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**Guidelines for Sustainability of Medicinal Plant Resources**

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**Foreword**

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## **Introduction**

Medicinal plants are valuable natural resources. Unplanned development and overexploitation of medicinal plants from non-managed, natural resources has not only resulted in shortage of various herbs, but extinction of several species in nature. In order to meet the growing demand for these plants, it becomes important to conserve these plant species either by way of domestication and cultivation or by other ex-situ and in situ conservation measures for their sustainable use. Emphasis on cultivation of the wild forms, rather than collection from the wild would also ensure botanical identity, genetic improvement, quality and continuity in supply. Such cultivation may have to be initiated under well-defined conditions showing for example micro-climates similar to the niche requirements of the various species

Draft African Standard for comments only — Not to be cited as African Standard



## Guidelines for Sustainability of Medicinal Plant Resources

### 1 Scope

This African Standard provides Guidelines for Sustainability of Medicinal Plant Resources. It also outlines good harvesting practices and conservation strategies aimed at ensuring continuous supply of raw materials for medicinal plant products.

### 2 Normative references

The following documents are referenced in this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21300, Traditional Chinese medicine — Guidelines and specification for Chinese materia medica

ARS 952, Guidelines on good agricultural and collection practices (GACP) for medicinal plants

### 3 Terms and definition

For the purpose of this standard, the following terms and definitions shall apply:

**Non – timber Forest Products (NTFPs)** - encompasses all biological materials other than timber which are extracted from forests for human use.

**Sustainable-** proper management of natural resources in a way that does not result to their harm or destruction and for the benefit of the entire human community.

**MAPs** – Medicinal and Aromatic plants

**IUCN** – International Union for Conservation of Nature - IUCN Red List: It is a critical indicator of the health of the world's biodiversity. It is the world's most comprehensive inventory of the global conservation status of biological species. It uses a set of precise criteria to evaluate the extinction risk of thousands of species and sub species.

#### 4.0 Determination of endangered species

In order to mount a successful conservation strategy for medicinal plant species, it is important to determine the rarity of the plant species in its habitat. To do this, the following steps have to be put into consideration.

- i. Confirm their existence on the ground;
- ii. Determine the present ecological and conservation conditions through an extinction risk assessment by using IUCN Red List methodology (2012).
- iii. Use of Species Distribution Model (SDM) to locate and extract current appropriate habitat suitability

#### 4.1 General Guidelines for sustainable harvesting of Medicinal plants

The medical practitioners and manufacturers should comply with the general guidelines or the best practices for sustainable collection of MAPs from Sustainable Harvesting Practices for Endangered Medicinal Plants.

##### 4.1.1. Check list - Preparation for the journey

The lists of things to be prepared before heading to forest for collection of medicinal plants are provided here.

- i. Packaging materials such as gunny bags, plastic lined gunny bags, polyethylene containers
- ii. Sharp harvesting tools such as knife, axe, sharp metal strips, secateurs, etc.
- iii. Labelled stickers for labelling the collection information such as name of collector, name of the plant collected, place of collection and quantity collected.
- iv. Pen and pencil
- v. Correct collection permit documents from the forestry officials.
- vi. Plant collection Forms.

### 4.1.1.1 Important points to remember

- i. Do not collect the whole population of a habitat. Ensure sustainability of the natural resources by following relevant national regulations.
- ii. Prune only the desired parts of medicinal plants. Minimize the harm to the mother plant.
- iii. Do not over harvest the twigs/branches
- iv. Do not collect the herbs from road sides, sea shores, ant hills, near sewage etc.
- v. Use proper equipment for cutting, shearing, digging, peeling, etc.
- vi. Start drying process immediately after collection.
- vii. Ensure complete drying before packing and storage.
- viii. Dry aromatic herbs, delicate fruits etc. under shade.
- ix. Do not dry two or more herbs in close vicinity to avoid accidental mixing.
- x. Pack the herbs in suitable packaging material to avoid losses due to external factors.
- xi. Store the herbs in properly constructed stores to minimize storage losses.

### 4.1.2. When to Harvest?

- i. Determine the right time for harvesting. The harvesting time may vary from one species to the other and from one place to another. Collect at a time when the plants are in optimum condition concerning required medical quality and efficacy.
- ii. Determine the best time for collection, e.g. the season, date, or time of day, according to the quality and quantity of the active ingredients than the total amount of material you can gather. This ensures the best possible quality of raw material and products. The concentration of biologically and medically active ingredients varies with the stage of plant growth and development.
- iii. Harvest medicinal plants under the best possible climatic conditions for the specific species to avoid either desiccation or fermentation and mould growth and thus deterioration of the material

### 4.1.3 What to harvest?

- i. Proper identification of the plant to be harvested shall be established. Distinguish clearly between the medicinal plant and its closely related relatives to avoid unwanted mixtures.
- i. (wet soil, dew, rain, or exceptionally on high air humidity is unfavourable
- ii. all equipment used should be clean and free from remains of last crop.
- iii. avoid mechanical damage that results in undesirable changes to the plant.



