE-SURVEY PLANNING AND PREPARATION

Effective pre-survey planning is fundamental to the success, efficiency, and scientific reliability of medicinal plant survey, inventory, and geospatial mapping. Thorough preparation enables field teams to optimize time and

resources, improve survey coverage, reduce operational risks, and ensure that field activities are aligned with survey objectives and methodological requirements.

Pre-survey preparation shall be undertaken systematically prior to field deployment and should include desk review, clarification of survey objectives and key questions, site prioritization, permissions and coordination, logistics planning, equipment preparation, and readiness assessment.

Proper planning is particularly important in Bhutan's mountainous terrain, where weather variability, accessibility constraints, protected area regulations, and remote field conditions may significantly influence survey implementation.

7.1. Desk Review and Background Assessment

A comprehensive desk review shall be conducted before field deployment to compile existing information, identify knowledge gaps, and guide the design of field activities. The desk review serves as the foundation for selecting priority survey sites, refining sampling strategies, and improving field efficiency.

Field teams should review and analyze all relevant secondary information, including:

a. Herbarium records and botanical references;
b. Previous medicinal plant survey reports and ecological studies;
c. National guidelines, species inventories, and conservation assessments;
d. Topographic maps, land-use maps, and satellite imagery;
e. Existing GIS layers and habitat distribution information;
f. Medicinal plant species lists and known occurrence records;
g. Historical collection zones and harvesting areas; and
h. Expected elevation ranges, ecological zones, and habitat preferences of priority species.

The desk review should aim to:

a. Identify priority habitats and survey areas;
b. Assess potential species occurrence and habitat suitability;

c. Determine likely access routes, camp locations, and logistical constraints;
d. Identify information gaps requiring field verification; and
e. Support the development of an appropriate sampling and geospatial strategy.

A well-conducted desk review significantly improves field preparedness and reduces duplication of effort during field implementation.

7.2. Defining Survey Objectives and Key Questions

Each medicinal plant survey shall be guided by clearly defined objectives and key questions to ensure that data collection remains focused, relevant, and aligned with management and conservation priorities. Survey questions should clearly articulate what information the survey intends to generate, why it is needed, and how the findings will inform decision-making.

Typical survey questions may include:

a. **Species Distribution:** Where are the medicinal plant species located?

b. **Habitat and Ecological Range:** What habitat types, ecological conditions, and elevation ranges support the species?

c. **Population Status and Abundance:** What is the density, distribution pattern, abundance, and regeneration status of medicinal species?

d. **Threat and Disturbance Assessment:** Which areas show signs of overharvesting, habitat degradation, grazing pressure, erosion, invasive species, or other ecological threats?

e. **Conservation Significance:** Which populations or habitats require priority conservation interventions?

f. **Sustainable Harvesting and Cultivation Potential:** What information is needed to support sustainable harvesting practices, restoration measures, or cultivation planning?

Clearly defined survey questions help determine:

a. the appropriate survey methodology;
b. sampling intensity and design;

c. geospatial mapping requirements;
d. data collection priorities; and
e. expected outputs and reporting needs.

7.3. Permissions, Coordination, and Operational Readiness

All required permissions and operational arrangements shall be completed prior to field deployment to avoid delays, restricted access, or disruptions during implementation. Field teams shall secure necessary approvals and coordinate with relevant institutions, particularly when surveys are conducted within protected areas, community forests, government reserves, or ecologically sensitive sites.

Required permissions may include:

a. Forestry or protected area permits;
b. Research or specimen collection authorization;
c. Local administrative clearances;
d. Community consultation and access agreements;
e. Special permits for restricted or security related areas; and
f. Institutional approval for inter-agency collaboration where applicable.

Therefore, contingency planning, logistical preparedness, and risk mitigation measures shall be completed prior to field deployment to ensure smooth implementation, minimize operational disruptions, and maintain the quality and consistency of survey outputs.

7.3.1. Minimum Operational Readiness Requirements

Before departure, survey teams shall confirm the following:

7.3.1.1. Travel and Field Logistics

a. Travel routes and access conditions verified.
b. Transport arrangements are finalized.
c. Camp or accommodation sites confirmed.
d. Food, fuel, and field supplies arranged.
e. Weather forecasts and suitable field windows assessed.
f. Emergency evacuation routes identified where necessary.

7.3.1.2. Communication and Safety Preparedness

a. Communication devices tested and functional.
b. Emergency contact arrangements confirmed.

c. Team movement and reporting protocols established.
d. First aid supplies prepared.
e. Field safety briefing conducted prior to departure.

7.3.1.3. Survey Equipment and Materials checklists

a. GPS devices, mobile mapping tools, and batteries charged.
b. Printed topographic maps and satellite imagery prepared as backup to digital tools.
c. Standardized field forms, clipboards, and notebooks packed.
d. Measuring tapes, quadrat frames, ropes, compass, and clinometer prepared.
e. Cameras or mobile devices are available for photographic documentation.
f. Voucher specimen collection material: labels and field tags, plant presses, storage bags packed, field clippers, digging tools, blotting or newspaper, where collection is authorized.
g. Spare batteries, power banks, chargers, and waterproof storage materials prepared.
h. Pictorial guides.
(Use FORM No.6 in ANNEXURE X)

8. SITE RECONNAISSANCE SURVEY AND HABITAT STRATIFICATION

8.1. Reconnaissance Survey

Reconnaissance is the first activity at each site. Its purpose is to confirm access, verify target species presence, identify habitat boundaries, note disturbance signs, and decide where tracks, transects, polygons, and plots should be placed. The reconnaissance record should include survey date, team, district and locality, site code, access route, elevation range, habitat type, target species, local informants consulted, disturbance signs, and weather. For reconnaissance surveys, (*Use FORM No.1 in ANNEXURE 1.)* Steps for conducting the reconnaissance survey are as follows:

8.1.1. Review and Prepare the Site Information

Before visiting the field, review available maps, satellite imagery, previous records, species distribution data, and the identified area of interest. Prepare survey forms, GPS devices, maps, and other required equipment for field verification.

8.1.2. Travel to the Survey Site and Confirm Accessibility

Visit the proposed survey area to verify whether the site can be safely and practically accessed. Assess road conditions, foot trails, terrain difficulty, river crossings, camping locations, and transportation requirements.

8.1.3. Verify Presence of Medicinal Species

Conduct an initial field inspection to confirm whether the medicinal plant species are present within the site. Observe species occurrence, approximate abundance, growth stages, and distribution patterns.

8.1.4. Identify and Delineate Habitat Boundaries

Examine the surrounding environment to identify habitat types and ecological boundaries suitable for the target species. Note variations in vegetation, slope, aspect, elevation, moisture condition, and land cover characteristics.

8.1.5. Assess Disturbance and Threat Factors

Observe and record signs of disturbance such as grazing, fire, legal or illegal harvesting, land conversion, invasive species, road construction, erosion, or other anthropogenic pressures that may affect medicinal plant resources.

8.1.6. Consult Local Informants and Community Members

Interact with residents, traditional healers, yak herders, forest users, or community representatives to gather indigenous knowledge regarding species occurrence, harvesting practices, seasonal availability, and local names of medicinal plants.

8.1.7. Determine Survey Design and Sampling Locations

Based on field observations, decide suitable locations for tracks, transects, polygons, plots, and occurrence points. Ensure that selected survey units adequately represent the habitat and species distribution within the area.

8.1.8. Record Geospatial and Environmental Information

Record coordinates, elevation, slope condition, habitat characteristics,

and access routes using GPS Garmin devices, SW Maps, QField, or other approved geospatial tools for future navigation and mapping for the whole area.

8.1.9. Document Reconnaissance Survey Details

Complete the reconnaissance record by documenting:

a. Survey date
b. Survey team members
c. District and locality
d. Site code
e. Access route1
f. Elevation range
g. Habitat type
h. Species observed
i. Local informants consulted
j. Disturbance signs
k. Weather conditions

8.1.10. Finalize and Validate the Survey Area

Review the collected reconnaissance information and confirm the feasibility of conducting the detailed survey and inventory. Finalize the survey boundaries, logistics arrangements, and field methodology before commencing the main inventory survey. And select which GIS or mobile based device is most suited for a particular location (Qfield, SWmaps, Epicollect5, GPS coordinates).

8.2. Habitat Stratification

Habitat stratification is a critical step undertaken following reconnaissance to ensure that medicinal plant surveys adequately capture the ecological diversity and variability of the survey area. The process involves dividing the landscape into **e**cologically meaningful and relatively homogeneous habitat units (strata) so that sampling reflects actual environmental conditions rather than being biased toward easily accessible locations.

In mountainous landscapes such as Bhutan, medicinal plant distribution is strongly influenced by elevation, slope, aspect, moisture availability, vegetation composition, and disturbance regimes. Consequently, a single survey area may contain multiple ecological zones supporting distinct medicinal plant communities. Without proper stratification, survey findings

may underrepresent less accessible habitats and fail to accurately characterize species' occurrence, abundance, and ecological patterns.

Habitat stratification shall be based on observable ecological and environmental characteristics that influence medicinal plant occurrence and habitat suitability. Survey areas should be divided into habitat units that are sufficiently distinct to justify separate observation, mapping, or sampling.

8.3. Representative Habitat Types for Medicinal Plant Survey and Inventory

The following habitat categories are commonly encountered during medicinal plant surveys in Bhutan and should be used during reconnaissance, habitat stratification, and ecological assessment.

8.3.1. Forest Type

Forest type is identified at a broader or general landscape level based on the dominant vegetation, climatic condition, and altitude zone of the area. It represents the overall classification of the forest ecosystem within a larger area. Forest types are usually determined using:

a. Dominant tree species
b. Altitudinal range
c. Climatic condition
d. Canopy characteristics

Forest type provides a general understanding of the ecological zone and vegetation formation of the study area.

Bhutan's forests are generally categorized into 11 primary types, considering factors such as altitude, climate, vegetation structure, and the composition of dominant species. Recognizing these forest types is crucial for conducting surveys and inventories of medicinal plants, as the distribution, abundance, phenology, and habitat preferences of medicinal species can differ substantially across various ecological zones. The 11 major forest types are:

8.3.1.1. Subtropical Forest


Precipitation: 2,500 – 5,000 mm/year (highest in the country; summer monsoon dominant).
Elevation: 200 - 1000 masl
Characteristics: Found in the southern foothills, contains many tropical genera and species forming dense jungle.
Major Area: Southern districts (Samtse, Sarpang, Samdrup Jongkhar, southern Chhukha).

8.3.1.2. Warm Broadleaved Forest


Precipitation: 2,300– 4,000 mm/year.
Elevation: 1000 - 2000 masl
Characteristics: Occurs at higher altitude with low rainfall compared to subtropical forests contain mixture of deciduous and evergreen broadleaved tree species.
Major Area: Central and eastern Bhutan (Punakha, Wangdue, Tsirang, Mongar, Trashigang).

8.3.1.3. Chirpine Forest

Precipitation: 1,000 – 1,300 mm/year (primarily summer monsoon; long dry season).
Elevation: 900 –1,800 masl
Characteristics: Low altitude xerophytic forest occurring in the deeper valleys of Bhutan. Almost no other trees in such forest other than Chirpine.
Major Area: Dry inner valleys and southern slopes (Punakha, Wangdue, southern Thimphu, Paro).

8.3.1.4. Cool Broadleaved Forest

Precipitation: 2000 - 3000 mm/year (moderate to high, depending on location).
Elevation: 2000 - 2900 masl
Characteristics: Usually found above the warm broad leave forest on the wetter slopes, dominated with both mixed deciduous and evergreen broadleaved species with oak being less common.
Major Area: Widespread across central and western Bhutan (Thimphu, Paro, Haa, Bumthang, Trongsa).

8.3.1.5. Evergreen Oak Forest

Precipitation: 2,000 – 3,000 mm/year.
Elevation: 1800 -2000 masl
Characteristics: Occurs above warm board leave forest, together with cool broad leave forest but on drier slopes, not much shrub layer, whilst shady humid floors are dominated by small herbs.
Major Area: Scattered in central and western Bhutan (Thimphu, Wangdue, Trongsa, Mongar).

8.3.1.6. Blue Pine Forest

Precipitation: 700 – 1,200 mm/year
Elevation: 2100 – 3000 masl
Characteristics: Found in dry inner valleys where rainfall is very low except in monsoon season. Xerophytic shrubs occur and herbs mostly appear during the monsoon season.
Major Area: Paro, Thimphu, Haa, Bumthang.