- iv. Choose healthy and well-developed plant material. Do not harvest plant material that is infested with fungal growth or insects. This is because the by-products of these organisms will alter the ingredient profile and could even be poisonous.
- v. Be sure the plants you intend to harvest have not been sprayed with pesticides, herbicides, or fertilizers. Be especially aware of this around the edges of farm fields, roadsides, or near industrial activity.
- vi. special care should be taken to avoid over harvesting and through it the danger extinction of the plant species in particular collecting area.
- vii. No plants or parts of endangered species list.

NOTE 1: The responsible collecting organization has to appoint a person responsible for correct identity of the collected plant material and the compliance of the collectors with provision and requirements described above.

#### 4.1.4 How to harvest

- i. Gather only plants that are abundant in that area. Be conscientious about leaving a healthy population behind.
- ii. Take special care with leaves and flowers which are much more vulnerable to deterioration than roots due to the nature of their tissue.
- iii. Avoid any unnecessary damage to the plant i.e. exercise caution to enable that the plant can re-grow
- iv. Avoid mechanical damage to the harvested material that results in undesirable quality changes.
- v. Identify and discard unwanted plant materials during harvesting. This is to ensure that no foreign matter, weeds, or toxic plants are mixed with the harvested medicinal plant materials.
- vi. Put different plant material in different containers.

#### 4.1.5 Equipment to use

- i. Make sure that all equipment used is clean and free of remnants of previously harvested plants.
- ii. Keep all containers used during harvesting clean and free from contamination by previously harvested medicinal plants and other foreign matter.
- iii. If plastic containers are used, pay particular attention to any possible retention of moisture that would lead to the growth of mould
- iv. When containers are not in use, keep them in dry conditions and in an area that is protected from insects, birds, and other pests.

##### 4.1.5.1 Personnel engaged in the collection of plant material

- i. Collectors should possess extensive knowledge about its environmental factors like shade, moisture soil etc identification of the plant from which the drug is derived, its physiological specifics and its requirement,
- ii. collectors should be able to distinguish clearly between the medicinal plant and its closely related relatives in order to avoid unwanted mixture and process
- iii. collectors should have sufficient knowledge about optimum conditions for the time of harvesting, the best technique enough knowledge about subsequent conservation process and storage conditions to ensure high of the raw material gathered.
- iv. Collectors should adhere to high degree of personal hygiene. They should not take part in the activities if suffering from infectious diseases transmissible by food such as diarrhoea etc

- v. the knowledge of collectors should be periodically reinforced and monitored by a Competent Authority (specialist of the collecting organization. this educated process should be documented.

### 4.2 Guidelines for sustainable harvesting of plant parts

For sustainability, it is recommended that where leaves will serve the same purpose, the root or stem should not be harvested.

#### 4.2.1 Guidelines for root harvesting

When the root of a plant is used for medicinal purposes, most times, the whole plant is uprooted by the plant collectors. As the plant continues to be used, it may end up extinct if sustainable harvesting is not adopted. To prevent this, the gatherers shall follow the following practices.

- i. Dig the root at a considerable distance, at least 30 cm, from the main stem or tap root.
- ii. Avoid severing of the tap root.
- iii. Collect only the lateral roots.
- iv. After digging cover the hole to ensure protection against infection and invasion by pests.
- v. Injure a limited number of roots to encourage sprouting of new root suckers

#### 4.2.2 Guidelines for bark harvesting

Harvesting of plant bark for medicinal use using with an axe or bush knife, most commonly through ring-barking where entire rings of bark are removed around the tree, inevitably leads to death of the tree. In order to ensure sustainable harvest of bark material the following recommendations should be followed:

- i. Peel the bark from the tree in small pieces leaving most of it intact on the trunk on the east and west side of the tree.
- ii. Remove the bark in long vertical strips using a thin flexible blade/bush knife.
- iii. Do not practice ring barking, which is the cut of off entire rings around the tree.
- iv. Remove the bark in small sections and leave some inner bark to protect the wood.
- v. Do not cut the edges of the strip with an axe as this causes the remaining bark to lift from the wood and dry out.
- vi. Possibly use 'tree seal', e. g. apply a piece of wet cow-dung and other natural sealants to the bark wound. This will prevent the wound from drying out, though it does not facilitate bark recovery or prevent the development of insect infestation or development of infections on the wound.

#### 4.2.3 Guidelines for leaf harvesting;

In most cases, leaf harvesting is regarded as least destructive form of harvesting to the plants. However, studies revealed that "business as usual" harvesting sometimes resulted in the collection of all the leaves from the tree including cutting down the branches and twigs.

In order to ensure sustainable harvesting of leaves it is recommended that one can:

- i. Pluck individual leaves instead of leaf stripping and avoid use of sharp pruning shears for leaves.
- ii. Regularly prune branches to improve the quality and quantity of leaves.