8.3.1.7. Spruce Forest

Precipitation: 500 – 1,000 mm/year
Elevation: 2500 – 3100 masl
Characteristics: Occupy the montane cloud forest zone of Bhutan between the temperate board leaved forest and tree line, found in lower altitudes and occupies drier valleys.
Major Area: Northern and high-altitude areas (Gasa, Bumthang, Lhuntse, northern Thimphu).

8.3.1.8. Hemlock Forest

Precipitation: 1,300 – 2,000 mm/year
Elevation: 2800-3100 masl
Characteristics: Found in similar zone with spruce forest but occupies wetter slope due to high precipitation requirement, shrubby and Rhododendrons are often mixed with this forest.
Major Area: Northern and western Bhutan (Gasa, Paro, Haa, Bumthang).

8.3.1.9. Fir Forest

Precipitation: 1,300 – 2,000 mm/year
Elevation: 3100 – 3300 m asl
Characteristics: It is the characteristics of highest forested ridge throughout Bhutan, has dense canopy providing humid environment for luxuriant understory of Rhododendrons and other shrubs, and the mossy ground layer which supports many small shrubs.
Major Area: High-altitude northern valleys (Gasa, Bumthang, Lhuntse, northern Thimphu, Paro).

8.3.1.10. Juniper-Rhododendron Scrub

Elevation: 3700 – 4200 masl
Characteristics: High-altitude scrub forest, characterized by stunted growth forms due to harsh climatic conditions, moist scrub vegetation occurring above tree line through northern and central Bhutan.
Major Area: Alpine regions, mountain passes, and upper treeline zones (Pele-la, Thrumshing-la, Halajula, Phajoding, Laya, Lunana).

8.3.1.11. Dry Alpine Scrub

Elevation: 4000 – 4600 masl.
Characteristics: More xerophytic vegetation, found at higher altitude than juniper/Rhododendron scrub.
Major Area: High Himalayan regions (Lunana, Laya, Soi, Jhomolhari, upper Bumthang). (DoFPS, 2022, DoFPS, 2016).

Field Note for Medicinal Plant Survey:

During reconnaissance, transect establishment, and plot-level ecological assessment, the forest type shall be recorded as a mandatory habitat variable, as it strongly influences medicinal plant occurrence, abundance, regeneration, and conservation status.

8.3.2. Habitat Types

Bhutan's geography ranges from subtropical foothills to alpine mountains, creating highly diverse habitats that support different medicinal plant communities. For a medicinal plant survey manual or SOP, habitats should be described according to ecological zones, elevation, vegetation type, and medicinal plant occurrence.
Below is a Bhutan-specific habitat classification in the context of medicinal plant surveys.

8.3.2.1. Alpine Meadow Habitat (High Himalaya)

Open grasslands occurring above the tree line in high mountain areas.

Elevation - 4,000 -5,500 masl
Characteristics • Treeless open meadows • Short growing season • Snow cover during winter • Strong winds and frost
Geographic Areas • Northern Bhutan • High-altitude regions of Laya, Lunana, Lingzhi, and northern Paro District
Common Medicinal Plants • *Ophiocordyceps sinensis* (Yartsa Guenboob) • *Nardostachys jatamansi* (pang poe) • Rhodiola imbricata (solo marpo) • *Saussurea gossypiphora* (jagod sugpa)
Survey Considerations • Short survey window (June–September) • Accessibility challenges • Climate-sensitive species

8.3.2.2. Alpine Scrub / Shrubland Habitat

Vegetation is dominated by dwarf shrubs below alpine meadows.

Elevation • 2,500–4,000 m
Characteristics • Dense shrub vegetation • Rocky slopes • Moist to cold conditions
Geographic Areas • Northern Bhutan • High-altitude regions of Laya, Lunana, Lingzhi, and northern Paro District
Dominant Vegetation • Rhododendron species • Juniper scrub • Dwarf shrubs
Common Medicinal Plants • *Juniperus recurva* (shugpa) • *Rheum australe* (Chuma tsi) • *Aconitum ferox* (tsen dug)
Survey Considerations • Useful for locating high-value alpine medicinal herbs in rocky microsites

8.3.2.3. Temperate Broadleaf Forest Habitat

Dense broadleaf forests dominated by oak and mixed hardwood species.

Elevation • 2,000–3,500 masl
Characteristics • Moist forest floor • Thick litter layer • Rich understory vegetation
Geographic Areas • Central and western Bhutan, including parts of Thimphu District, Haa District, and Bumthang District
Common Medicinal Plants • *Paris polyphylla* (Thoksumpa) • *Valeriana jatamansi* (Gatig) • *Swertia chirayita* (ja tig)
Survey Considerations • Excellent habitat for shade-loving medicinal plants.

8.3.2.4. Conifer Forest Habitat

Forests are dominated by conifer species.

Elevation • 1,800–4,000 masl
Characteristics • Needle litter • Cooler climate • Moderate understory diversity
Dominant Vegetation • Blue pine forest • Fir forest • Hemlock forest • Spruce forest
Geographic Areas • Northwestern Bhutan (Haa & Paro) • Central Bhutan (Thimphu & Wangdue Phodrang) • Eastern Bhutan (Mongar & Trashigang) • High-altitude regions (like Bumthang) are often above 3,000 meters.
Common Medicinal Plants • *Taxus baccata* • *Berberis aristata* (kyer pa karpo) • *Daphne bholua* (Sinshing Na ma Karpo)
Survey Considerations • Good habitat for understory medicinal herbs and shrubs.

8.3.2.5. Subtropical Broadleaf Forest Habitat

Warm, humid forests in southern Bhutan.

Elevation • 150–2,000 masl
Characteristics • Heavy rainfall • Dense vegetation • Evergreen trees
Geographic Areas • Southern districts of the country such as Sarpang, Samtse, and Zhemgang District
Common Medicinal Plants • *Terminalia chebula* (Aru) • *Phyllanthus emblica* (Baru) • *Cinnamomum tamala* (shing tsha)
Survey Considerations • High medicinal plant diversity but difficult access.

8.3.2.6. Riparian / Stream-edge Habitat

Vegetation growing along streams, rivers, and wetlands and it occurs across all elevations

Elevation • 200 - 3,800 masl
Characteristics • Moist soil • Frequent flooding • High nutrient availability
Geographic Areas • Western Bhutan (Paro and Thimphu Valleys) • Central Bhutan (Punakha and Wangdue Phodrang) • Eastern Bhutan (Mongar and Trashigang) • Southern Bhutan (Sarpang and Samdrup Jongkhar)
Common Medicinal Plants • *Houttuynia cordata* • *Centella asiatica* • *Mentha longifolia*
Survey Considerations • High density of herbaceous medicinal species.

8.3.2.7. Wetland / Marsh Habitat

Waterlogged ecosystems with permanent or seasonal moisture. The main wetland types are swamp, bog, fen and peat land.


Elevation • 200 - 3,000 masl
Characteristics • Saturated soils • Slow drainage • Rich organic matter
Geographic Areas • Bumthang Valley • Punakha Valley • Phobjikha Valley • East Bhutan (Trashigang) • Bhutan's Southern Regions (Sarpang and Samdrup Jongkhar): These areas have subtropical wetlands that retain moisture throughout the year and support diverse flora.
Common Medicinal Plants • *Acorus calamus* (shu dag nagpo) • *Equisetum arvense*
Survey Considerations • Seasonal accessibility

8.3.2.8. Grassland / Open Pasture Habitat

Open terrestrial ecosystems dominated by grass and herbaceous plants, including open grazing lands and abandoned agricultural areas.

Elevation • 200 - 4,500 masl
Characteristics • Open sunlight • Grazing pressure • Seasonal flowering
Geographic Areas • Bumthang Valley • Central Bhutan (Punakha and Wangdue Phodrang) • Phobjikha Valley • Southern Bhutan (Sarpang and Samdrup Jongkhar): These areas feature subtropical grasslands, providing pastures for livestock. • Northern Regions (Lunana & Dungkar)
Common Medicinal Plants • *Artemisia vulgaris* (khenpa) • *Plantago major* (na ram)
Survey Considerations • Good for transect-based inventories.

8.3.2.9. Rocky Terrain / Scree Slope Habitat

Refers to steep, unstable landforms dominated by exposed rocks, loose stones, boulders, gravel, cliffs, and fragmented mountain debris. These habitats develop primarily on mountain slopes where physical weathering, freeze–thaw cycles, erosion, landslides, and rockfall continuously break down bedrock into loose materials.

Elevation • 200 - 4,500 masl
Characteristics • Poor soil • High exposure • Specialized vegetation
Geographic Areas • Northern Bhutan (Lunana Region) • The Eastern Himalayas (Kunzang and Kharpung) • Bhutan's Western Himalayas (Jhomolhari) • Paro Taktsang (Tiger's Nest) • Bagyud and Laya areas
Common Medicinal Plants • *Bergenia ciliata* • *Rheum nobile* (Chukar meto)
Survey Considerations • Difficult terrain requiring safety measures. Mostly found high-value medicinal and aromatic plants (MAPs)

8.3.2.10. Disturbed / Secondary Habitat

Disturbed / Secondary Habitat refers to ecosystems that have been altered, modified, or regenerated following natural disturbances or human activities. These habitats are characterized by vegetation that develops after the original vegetation cover has been partially or completely disturbed.
Secondary habitats are particularly important in medicinal plant surveys because many medicinal species thrive in open, nutrient-rich, disturbed environments with increased sunlight and reduced competition. Certain medicinal herbs are even more abundant in disturbed areas than in mature forests.

Characteristics • Early successional vegetation • Fast-growing herbs and shrubs
Common Medicinal Plants • *Urtica dioica* (Zadrum/ Za kar) • *Artemisia indica* • *Rumex nepalensis* (sho mang)
Survey Considerations • Useful for assessing anthropogenic impacts on medicinal plant populations.

Habitat type is identified at a more specific or localized level, often within a particular sampling plot, quadrant, or survey site. It describes the actual living environment and ecological condition present within that smaller area. Habitat type focuses on:

a. Vegetation structure
b. Moisture condition
c. Landform
d. Presence of water sources
e. Wildlife usage
f. Human disturbance

A single forest type may contain several different habitat types. For example, within a cool broadleaf forest, habitats may include streamside habitat, dense forest habitat, open canopy habitat, or grazing meadow habitat

8.3.3. Soil

Soil science forms the ecological foundation for understanding the spatial distribution and habitat preferences of medicinal plants in Bhutan. Variations in soil texture, pH, organic matter, and nutrient composition directly influence plant physiology, growth rate, and secondary metabolite production (Dendup & Rai, 2022, Liu et al., 2015, Suwaidi & Farsi, 2025). High-value species such as *Paris polyphylla, Aconitum ferox*, and *Nardostachys jatamansi* exhibit strong dependence on loamy and peaty soils of temperate and alpine zones, where moisture retention and nutrient cycling support optimal regeneration.

8.3.3.1. Soil Condition

Soil conditions in high-altitude ecosystems are a key factor influencing the distribution, diversity and growth of wild medicinal plants. In fragile mountain environments such as Soe, Naro and Lingshi, soil properties including texture, organic matter content, soil pH, and nutrient availability strongly determine plant diversity and productivity. Understanding soil characteristics is therefore essential for identifying suitable habitats for important medicinal species and for ensuring their conservation and sustainable use.

8.3.3.2. Soil types (WRB Classification) in medicinal plant survey

In medicinal plant surveys, soil is best described using the World Reference Base for Soil Resources (WRB). Soil properties strongly influence plant distribution, biomass, and medicinal value, especially in high-altitude ecosystems.

8.3.3.3. Soil type assessment in field quadrats

Soil type is recorded within each sampling quadrat or plot, as soil properties can change significantly even over short distances in mountainous terrain.

8.3.3.4. Field assessment includes:

a. Polygon no
b. Quadrat no

c. Location
d. Aspect
e. Slope
f. Soil type (World Reference Base)
g. Soil texture (sand, silt, clay proportion)
h. Soil color
i. Moisture condition (dry, moist, wet)
j. Organic matter content (low, moderate, high)
k. Drainage condition (well-drained to poorly drained)
l. Soil depth (cm)
m. Coarse fragment content (stones, gravels) in %
n. N, P, K content (low, moderate, high)
o. These parameters help interpret habitat quality and medicinal plant distribution patterns.

8.3.3.5. Guide to Soil Sampling for Medicinal Herbs and Trees

Soil testing is essential for assessing soil fertility. It helps determine the nutrient status of a given area and provides a scientific basis for recommending fertilizers and soil amendments such as lime in acidic soils.

8.3.3.6. Materials Required

a. Soil auger or a long, narrow - bladed shovel (or any available shovel, spade, or trowel)
b. Measuring tape to ensure correct sampling depth
c. Tray or pail for collecting and mixing soil
d. Plastic bags and rubber bands for sample storage
e. Paper and pen for labeling samples
f. Soil analysis request form

8.3.3.7. Soil Sampling Procedure for herbs

a. Divide the field into sections based on landform or slope. Collect a separate sample from each section.
b. Clear away grass, litter, or plant residues from the soil surface before sampling.
c. Using an auger, collect soil from a depth of 0 to 20 cm (for herbs) and place it in a tray. If an auger is not available, dig a pit with a spade, remove excess soil to expose a clean vertical face and cut a thin slice (about 5 cm thick) from the 0 - 20 cm depth.

d. Collect 8 - 10 subsamples from different locations within sections (about 1 acre) and combine all subsamples in the tray.
e. Mix all the subsamples thoroughly to form one composite sample. Remove roots, stones and debris.
f. Take about 500 gm to 1 kg of the mixed soil and place it in a labeled plastic bag and secure it properly.
g. Submit the sample to SPAL, NSSC for laboratory analysis along with the filled soil analysis request form.

8.3.3.8. Helpful Tips for Soil Sampling

a. Each sample should represent a single soil type or uniform condition.
b. Avoid sampling at boundaries between different soil types.
c. Ensure the sample is representative of the entire area.
d. Collect sufficient subsamples (8 to 10 per acre).
e. Do not sample from fertilizer bands or recently fertilized spots.
f. Avoid unusual or disturbed areas.
g. Always sample to the correct depth.
h. Unless specified otherwise, collect soil from the plough depth (15 - 20 cm) for herbs and field crops.

8.3.3.9. Guide to Subsoil Sampling for Medicinal Trees

a. First, collect topsoil (0 - 20 cm) using an auger and place it in a tray.
b. From the same hole, collect subsoil from 20 - 40 cm depth and place it in a separate tray.
c. Follow the same procedure as for topsoil sampling.
d. Collect samples from 8 - 10 different locations within the same area for both depths and keep topsoil and sub soil samples separate.
e. Mix all topsoil samples thoroughly to make one composite topsoil sample. Similarly, mix all subsoil samples to make one composite subsoil sample.
f. Take about 500 gm. to 1 kg from each composite sample and place it in labeled bags, and seal properly.
g. Attach completed soil analysis forms for each sample.
h. Submit both samples to SPAL for analysis.

Relationship Between Forest Type, Habitat Type, and Soil Type
The three components are interconnected but represent different scales of ecological observation:
Forest type: broad landscape classification
Habitat type: localized ecological condition within a quadrant or plot
Soil type: ground-level physical condition within the same quadrant

9. HABITAT STRATIFICATION PROCEDURE (Field SOP)

Following reconnaissance, the survey team shall systematically delineate habitat strata before initiating detailed ecological sampling.

9.1. Step 1: Review of Reconnaissance Findings

Review field observations, topographic information, satellite imagery, Geospatial records, species sightings, and habitat notes collected during reconnaissance to identify preliminary ecological zones.

9.2. Step 2: Delineate Ecological Units

Divide the survey area into ecologically meaningful habitat units based on distinct environmental characteristics such as vegetation type, elevation band, moisture regime, landform, slope position, and observable habitat transitions.

Habitat boundaries may be identified using:

a. Visible vegetation changes;
b. Changes in elevation and terrain;
c. Moisture gradients;
d. Soil or substrate differences;
e. Slope and aspect variation;
f. Species composition and dominance patterns; and
g. Human disturbance or harvesting intensity.

9.3. Step 3: Assign Habitat Codes and Descriptions

Each habitat stratum should be assigned a unique habitat code and brief ecological description to support consistency in mapping, field recording, and later analysis.

At minimum, habitat records should include:

a. Forest type;
b. Habitat type;
c. Soil type;
d. Dominant vegetation;
e. Elevation range;
f. Moisture condition;
g. Degree of disturbance;
h. Dominant medicinal plant species; and

i. Preliminary ecological observations.

9.4. Step 4: Allocate Sampling Effort

Sampling intensity, transect placement, and quadrat allocation shall be distributed proportionally across habitat strata to ensure ecological representativeness.

Greater sampling effort should be considered for:

a. Habitats with high medicinal plant richness;
b. Rare or conservation-priority ecosystems;
c. Areas showing strong ecological variation;
d. Known medicinal plant collection zones; and
e. Habitats facing visible threats or harvesting pressure.

9.5. Step 5: Validate Stratification in the Field

Habitat boundaries and classifications should be field verified before finalizing transects, polygons, or plot locations. Necessary adjustments may be made based on actual field conditions.

10. VARIABLES FOR SELECTING SAMPLING DESIGN

Selection of the sampling strategy and ecological design shall be informed by environmental and biological variables known to influence medicinal plant occurrence and distribution.

10.1. Purpose and Sampling Designs for Medicinal Plant Survey

Selection of an appropriate sampling design is a critical component of medicinal plant surveys because medicinal plant species are often distributed unevenly across landscapes and habitats. A poorly selected sampling design may result in biased estimates, underrepresentation of rare species, inaccurate population assessment, and inefficient field effort. The choice of sampling design shall therefore be determined by ecological, geographical, biological, and operational variables that influence medicinal plant occurrence and detectability. Each sampling design has a distinct purpose, operational procedure, strengths, and limitations. This section provides guidance on the key variables that should be considered before selecting a suitable sampling method such as:

10.1.1. Random Sampling

Random Sampling is a probability-based sampling method in which sample locations are selected entirely by chance, ensuring that every unit or location within the survey area has an equal probability of being selected. Surveyors visit randomly selected locations and assess medicinal plant occurrence.

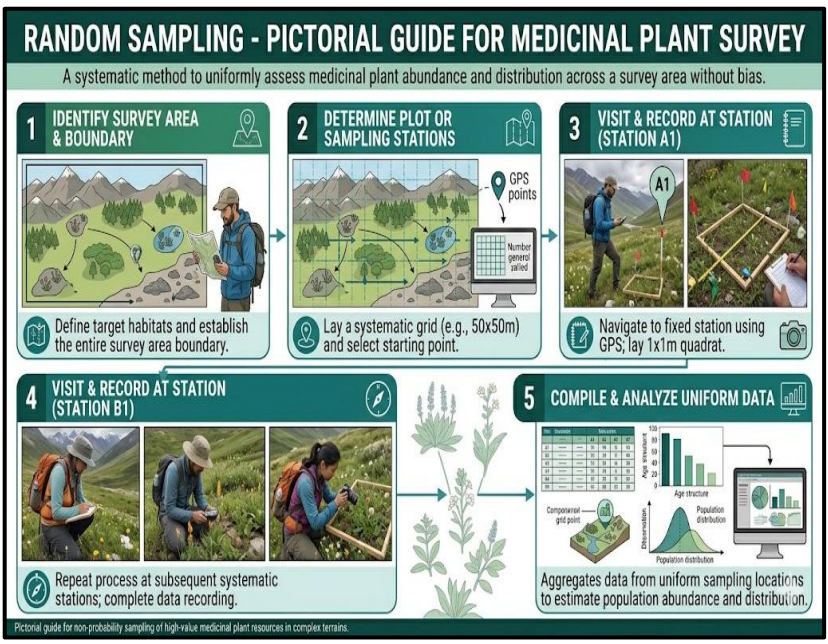

Figure II. Random Sampling pictorial guide for Medicinal Plant survey

This method minimizes investigator bias and provides statistically reliable estimates of medicinal plant occurrence and abundance. In random sampling, plots or observation points are selected without subjective judgment. Selection may be performed using:

a. Random coordinates;
b. Random number tables;
c. GIS-generated random points;
d. Lottery methods.

Field Procedure	• Define survey boundaries. • Divide survey area into sampling units. • Generate random sample locations. • Navigate to selected points using mobile based GIS applications. • Establish quadrats or observations. • Record medicinal plant data.
Useful when	• Habitat is relatively homogeneous. • Species distribution is widespread. • Statistical precision is required. • Survey bias must be minimized.
Advantages	• Reduces observer bias. • Statistically valid. • Easy data analysis. • Good for estimating abundance.
Limitations	• May miss rare medicinal plants. • Difficult in inaccessible terrain. • May cluster unintentionally.

10.1.2. Systematic Sampling

Systematic Sampling is a sampling method where observations or plots are placed at fixed, regular intervals across the survey area. Plots are established according to a predetermined spacing pattern. Instead of selecting points randomly, sampling locations are arranged systematically. This ensures spatial coverage.

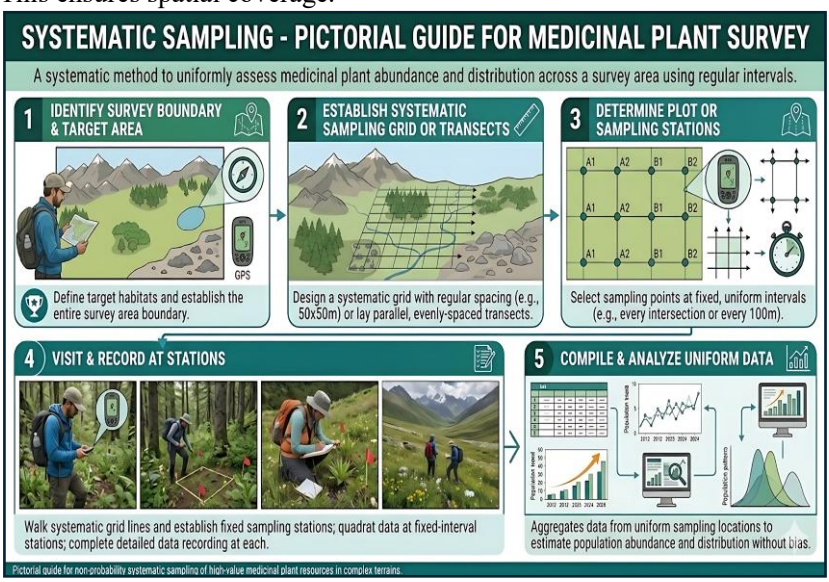

Figure III. Systematic sampling pictorial guide for Medicinal Plant survey

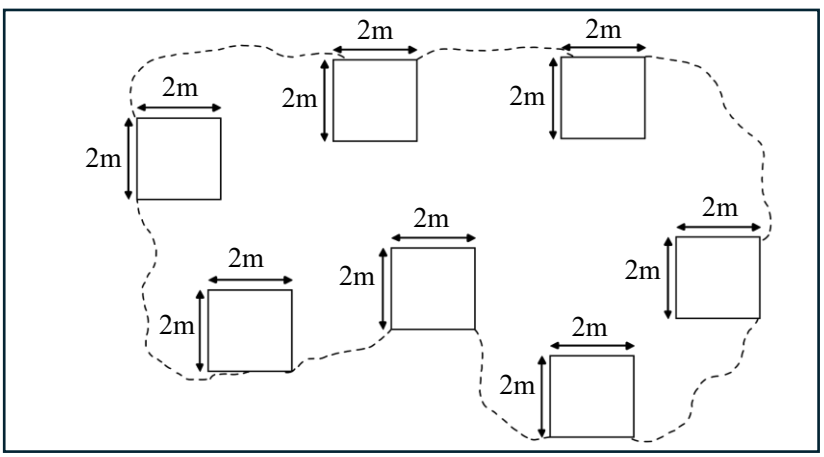

Figure IV. Standard Plot/Quadrat layout under systematic sampling method

Field Procedure	• Select starting point. • Determine interval distance. • Establish plots at fixed spacing. • Record medicinal plant information.
Useful when	• Survey area is large. • Habitat is relatively consistent. • Spatial representation is important.
Advantages	• Easy to implement. • Good spatial coverage. • Efficient field logistics.
Limitations	• May miss patchy populations. • Risk of sampling bias if intervals align with habitat patterns.

10.1.3. Stratified Sampling

Stratified sampling is a method where the survey area is divided into ecologically distinct subgroups (strata) before sampling is conducted separately within each stratum. This is often the preferred sampling strategy.

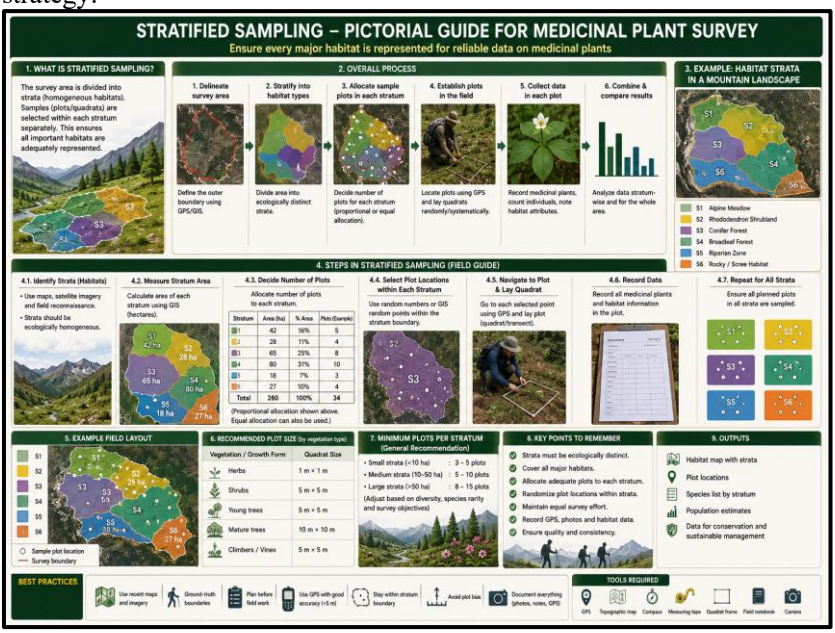

Figure V. Stratified sampling pictorial guide for Medicinal Plant survey

Field Procedure	• lineate habitats. • Divide area into strata. • Select sample points in each stratum. • Conduct field surveys.
Useful when	• Habitat heterogeneity is high. • Medicinal plants vary among habitats. • The landscape is ecologically complex.
Advantages	• Better ecological representation. • Improves accuracy. • Reduces habitat bias.
Limitations	• More planning required. • Requires habitat classification.

10.1.4. Quadrat Sampling

Quadrat Sampling is a plot-based sampling method where medicinal plants are assessed within a fixed-area sample unit known as a quadrat. A quadrat is a square or rectangular frame placed on the ground to measure:

a. Species abundance
b. Density
c. Frequency
d. Regeneration
e. Cover

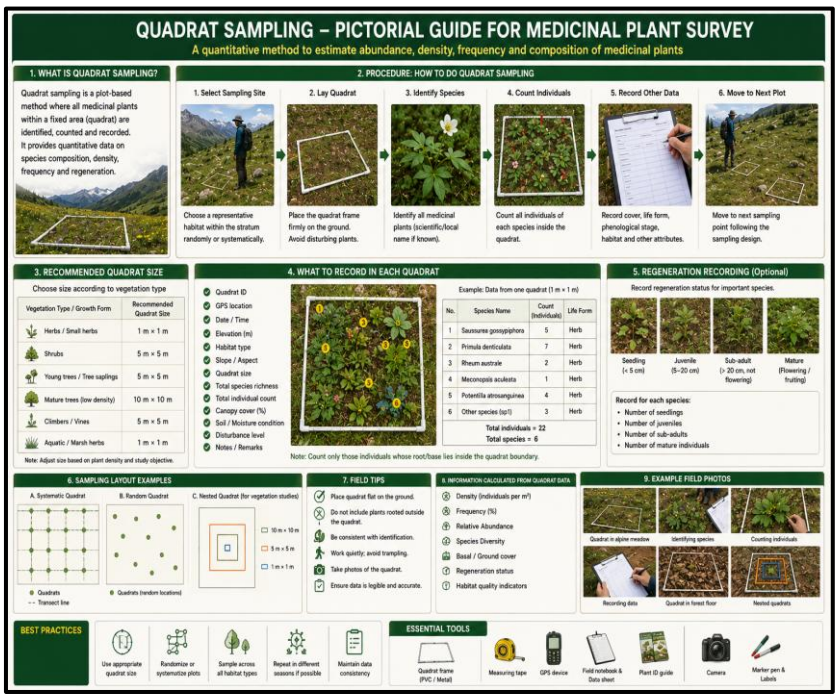

Figure VI. Quadrat sampling pictorial guide for Medicinal Plant survey

Field Procedure	• Select quadrat location. • Establish plot boundaries. • Identify medicinal plants. • Count individuals. • Record regeneration and abundance.

Useful when	• Population estimation. • Density studies. • Ecological monitoring.
Advantages	• Quantitative results. • Accurate density estimates. • Good for monitoring.
Limitations	• Time intensive. • Less suitable for large areas.

Recommended Quadrat Sizes	
Growth Form	**Quadrat Sizes**
Herbs	2 x 2 m
Shrubs	5 x 5 m
Trees	20 x 20 m

10.1.5. Transect Sampling

Transect Sampling is a survey method in which medicinal plants are recorded along a defined line or belt crossing the landscape. Transects are used to observe vegetation changes across habitats.

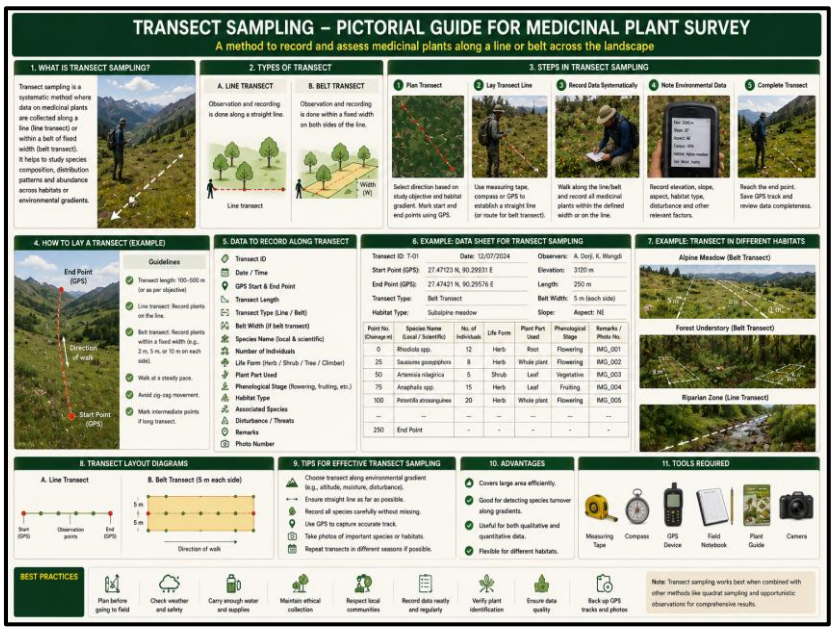

Figure VII. Transect sampling pictorial guide for Medicinal Plant survey

Types:

a. **Line Transect:** Observation along a line.

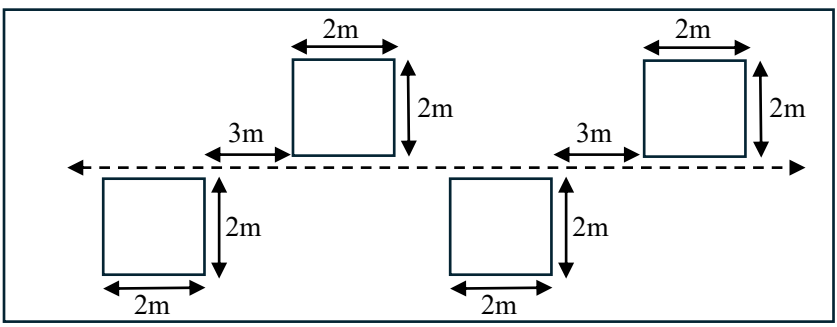

Figure VIII. Standard Quadrat /Plot layout for Line Transect

b. Belt Transect: Survey conducted within a fixed-width strip.

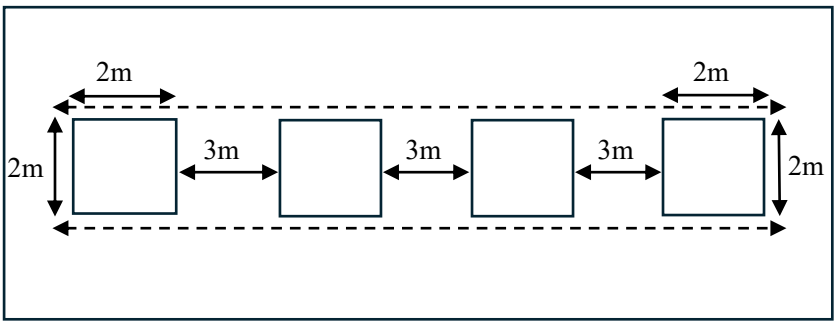

Figure VIII. Standard Quadrat /Plot layout for Belt Transect

Field Procedure	• Establish a transect line. • Mark starts and ends GPS. • Walk systematically. • Record medicinal plants along the transect.
Useful when	• Mountain slopes. • Habitat gradients. • Large landscapes.
Advantages	• Covers large area. • Good habitat comparison. • Efficient in rugged terrain.
Limitations	• May miss scattered populations. • Less precise density estimates.

10.1.6. Cluster Sampling

Cluster Sampling is a method in which groups (clusters) of sampling units are selected instead of individual points. The landscape is divided into clusters.

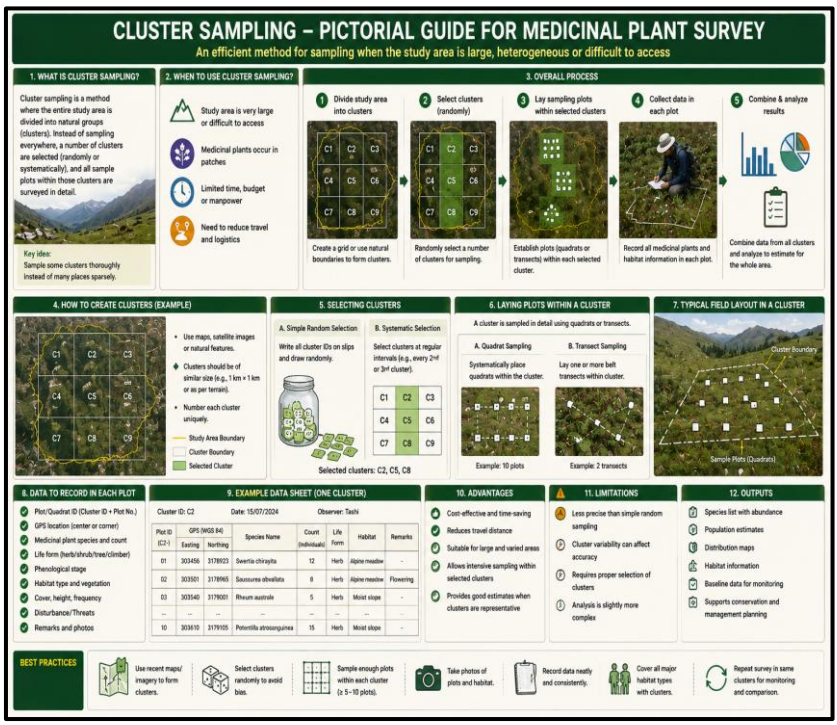

Figure IX. Cluster sampling pictorial guide for Medicinal Plant survey

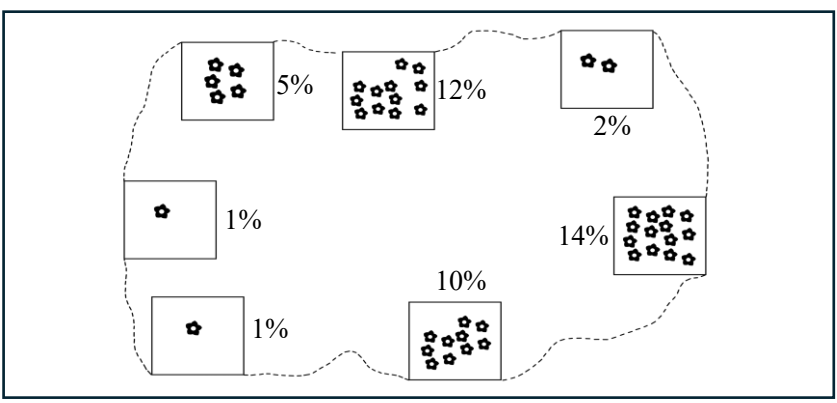

Figure X. % of species distribution in the quadrat for cluster sampling

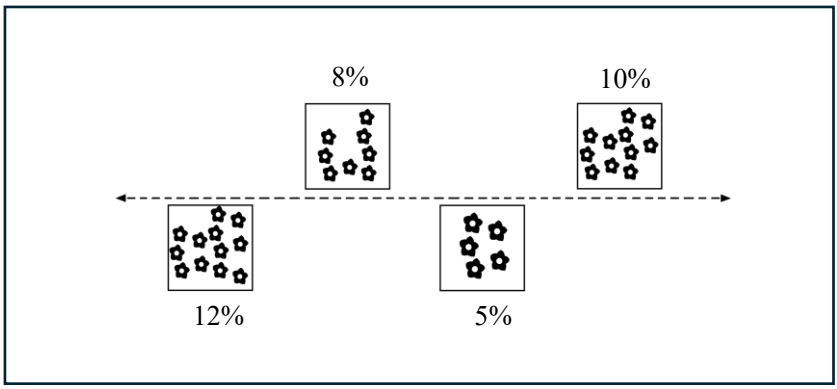

Figure XI. % of species distribution in the quadrat for cluster sampling

Field Procedure	• Divide the landscape into clusters. • Randomly select clusters. • Survey plots within clusters.
Useful when	• Area is very large. • Accessibility is difficult. • Resources are limited.
Advantages	• Reduces travel time. • Cost-effective.
Limitations	• Less statistically precise. • Risk of missing variation.

10.1.7. Purposive Sampling

Purposive Sampling is a non-random sampling method where plots or sites are deliberately selected based on expert knowledge or known medicinal plant occurrence. Surveyors intentionally target locations likely to contain medicinal plants.

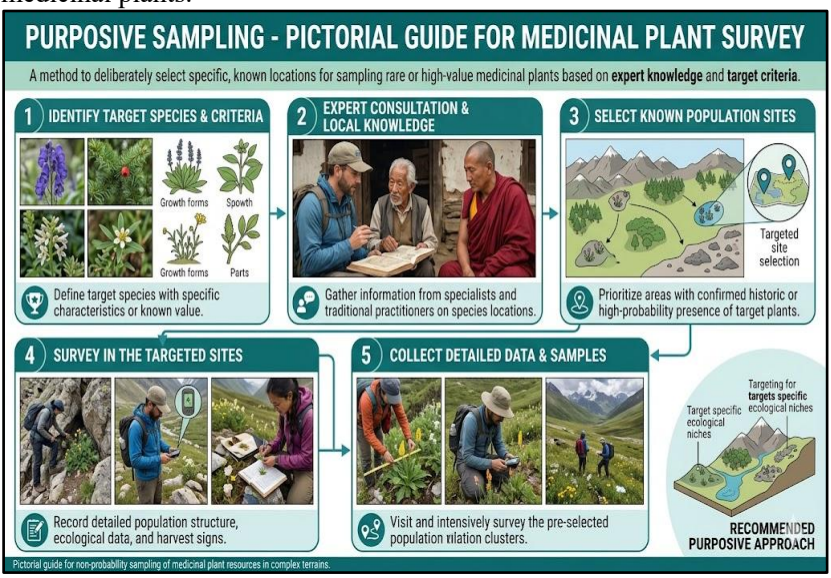

Figure XII. Purposive sampling pictorial guide for Medicinal Plant survey

Field Procedure	• Identify likely medicinal plant habitat. • Select sampling locations intentionally. • Conduct a survey.
Useful when	• Rare medicinal plants. • Threatened species. • Habitat-specific species.
Advantages	• Efficient. • Good for rare species.
Limitations	• Subjective. • Statistical bias possible.

10.1.8. Opportunistic Sampling

Opportunistic Sampling is a flexible survey method in which medicinal plant observations are recorded whenever encountered during field movement. Species are documented as encountered, even outside planned plots. Useful in difficult terrain.

Field Procedure	• Move through the survey area. • Record medicinal plants encountered. • Document GPS and habitat.
Useful when	• Rapid surveys. • Rare species detection. • Reconnaissance surveys.
Advantages	• Flexible. • Efficient.
Limitations	• Non-statistical. • Difficult to compare.

10.1.9. Species-Specific Sampling

Species-Specific Sampling is a targeted survey approach focused on one medicinal plant species for detailed ecological and population assessment. The survey is designed specifically for a priority species.

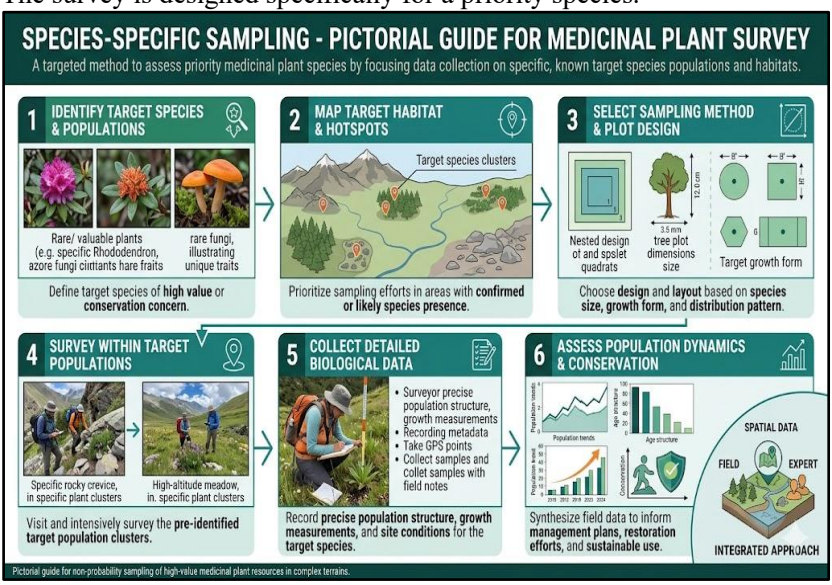

Figure XIII. Species-Specific sampling pictorial guide for Medicinal Plant survey

Field Procedure	• Identify target species. • Delineate habitat. • Establish plots/transects. • Assess population structure.
Useful when	• High-value species; • Threatened medicinal plants; • Conservation planning.
Advantages	• Detailed information • Supports management planning.
Limitations	• Limited broader ecosystem data. For medicinal plant inventory in Bhutan, a combined sampling approach is recommended Habitat Stratification + Reconnaissance + Transect Sampling + Quadrat Sampling +GPS Mapping + Opportunistic Observation + Species-Specific Assessment This integrated method improves: • Ecological representation; • Detection of rare medicinal plants; • Population estimation; • Habitat mapping; • Conservation planning. The selection process should ensure: • Scientific reliability. • Ecological representativeness. • Cost-effectiveness. • Operational feasibility. • Habitat coverage. • Reliable population estimation.

11. FREQUENCY/INTERVAL OF LAYING SAMPLING PLOTS FOR MEDICINAL PLANT SURVEY

The frequency of laying sampling plots refers to the spacing, number, and intensity of sample plots established within a survey area to adequately represent medicinal plant diversity, abundance, and habitat variation. In medicinal plant surveys, plot frequency should not be fixed universally. Instead, it should be based on:

a. Habitat type;
b. Terrain condition;
c. Species distribution pattern;
d. Survey objective;
e. Habitat size;
f. Ecological variability;
g. Accessibility;
h. Conservation important.

11.1. General Principle for Plot Frequency

The number and spacing of plots shall be sufficient to:

a. Represent habitat variability.
b. Capture medicinal plant diversity.
c. Estimate abundance accurately.
d. Detect rare species.
e. Minimize sampling bias.

11.2. Rule of Thumb

Higher ecological variability → **Higher plot frequency**
Homogeneous habitat → **Lower plot frequency**

11.3. Recommended Plot Frequency by Habitat Type

Habitat Type	Recommended Plot Interval	Sampling Intensity	Remarks
Alpine Meadow	Every 50–100 m	High	High medicinal plant richness
Alpine Scrubland	Every 75–150 m	Moderate–High	Patchy distribution
Temperate Broadleaf Forest	Every 100–200 m	Moderate	Understory species
Conifer Forest	Every 100–250 m	Moderate	More uniform habitat
Subtropical Broadleaf Forest	Every 150–250 m	Moderate	Dense vegetation
Riparian Habitat	Every 25–50 m	High	Highly variable moisture
Wetland/Marsh	Every 25–75 m	High	Sensitive habitat
Rocky/Scree Habitat	Opportunistic + 50–100 m	High	Patchy occurrence

Grassland/Open Pasture	Every 50–100 m	Moderate	Open habitat
Disturbed/Secondary Habitat	Every 50–100 m	Moderate–High	Rapid vegetation change

11.4. Plot Frequency by Survey Objective

a. Survey Objective: General Medicinal Plant Inventory.

Objective	Broad documentation of medicinal plants.
Recommended Frequency	Plot every 100–200 m combined with transects
Recommended Intensity	5– 10% habitat coverage

b. Survey Objective: Population Density Assessment.

Objective	Estimate abundance of medicinal plants.
Recommended Frequency	• More intensive sampling • Plot every 25–100 m
Recommended Intensity	10 – 20% habitat coverage
Useful for	• Density calculation • Biomass estimation • Sustainable harvest assessment

c. Survey Objective: Rare or Threatened Species Survey

Objective	Assess rare medicinal plants.
Recommended Frequency	• High intensity • Plot every 20–50 m • Supplement with purposive search
Recommended Intensity	Target known habitat zones.

d. Survey Objective: Habitat Comparison Study.

Objective	Compare medicinal plant diversity among habitats.

Recommended Frequency	Equal number of plots per habitat stratum
Recommended Intensity	Minimum 5–10 plots per habitat type

e. Survey Objective: Monitoring and Permanent Sample Plots.

Objective	Long-term monitoring.
Recommended Frequency	• Fixed intervals (100–200 m) • Representative habitat zones
Monitoring interval:	• Annually • Every 2–5 years

11.5. Plot Frequency by Species Distribution Pattern

Medicinal plant distribution greatly influences plot spacing.

Species Distribution	Recommended Plot Frequency
1. Uniform	Wider spacing (100–250 m)
2. Random	Moderate spacing (50–150 m)
3. Clumped/Patchy	Closer spacing (20–75 m)

Bhutan Context: Many medicinal plants occur in patches.

Examples:

a. *Cordyceps sinensis*
b. *Swertia chirayita*
c. *Paris polyphylla*

These require closer plot frequency.

11.6. Plot Frequency by Terrain Condition

Terrain Condition	Examples	Frequency
Gentle Terrain	• Meadows • Valleys • Pastures	Every 100–200 m
Moderate Slope	Forested hill slopes	Every 50–100 m
Steep or Rocky Terrain	• Scree slopes	Every 25–75 m

Plus: Opportunistic observations **Reason:** Medicinal plants occur in microsites.	• Cliff habitats	

11.7. Recommended Number of Plots by Habitat Size

Habitat Area	Minimum Number of Plots
<10 ha	5–10 plots
10–50 ha	10–20 plots
50–100 ha	20–40 plots
>100 ha	40+ plots
*Rare medicinal plant habitats should receive higher plot density. *	

11.8. Quadrat Frequency Along Transects

When using transect + quadrat methods:

Recommended Spacing

Habitat	Quadrat Interval
Forest	Every 100 m
Meadow	Every 50 m
Rocky terrain	Every 25–50 m
Riparian	Every 25–50 m
Disturbed habitat	Every 50–75 m
Example: A 500 m transect in alpine meadow: Total:10 quadrats	Quadrat every 50 m

12. RECOMMENDED SAMPLING INTENSITY

Sampling intensity refers to the proportion of habitat sampled.

Survey Type	Sampling Intensity
Rapid assessment	2–5%
Routine inventory	5–10%
Detailed ecological study	10–20%
Rare species assessment	>20% target habitat

13. CRITERIA FOR INCREASING PLOT FREQUENCY

Field teams should increase plot density when:

a. Habitat heterogeneity is high.
b. Medicinal plant diversity is high.
c. Rare species are present.
d. Harvest pressure is high.
e. Conservation concern exists.
f. Habitat changes rapidly.
g. Species occur in patches.

14. CRITERIA FOR REDUCING PLOT FREQUENCY

Plot spacing may be widened when:

a. Habitat is uniform.
b. Species are common.
c. Terrain is safe and accessible.
d. Preliminary surveys show low variation.

15. MAJOR VARIABLES INFLUENCING SAMPLING DESIGN SELECTION

The following variables shall be evaluated before determining the survey design.

15.1. Survey Objective

The primary purpose of the survey is the most important factor determining sampling design.
Different objectives require different approaches.

Survey Objective	Recommended Sampling Design
General medicinal plant inventory	Stratified + Transect
Population estimation	Quadrat Sampling
Rare species assessment	Purposive Sampling
Habitat comparison	Stratified Random Sampling
Sustainable harvesting study	Quadrat + Ecological assessment
Monitoring changes over time	Permanent plots
Species distribution mapping	Transect + GPS survey
Rapid field assessment	Reconnaissance survey

15.2. Field Application

If the objective is to estimate the population density of a medicinal herb such as *Paris polyphylla*, quadrat sampling is more suitable than opportunistic observation because it allows quantitative estimation.

For broad medicinal plant inventories across large landscapes, stratified sampling is preferable.

16. HABITAT TYPE AND ECOLOGICAL VARIABILITY

Medicinal plants are highly habitat specific. Habitat complexity strongly influences sampling strategy.

16.1. Homogeneous Habitat

Areas with similar vegetation and environmental conditions.

Examples:	• Uniform alpine meadow • Dense conifer forest
Recommended Design	• Systematic sampling • Random quadrats

16.2. Heterogeneous Habitat

Areas with varying vegetation and microhabitats.

Examples:	• Mountain slopes • Mixed forests • Rocky terrain
Recommended Design	• Stratified sampling • Combined transects and quadrats

Field Consideration

In Bhutan, steep altitudinal gradients create substantial habitat variation within short distances. Therefore, habitat stratification is often necessary before sampling.

Example:

A slope may include:

a. Conifer forest
b. Shrubland

c. Alpine meadow
d. Scree slope

Each habitat should be sampled separately.

17. SPECIES DISTRIBUTION PATTERN

Medicinal plants may occur in different spatial distributions. Understanding distribution helps determine plot placement.

Distribution Pattern	Recommended Design
A. Uniform Distribution: Species are evenly spaced. Examples: Managed plantations	Systematic sampling
B. Random Distribution: Species scattered unpredictably. Examples: Naturally dispersed herbs	Random sampling
C. Clumped or Patchy Distribution Most medicinal plants occur in patches. Examples: • *Nardostachys jatamansi* • *Cordyceps sinensis* • *Swertia chirayita*	• Stratified sampling • Cluster sampling • Transect-based sampling
Field Implication Patchy species require more intensive sampling to avoid underestimation.	

18. SPECIES ABUNDANCE AND DENSITY

Population abundance affects sampling intensity.

Species Status	Recommended Approach
Very common	Random/systematic plots
Moderately common	Transects + quadrats
Rare species	Purposive survey
Threatened species	Species-specific survey

19. RARE SPECIES CONSIDERATION

Rare medicinal plants often require:

a. Habitat-targeted surveys
b. GPS point mapping
c. Purposive sampling

Rare populations may be missed under random designs.

20. TERRAIN AND ACCESSIBILITY

Bhutan's rugged mountain topography strongly influences field practicality.

Terrain factors include:

a. Slope steepness
b. Elevation
c. Accessibility
d. Weather risk
e. Remoteness

Terrain	Recommended Sampling
Gentle Terrain Examples: 1. Open pasture 2. Valley bottoms	• Quadrat sampling • Systematic grids
Steep Terrain Examples: 1. Rocky scree slopes 2. Cliff systems	• Transect walks • Opportunistic survey • Purposive plots

Field Consideration

- In inaccessible terrain, strict random sampling may become impractical or unsafe.
- Operationally adaptive designs may be required.

21. HABITAT SIZE AND SPATIAL EXTENT

Survey area size affects design complexity.

Habitat Size	Recommended Sampling
Small Survey Area (<10 ha)	1. Complete enumeration 2. Intensive quadrat survey
Medium Area (10–100 ha)	1. Systematic sampling

	2. Stratified plots
Large Landscape (>100 ha)	1. Stratified sampling 2. Transects 3. Cluster plots
Large areas should prioritize representative sampling over exhaust coverage.	

22. VEGETATION STRUCTURE

Different vegetation layers require different methods.

Vegetation Type	Suitable Method
Herbaceous vegetation	Small quadrats
Shrubland	Medium quadrats
Forest habitat	Larger plots
Mixed vegetation	Nested plots

23. SEASONALITY AND PHENOLOGY

Medicinal plant detectability varies by season.

Flowering/Fruiting Period: Best for species identification.
Dormancy Period: Species may be difficult to detect.
Recommended Approach:
Highly seasonal species may require:

a. Repeated sampling
b. Multi-season surveys
c. Phenology-based scheduling

24. RESOURCE AVAILABILITY

Field logistics influence sampling feasibility.

Consider:

a. Available budget
b. Survey duration
c. Workforce
d. Equipment
e. Technical expertise

Resource Availability	Recommendation
Limited Resources	• Rapid assessment • Transect sampling • Purposive survey
Adequate Resources	• Stratified random sampling • Intensive quadrat surveys • Permanent monitoring plots

25. DATA ACCURACY REQUIREMENT

Required precision affects sampling intensity.

Data Accuracy	Design
Low Precision Need Rapid inventories.	• Reconnaissance survey
Moderate Precision Routine inventory.	• Transects + quadrat
High Precision Scientific research.	• Stratified random sampling • Replicated plots • Statistical sampling

26. CONSERVATION STATUS OF SPECIES

Threatened medicinal plants require specialized sampling.

Species of conservation concern should use:

a. Non-destructive methods
b. GPS mapping
c. Permanent monitoring plots
d. Habitat-based purposive sampling

Examples:

a. Taxus wallichiana
b. Nardostachys jatamansi
c. Swertia chirayita

27. DISTURBANCE LEVEL

Disturbance affects medicinal plant abundance and visibility.

Disturbance Level	Suggested Design
Low disturbance	Random/systematic
Moderate disturbance	Stratified
High disturbance	Targeted assessment

Field teams shall assess:

a. Grazing
b. Harvesting pressure
c. Fire
d. Roads
e. Human settlement

28. MAPPING AND GEOSPATIAL STANDARDS

28.1. Purpose and Scope

Geospatial information forms the foundation of medicinal plant resource inventory and spatial analysis. Accurate geospatial data improves understanding of species distribution, habitat association, ecological range, population hotspots, harvesting pressure, and conservation priority areas.

All medicinal plant surveys shall integrate standardized geospatial recording to ensure that field observations are spatially referenced, reproducible, GIS-compatible, and suitable for long-term monitoring and planning purposes.

Geospatial mapping shall support:

a. Species occurrence mapping.
b. Habitat delineation.
c. Population distribution analysis.
d. Threat and disturbance assessment.
e. Conservation prioritization.
f. Sustainable harvesting and cultivation planning.

28.2. Minimum Geospatial Spatial Recording Standards

To maintain consistency and interoperability across survey teams and institutions, all spatial records shall follow standardized geospatial protocols as per the *National Guidelines for Geospatial Mapping and Inventory of Medicinal Plants Resources section 16.3.*

Before recording coordinates, field teams shall:

a. Verify Mobile GIS and field data collection application's signal stability.
b. Allow sufficient satellite lock time.
c. Record coordinates in open areas where feasible.
d. Cross-check suspicious coordinates.
e. Document positional accuracy where possible.

28.3. Minimum Required Spatial Features

At minimum, the following features shall be geo-referenced during field surveys:

a. Plot and quadrat center points.
b. Transect start, midpoint, and end points.
c. Opportunistic medicinal plant observations.
d. Voucher specimen collection site's location.
e. Dense medicinal plant population patches.
f. Threat and disturbance points.
g. Habitat transition areas.
h. Access routes and survey tracks.

Where feasible, habitat patch polygons and medicinal plant concentration zones shall also be mapped to support spatial analysis and management planning.

28.4. Core Geospatial Feature Types

The following standardized geospatial feature types shall be used throughout medicinal plant surveys:

Feature Type	Definition	Typical Use	Feature Differentiation
Point	A single geo-referenced location	Species occurrence, threat point, voucher site	Represents a specific location
Track	Continuous movement path	Trail, survey route, ridge or valley walk	Represents movement or access routes

Transect	Planned linear ecological sampling route	Observation and plot placement	Represents structured ecological sampling lines
Polygon	Mapped area with defined boundary	Habitat patch, wetland, medicinal stand	Represents spatial extent or habitat area
Plot / Quadrat	Fixed ecological sampling unit	Species abundance and ecological assessment	Represents ecological sampling units nested within transects or mapped areas.

29. STANDARD SURVEY AND MAPPING (S&M) METHODOLOGY

The Survey and Mapping (S&M) methodology for medicinal plant inventory shall adopt a combination of Sampling and Line Transect methods to ensure representative ecological coverage and reliable assessment of medicinal plant resources.

The selection of sampling methods shall depend on:

a. Elevation and habitat type;
b. Species diversity and richness;
c. Population density and distribution patterns;
d. Slope gradient and slope aspect;
e. Vegetation composition and dominant species; and
f. Size and accessibility of the survey area.

The following standard procedure shall be followed during field implementation.

29.1. Step 1: Conduct Reconnaissance Survey

Conduct a reconnaissance survey to verify:

a. Survey tracks and access routes.
b. Preliminary survey polygons and Areas of Interest (AOIs)
c. Habitat conditions.
d. Presence of medicinal plant species.
e. Terrain accessibility.
f. Feasibility of sampling locations.

The reconnaissance survey shall guide the final placement of transects, quadrats, and survey routes.

29.2. Step 2: Prepare Survey Tracks and Polygons

Based on desktop analysis and reconnaissance findings:

a. Define Survey and Mapping (S&M) areas;
b. Identify survey tracks and transect routes;
c. Establish survey points at approximately (500-1000) meter intervals along the survey tracks and transect routes depending on terrain, ecological variability, and safety condition
(Shorter transects may be appropriate in steep or highly heterogeneous landscapes; and longer transects may be suitable in broad alpine or relatively uniform habitat zones).

Transect Orientation

Transect should preferably run:

I. Across elevation gradients;
II. Across the main slope direction; or
III. Across ecological transitions.

This improves detection of:

I. Species turnover;
II. Habitat change;
III. Variation in abundance;
IV. Microclimatic differences; and
V. Ecological thresholds.

Transect should avoid excessive bias toward roadsides or highly disturbed areas unless disturbance assessment is the intended objective.

For every transect, the following minimum information shall be recorded:

Required Variable	Description
Transect ID	Unique identifier
Site Code	Survey site linkage
Start GPS Coordinate	Start point
End GPS Coordinate	End point
Elevation (Start, Midpoint, End)	Ecological gradient

Transect Length	Measured distance
Slope Gradient	Terrain characteristic
Slope Aspect	Exposure direction
Habitat Transitions	Major ecological shifts
Dominant Vegetation	Habitat condition
Observer Names	Survey Personnel
Date	Survey Date

a. Based on the reconnaissance survey findings and interpretation of satellite imagery, delineate survey polygons within open habitats, sparsely forested areas, and accessible open spaces identified inside the Area of Interest (AOI).
b. Exporting the data in GIS compatible format
c. Load data into mobile based GIS application devices (Garmin GPS units; SW Maps; QField; EpiCollect5, Other approved GPS-enabled GIS applications).

Survey teams shall verify that all tracks and survey areas are correctly synchronized prior to field deployment.

29.3. Step 3: Geo-Track the Survey Route

Navigate and geo-track the imported survey route and transect line in the field using GPS-enabled devices while verifying habitat conditions, accessibility, and suitability of the survey area.

29.4. Step 4: Locate and Verify Sampling Points

Locate the imported sampling points established at approximately (500-1000) meter intervals along the transect route.
Verify the suitability of each point based on medicinal plant presence, habitat condition, terrain accessibility, and field safety. Where the exact point is unsuitable or medicinal plants are absent, the survey team may shift the location within an approximate range of 100–200 meters to establish the quadrat in a representative medicinal plant habitat.

All adjusted locations shall be geo-referenced and documented.

29.5. Step 5: Establish Quadrat

Establish a standard quadrant at the verified sampling location for medicinal plant inventory and ecological assessment.

Assign a unique quadrat identification number linked to the transect and polygon ID.

29.6. Step 6: Record Species, Morphological, and Ecological Information

Within each quadrat, record:

a. Medicinal plant species are present.
b. Species count and abundance.
c. Regeneration status.
d. Habitat and vegetation characteristics.
e. Disturbance observations.
f. Morphological characteristics of flowers, leaves, stems, fruits, seeds, and roots.
g. Traditional uses and parts used.
h. GPS coordinates and photo records were applicable.

29.7. Step 7: Maintain Daily Field Records

Maintain daily records of survey coverage, quadrat completion, GPS tracks, photos, species observations, and field notes.

29.8. Step 8: Verify and Backup Data

At the end of each field day:

a. Review field forms for completeness;
b. Verify Geospatial records and quadrat IDs;
c. Check photos and spatial data; and
d. Back up all digital records for Geospatial validation and database integration.

30. COMMON ERRORS TO AVOID DURING FIELD SURVEY

a. Do not change quadrat size in the field without recording the change explicitly.
b. Do not place all quadrats only in dense species patches unless the method specifically requires targeted abundant plots.
c. Do not separate spatial data from biological data; all records must share common IDs.

Figure XIV. Medicinal Plant Survey and Mapping Workflow

31. TRANSECT RECORDING REQUIREMENTS

31.1. Species Recording, Photography, and Voucher Specimens

Field identification should use standard floras, medicinal plant manuals, herbarium references, local names cross-verified with experts, and diagnostic morphological characters. Local names are helpful, but they are not sufficient alone for final identification.

31.2. Photo Standards

For uncertain or important taxa, take geo-tagged photographs of the whole plant habit, leaves, flowers, fruits, bark or roots if visible, the surrounding habitat, and any disturbance evidence. A consistent photo record improves later validation and supports voucher decisions.

31.3. Voucher Specimen Collection

Voucher specimens should be collected only when necessary and permitted. Each voucher record should include the voucher ID, collectors name, date, site code, Geospatial location, elevation, tentative field identification, local

name, family, growth form, diagnostic features, habitat description, estimated population size, and justification for collection. Label vouchers at the end of each field day and link them to photo and Geospatial records.

a. Do not collect rare species unnecessarily.
b. Collect diagnostic material when reproductive parts are available and collection is allowed.
c. Press, label, and store specimens daily to avoid confusion and specimen loss.

Use or follow FORM No. 8 in ANNEXURE XII

32. POPULATION, ABUNDANCE, AND REGENERATION ASSESSMENT

Population assessment methods should match the species and habitat. The guideline recommends direct count for sparse or rare species, density per quadrat for herbs and clustered species, cover estimation for ground-layer species, frequency across plots, and DBH or basal diameter for woody species.

32.1. Abundance Classes

Code	Class	Field interpretation
A1	Rare	1–5 individuals or highly localized
A2	Occasional	6–20 individuals or scattered
A3	Common	Present in several plots or at moderate density
A4	Abundant	High density or widespread dominance

Use or follow FORM No. 2 in ANNEXURE VI

32.2. Regeneration Recording

At minimum, record seedlings, juveniles or saplings, mature plants, and senescent plants. A balanced population contains all age classes. A declining population has very few seedlings and juveniles. A critical population is represented mainly by mature or senescent plants.
Use or follow FORM No. 2 in ANNEXURE VI

33. THREAT ASSESSMENT AND HARVEST PRESSURE

33.1. Purpose

To standardize the qualitative scoring and spatial tracking of localized human pressures and environmental hazards affecting wild medicinal plant populations. Identifying these pressure zones protects vulnerable habitats from over-exploitation and ecological collapse.

33.2. Scope

Mandatory for inclusion in the final environmental assessment portion of each survey station log, covering a 10-meter radius surrounding the plot center peg.

33.3. Diagnostic Field Indicator

Field teams must inspect the assessment zone for physical evidence of the following three core stressors:

1. **Harvesting Pressure:** Discarded non-target vegetative biomass, characteristic excavation pits left by root-diggers, broken surrounding stems, or localized footpaths worn by collectors.
2. **Livestock Grazing Trauma (*Tsamdro* Pressures):** Truncated or shredded leaf blades, livestock dung accumulations, visible hoof erosion on fragile alpine turf, and pathways created by yaks or cattle.
3. **Environmental Hazards:** Natural physical threats such as active topsoil erosion, structural landslides, glacial outwash damage, frost-heave displacements, or localized disease outbreaks.

33.4. Threat Grading Matrix

To minimize observer bias, field teams must rate observed pressures using a uniform score ranging from T0 to T3 based on the specific operational criteria defined below:

Threat Score	**T0**
Severity Class	**Pristine**
Visual Indicators and Diagnostic Field Criteria	Zero signs of human entry, structural plant breaking, or livestock presence. Ground cover is completely intact and undisturbed.
Required Management Response	Continuous monitoring; maintain current management strategy.
Threat Score	**T1**
Severity Class	**Low Impact**
Visual Indicators and Diagnostic Field Criteria	Minor grazing damage on common understory plants; occasional older trails visible. Target medicinal plant populations show no signs of active collection.

Required Management Response	Periodic monitoring; maintain standard community-based controls.
Threat Score	**T2**
Severity Class	**Moderate Impact**
Visual Indicators and Diagnostic Field Criteria	Clear signs of harvesting present (e.g., active digging holes, cut stems). Target plants are uncommon near trails but persist in less accessible areas.
Required Management Response	Recommend localized harvest caps, implementation of a rotation system, and increased monitoring.
Threat Score	**T3**
Severity Class	**Severe Impact**
Visual Indicators and Diagnostic Field Criteria	Extensive habitat damage; widespread soil exposure from digging or heavy livestock trampling. Target medicinal plants are rare, stunted, or missing mature reproductive cohorts.
Required Management Response	Immediate closure of the sector to harvesting; implement strict restoration protocols and enforcement patrols.

Use or follow FORM No. 4 in ANNEXURE VIII

34. COMMUNITY KNOWLEDGE AND ETHICAL SAFEGUARDS

Community knowledge can identify local species names, seasonality, historical collection areas, inaccessible habitats, changes in abundance over time, and local harvesting practices. These contributions are valuable, but they must be documented with prior informed consent and appropriate confidentiality safeguards.

a. Explain the purpose of the survey before any interview or knowledge recording.
b. Do not record restricted or proprietary knowledge without permission.
c. Protect sensitive location data of vulnerable species.
d. Respect local intellectual and cultural ownership.

35. DATA MANAGEMENT, QUALITY ASSURANCE /QUALITY CONTROL, AND SUBMISSION PROCEDURES

35.1. Daily Field Quality Assurance

At the end of each field day, the team leader should review all forms, verify completeness, confirm that all GPS points are saved, back up photographs, label vouchers, and note uncertainties for next-day verification. This daily control step prevents data loss and helps catch problems while the team is still on site.

35.2. Office Data Quality Assurance

After fieldwork, standardize species names, verify coordinates, check missing values, remove duplicates, cross-check photo IDs, verify voucher records, and inspect outliers in elevation or habitat. Clean data should then be organized into GIS-ready layers and master tables.

35.3. Submission Workflow

a. Download Geospatial data and save GPX or GIS-compatible files using the standard naming convention.
b. Transfer and rename photographs according to site, plot, species, date, and photo sequence.
c. Enter or synchronize paper and digital records into the master workbook or database tables.
d. Validate species names, linked IDs, and coordinates.
e. Prepare GIS layers for sites, transects, plots, polygons, species points, threats, and vouchers.
f. Compile the cleaned workbook, GPS files, photo log, voucher log, and required maps for submission to the responsible program or database.

36. REQUIRED OUTPUTS AND REPORTING

Each completed survey should produce a report containing an executive summary, background and objectives, survey area description, methodology, target species and habitats, findings on species, abundance, regeneration, and threats, GIS maps and spatial analysis, priority species and site ranking, recommendations, and annexes containing forms, GPS logs, voucher lists, and photo lists.

Sl.No.	Minimum map outputs	Remarks
1	Base map of survey area	
2	Survey site and transect map	
3	Species occurrence map(s)	

4	Elevation distribution map	
5	Habitat association map	
6	Threat hotspot map	
7	Conservation priority zone map	
8	Potential cultivation suitability map, where part of the objective	

37. FIELD SAFETY AND ENVIRONMENTAL CARE

Teams should conduct a pre-departure briefing, carry first aid supplies, use communication devices, avoid solo movement in remote terrain, monitor weather and wildlife risks, and inform local authorities or host communities of planned routes when necessary. Environmental ethics require minimizing trampling, avoiding unnecessary collection, restoring disturbed ground where feasible, and protecting sensitive sites.

38. QUICK OPERATIONAL CHECKLIST

38.1. Before departure: Relevant permissions confirmed, maps prepared, devices charged, forms packed, team roles assigned.

38.2. At site arrival: Complete reconnaissance, confirm habitat strata, verify start points for tracks, transects, and polygons.

38.3. During fieldwork: Maintain spatial records, complete forms fully, photograph key taxa and threats, and link all observations to IDs.

38.4. End of day: Review forms, back up GPS and photos, label vouchers, and list corrections for the next day.

ANNEXURE I.

1. Summary of Survey Forms Workbook

The survey forms workbook provides standardized field sheets for paper or digital capture. The following summary should be used to align field recording with later data entry and QA/QC.

Sheet	Purpose	Key fields / use
Site Recon	Site reconnaissance	Survey date, team, district, locality, site code, access route, elevation range, habitat type, target species, informants, disturbance, weather
Transect	Transect or track record	Transect ID, site code, date, surveyors, start and end GPS, elevations, length, bearing, slope class, aspect, plot interval, observation belt width
Plot Quadrat	Core ecological sampling	Plot ID, transect ID, site code, date, recorder, latitude, longitude, elevation, plot size, slope, aspect, forest type, canopy cover, understory density
Opportunistic	Off-plot species observation	Observation ID, date, observer, site code, botanical name, local name, GPS point, elevation, habitat type, microhabitat, population estimate, patch size, phenology, part used
Inventory Register	Master species inventory	Species code, botanical name, family, local name, habit, part used, habitat type, elevation range, frequency, abundance, conservation concern
Threat Assessment	Threat documentation	Linked site/plot/observation ID, botanical and local names, threat type, intensity, area affected, evidence observed, trend, suggested action, remarks
Voucher	Voucher specimen record	Voucher ID, collector, date, site code, GPS, elevation, field identification, family, growth form, diagnostic features, habitat, population size, collection justification
Community Knowledge	Interview and local knowledge	Interview ID, date, village, interviewee category, consent, species name, habitat, seasonality, harvest season, part used, trend, threats, conservation suggestions, sensitivity restriction

Daily Checklist	Daily readiness and closure	Equipment status, GPS backup, photo storage, form review, safety items
Kobo Data Dict	Digital form structure	Question types, variable names, labels, validation rules, and constraints for mobile collection
Kobo Choices	Digital coding lists	Yes/No, abundance classes, and harvest classes used in Kobo or related forms

ANNEXURE II.

2. Summary of Survey Toolkit Workbook

The toolkit workbook provides a structured database layout for clean submission and analysis. Teams can use it as the final normalized data package even if initial field collection was done on paper forms.

Sheet	Function	Key fields / use
Site Master	Master site table	Site code, district, locality, date, team, elevation min/max, habitat, disturbance, notes
Transects	Transect register	Site code, transect ID, type, length, width, bearing, start and end coordinates, remarks
Plots	Plot register	Plot ID, site code, transect ID, plot size, shape, coordinates, elevation, slope, aspect, habitat code, canopy cover
Quadrats	Quadrat observations	Quadrat ID, plot ID, position, species code, count, cover percent, seedlings, flowering count, harvest damage, notes
Species Records	Species-level observations	Record ID, linked IDs, scientific name, code, life form, count, cover, phenology, regeneration
Opportunistic Observations	Off-sample records	Observation ID, site code, date, species code, scientific name, count, pattern, phenology, habitat code, coordinates, elevation
GPS Attributes	Spatial feature register	Feature type, category, site code, linked record, waypoint, coordinates, elevation, accuracy, notes
Photo Log	Photographic evidence	Log ID, date, site code, linked record type and ID, photo ID, photo type, species name, voucher link, collector, condition
Voucher Log	Specimen storage log	Voucher ID, site code, species code, collector, date, storage, condition, notes

Metadata Codebook	Codes and definitions	Code type, code, description for controlled vocabulary
Species Master List	Reference species list	Species code, scientific and local names, family, life form, medicinal part used, conservation status, notes

ANNEXURE III.

3. Recommended Coding System and File Naming

Item	Recommended format
Site ID	MP-THI-01
Transect ID	MP-THI-01-T1
Plot ID	MP-THI-01-T1-P03
Observation ID	MP-THI-01-OBS-014
Voucher ID	MP-THI-01-V-005
GPS file	District Site Date.gpx
Photo file	Site Plot Species Date No.jpg
Spreadsheet	Medicinal Plant Survey Master YYYY/MM/DD
Map PDF	Priority Species Distribution District v1.pdf

ANNEXURE IV.

4. Checklist for Essential Survey Toolkits

Sl.No.	Essential Survey Toolkits	Specification
1	Maps / satellite printouts packed	
2	Field forms / clipboard prepared	
3	Measuring tapes / ropes ready	
4	Compass / clinometer packed	
5	Plant press / specimen bags available	
6	Labels / markers packed (permanent) OHP pen	
7	Daily forms reviewed by team leader	
8	GPS charged / spare batteries available	
9	Power bank ready	
10	GPS data backed up at day end	
11	First aid kit checked Self arrange	
12	Rain gear packed (Umbrella)	
13	Hoe	
14	Four men Tent	
15	Tarpaulin (for kitchen)	
16	Transparent plastic (thick)	
17	Tarpaulin bag	

ANNEXURE V.

5. Reconnaissance Survey Field FORM I.

1. Basic Site Information		
1	**Site Code:**	
2	**Site Name / Locality:**	
3	**District:**	
4	**Gewog / Village:**	
5	**Survey Date:**	
6	**Survey Team Members:**	
2. Desk Review Summary (Pre-Field Information)		
Area of Interest identified from: Maps / Satellite Imagery / Previous Records / Literature / Community Info		
1	**Target medicinal species:**	
2	**Expected habitat type:**	
3	**Remarks:**	
3. Site Accessibility Assessment		
1	**Access route used:**	
2	**Road condition:**	Good / Moderate / Poor / Not accessible
3	**Foot trail condition:**	Easy / Moderate / Difficult
4	**Terrain type:**	Flat / Gentle slope / Steep / Very steep
5	**River crossing required:**	Yes / No
6	**Estimated travel time:**	
7	**Suggested base/camping location:**	

4. Medicinal Species Presence Verification		
1	**Species observed:**	Yes / No / Partially
2	**Occurrence type:**	Scattered / Clustered / Dense / Rare
3	**Growth stage:**	Seedling / Juvenile / Mature / Flowering / Fruiting
4	**Approximate abundance:**	
5	**Notes:**	
5. Habitat Characteristics & Delineation		
1	**Habitat type:**	Forest / Shrubland / Alpine / Wetland / Grassland / Other
2	**Elevation range (m):**	
3	**Slope:**	Low / Moderate / High
4	**Aspect:**	
5	**Soil/moisture condition:**	
6	**Characteristics of Vegetation:**	
7	**Preliminary boundary identified:**	Yes / No
6. Disturbance & Threat Assessment		
1	**Disturbances:**	Grazing / Fire / Legal harvesting/Illegal harvesting / Land conversion / Invasive species / Road construction / Erosion / None
2	**Severity:**	Low / Moderate / High
3	**Notes:**	
7. Local Knowledge / Community Consultation		
1	**Informants consulted:**	
2	**Local names:**	
3	**Harvesting season:**	

4	**Traditional uses:**	
5	**Abundance of trends:**	
8. Survey Design Decisions		
1	**Method:**	Transect / Plot / Polygon / Occurrence points
2	**Sampling locations:**	
3	**Justification:**	
9. Geospatial Data Collection		
1	**Tool used:**	Garmin GPS / SW Maps / QField / Epicollect5
2	**Data recorded:**	Tracks / Transects / Polygons / Points
3	**Coordinate system:**	
4	**Elevation recorded:**	Yes / No
5	**Notes:**	
10. Survey Completion Summary		
1	**Site suitability:**	Suitable / Partial / Not suitable
2	**Recommendation for detailed survey:**	Yes / No
3	**Reason:**	
11. Recommended Digital Tool		
1	QField / SW Maps / Epicollect5 / Garmin GPS	
2	**Justification:**	

Final Remarks & Approval	
Prepared by:	
Signature:	
Reviewed by:	
Approved:	
Signature:	
Date:	

ANNEXURE VI.

6. Habitat Stratification Procedure (Field SOP) survey.

FORM 2

1. Location Details

Dzongkhag	
Drungkhag	
Gewog	
Chiwog	
Village	
Place	

Date (dd/mm/yyyy)	
Survey Day	
Sampling Design	
Polygon No.	
Polygon Length (km)	
Transect No.	
Transect Length (m)	
Transect Position	
Plot/Quadrat Number	
Plot/Quadrat Interval	
GPS coordinate	
Elevation (masl)	
Slope aspect (°)	
Slope gradient (%)	
Forest type	
Habitat	
Other (specify)	

Forest Type:

A-*Tropical*, ***B***-*Sub-Tropical Broad Leaves*, ***C***-*Chrine Pine Forest*, ***D***-*Warm Broad-Leaves Forest*, ***E***-*Blue Pine Forest*, ***F***-*Cool broad-leaved forests*, ***G***-*Mixed Coniferous forests*, ***H***-*Fir Forest*, ***I***- *Spruce Forest*, ***J***- *Juniper Forest/Woodland*, ***K***- *Alpine/Dwarf Shrub Vegetation*

Habitat:

A-*Alpine Meadow*, ***B***-*Alpine Shrubs*, ***C***-*Temperate Broadleaves Forest*, ***D***-*Coniferous Forest*, ***E***-*Sub-Tropical Broadleaves Forest*, ***F***-*Riparian/Stream-Aged*, ***G***- *Wetland/Marsh*, ***H***-*Grassland/Open pasture*, ***I***-*Rocky terrain/Scree slope*, ***J***-*Disturbed/ Secondary habitat*
F-*Shrub land*

Sampling Design: ***A***-*Random*, ***B***-*Systematic*, ***C***-*Stratified*, ***D***-*Quadrat*, ***E***-*Transect*, ***F***-*Cluster*, ***G***-*Purposive*, ***H***-*Opportunistic*, ***I***-*Species-Specific*

2. Plot Data

Plot/Quadrat No.:			**Polygon No.:**					**Transect No.:**			
TRANSECT POSITION:											
Sl. No.	**gSoRig Name**	**Botanical Name**	**Family**	**Distr.**	**Hgt. mm/ cm/m**	**Cnt.**	**Reg en.**	**Tht.**	**Parts Used**	**Abund.**	**Cover %**
Distribution (Distr.): ***A****- Sporadic,* ***B****- Patchy and* ***C****- Uniform*											
Regeneration (Regen.): *Yes/No*											
Threat (Tht.): ***A****-Human being,* ***B****- Domestic Animals,* ***C****- Wildlife,* ***D****-Natural*											
Parts Used*:* ***A****-Bulb,* ***B****- Stem,* ***C****- Bark,* ***D****-Tuber,* ***E****- Rhizomes,* ***F****- Leaves,* ***G****- Seeds,* ***H****- Fruits,* ***I****- Flower,* ***J****- Resin,* ***K****- Whole Plant*											
Abundance (Abund.): ***A1:*** *Rare,* ***A2:*** *Occasional,* ***A3:*** *Common,* ***A4:*** *Abundant*											

3. Enumerators' detail

Collection date (dd/ mm/yyy)	
Surveyor Name	
Designation	
Mobile no.	
Workplace	
Survey Team	
Remarks	

ANNEXURE VII.
7. Daily Listing. FORM 3

Dzongkhag		**Drungkhag**	
Gewog		**Chiwog**	
Village		**Place**	

Date (dd/mm/yyyy)			
Survey Day			
Listing Type	☐ Journey Track	☐ Polygon Track (Polygon No……)	☐ Transect Track (Line/Belt)
GPS coordinate	Start:	End:	
Elevation (masl)	Start:	End:	

Sl.No.	gSorig Name	Botanical Name	Family	Parts Used	Distr.	Remarks

***Distribution (Distr.): A**- Sporadic, **B**- Patchy and **C**- Uniform*

***Parts Used**: **A**-Bulb, **B**- Stem, **C**- Bark, **D**-Tuber, **E**- Rhizomes, **F**- Leaves, **G**- Seeds, **H**- Fruits, **I**- Flower, **J**- Resin, **K**- Whole Plant*

If there is a human threat recorded in form no. 2 complete form no. 4

ANNEXURE VIII.

8. Threat Details, FORM 4

Respondent details

Name	
Age	
Occupation	
Gender	
Village	
Gewog	
Dzongkhag	
Company Name	
Contact Number	

Sl. No.	gSorig Name	Botanical Name	Local Name	Year	Tht. score	Product	Qty. (Kg)	Remarks

Threat (Tht.) Score: T0 - *Pristine,* ***T1 -*** *Low Impact,* ***T2 -*** *Moderate Impact,* ***T3 -*** *Severe Impact*

ANNEXURE IX.
9. Herbarium Name Tag. FORM 5

Voucher Specimen No.	
Sorig Name	
Botanical Name	
Family	
Place	
Village	
Gewog	
Dzongkhag	
Elevation	
Coordinates	
Uses	
Collector	
Date of Collection	

ANNEXURE X.

10. Survey Equipment and Materials checklists (Issued and received) FORM 6.

Sl. No	Essential Survey Toolkits	Qty	Issued Yes/No	Received Yes /No
1	Maps / satellite printouts packed			
2	Field forms / clipboard prepared			
3	Measuring tapes / ropes ready			
4	Compass / clinometer packed			
5	Plant press / specimen bags available			
6	Labels / markers packed (permanent) OHP pen			
7	Daily forms reviewed by team leader			
8	GPS charged / spare batteries available			
9	Power bank ready			
10	GPS data backed up at day end			
11	First aid kit checked Self arrange			
12	Rain gear packed (Umbrella)			
13	Hoe			
14	Four men Tent			
15	Tarpaulin (for kitchen)			
16	Transparent plastic (thick)			
17	Tarpaulin bag			

Issued by……. Received by…….....

Date: ……. Date: ……..

ANNEXURE XI.

11. Medicinal Plant Soil Survey Data Collection. FORM 7

Section	Parameter	Details
General Information	Polygon No	
	Quadrat No	
	Location (Village/Block/GPS)	
Site Characteristics	Aspect (Degree or N, NE, E, etc.)	
	Slope (%)	
Soil Classification	Soil Type (WRB)	
Soil Physical Properties	Soil Texture (Sand/Silt/Clay %)	
	Soil Color	
	Soil Depth (cm)	
	Coarse Fragment Content (%)	
Soil Moisture & Condition	Moisture Condition (Dry/Moist/Wet)	
	Drainage Condition (Well - Poorly Drained)	
This needs to be filled in only if you are using Rapid Soil Testing Kits		
Soil Fertility Indicators	Soil pH (Low/Moderate/High)	
	Nitrogen (N) (Low/Moderate/High)	
	Potassium (K) (Low/Moderate/High)	
	Phosphorus (P) (Low/Moderate/High)	
Remarks	Observations	
Survey Details	Surveyor Name	
	Date	

ANNEXURE XII.
12. Voucher Specimen Collection. FORM 8

Voucher ID	
Collector(s)	
Site code	
GPS	
Elevation	
gSorig Name	
Botanical name	
Family	
Local name	
Growth form	
Diagnostic features	
Habitat description	
Population size	
Collection justification	
Permit reference/No.	
Herbarium confirmation (Final ID)	
Remarks	

Growth form: ***A:*** *Herb,* ***B:*** *Shrub,* ***C:*** *Tree,* ***D:*** *Climber*
Diagnostic features: ***A:*** *Flower,* ***B:*** *Fruit,* ***C:*** *Leaf,* ***D:*** *Root notes*

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