#### 4.2.4 Guidelines for fruit harvesting

The commercial harvesting of fruits can affect not only species regeneration but also the quality of the resource in an area. This is particularly the case if the fruits and seeds of an inferior quality, such as small and rotten ones, are left to regenerate. Thus, fruits also need to be extracted in a sustainable manner so that the biotic integrity of forests and woodlands is supported. In order to ensure sustainable harvesting of leaves it is recommended the users can be guided by ARS 952 on harvesting and sustainability.

#### 4.3 Guidelines for whole plant harvesting

There are five (5) separate groups of whole plants which are subject to different regulatory requirements depending on their risk from unsustainable harvest practices.

Under the BC Act, Part 2 of Schedule 6 comprises five separate groups of whole plants. These plants/groups are subject to different regulatory requirements depending on their risk from unsustainable harvest practices.

##### 4.3.1 Group 1

Plants in this group are those known to be harvested from the wild to support current market demand, are relatively fast growing and commercial sales are, in part, supplemented by cultivated material.

Harvesting and post-harvest management of these species is considered to be relatively simple and survivorship of harvested material is reported to be high. Overall, these species are considered to be at low to moderate risk from unsustainable management practices. However, harvesting should be monitored to ensure that it is sustainable.

The requirements to commercially harvest or grow any species in Group 1 are:

- i. A wild harvester, approved harvester or grower licence will be required
- ii. Harvest site protocols apply for wild harvester and approved harvester licensees
- iii. Restrictions on the quantities that can be harvested, except for material produced under a grower licence may be imposed by the regulatory body
- iv. NPWS tags must be applied to wild harvester and approved harvester products
- v. Grower tags must be applied to grower products when plants are individually offered or displayed for retail sale
- vi. An export permit will be required (unless the species is in the list of exempt native species).

##### 4.3.2 Group 2

Plants in this group are known to be harvested from the wild to support current market demand. They are slow growing and are only just beginning to be supplemented by cultivated material. Harvesting and post-harvest management can be difficult. Survivorship of harvested material can be low when not undertaken by experienced harvesters. These species are considered to be at risk from overharvesting. Strict harvest limits will be imposed for extractive licenses.

In summary, the requirements to commercially harvest or grow any species in Group 2 are:

- i. Only approved harvester or grower licences will be issued for species in this group to ensure product quality and survivorship
- ii. Harvest site and stockpile site requirements must be complied with for approved harvester licensees
- iii. Restrictions on the quantities that can be harvested, except for material produced under a grower licenses may be imposed
- iv. NPWS tags are required for approved harvester products
- v. Grower tags must be used for grower products when plants are individually offered or displayed for retail sale

- vi. An export permit will be required (unless the species is in the list of exempted species).

### 4.3.4 Group 3

Plants in this group are known to be harvested from the wild to support current market demand. These products are slow growing and they are unlikely to be directly supplemented by cultivated material. Harvesting and post-harvest management can be difficult, and survivorship of harvested material can be low when not undertaken by experienced harvesters.

In summary, the requirements to commercially harvest or grow any species in Group 3 are:

- i. Only approved harvest (salvage only) or grower licences will be issued for species in this group
- ii. Harvest site and stockpile site requirements must be complied with for approved harvester licensees
- iii. Restrictions on the quantities that can be harvested, except for material produced under a grower licence may be imposed
- iv. NPWS tags are required for approved harvester (salvage-only) products
- v. Grower tags to be used for grower products when plants are individually offered or displayed for retail sale
- vi. An export permit will be required (unless the species is in the list of exempt native species).

### 4.3.5 Group 4

Plants in this group are those species that are well established in cultivation but where the cultivated material is not readily discernible from wild harvested material and the species may be subject to illegal wild harvest.

The requirements to cultivate any species in Group 4 are summarised here:

- i. Only a grower licence will be issued for species in this group
- ii. No production limits will be imposed
- iii. Grower tags are to be used for this group when plants are individually offered or displayed for retail sale
- iv. An export permit will be required (unless the species is in the list of exempt native species).

### 4.3.6 Group 5

Plants in this group include those that are identified as having special requirements. These will include national listed threatened species or other species that are of particular concern to other jurisdictions.

To support the conservation of species within this group, the regulatory body may impose specific restrictions or tagging requirements on these products, such as these:

- i. Only a grower licence will be issued for species in this group
- ii. Grower tags are to be used for this group when plants are individually offered or displayed for retail sale
- iii. No production limits will be imposed
- iv. An export permit will be required (unless the species is in the list of exempt native species).

## 5. Conservation strategies

### 5.1 *In situ* conservation (onsite conservation)

This ensures that stock of biological community and wild species are protected and preserved in their natural habitat. It shall be done in the following ways:

### 5.1.1 Protectorates

Protectorates shall be reserved areas of important wild resources created to preserve and restore biodiversity

### 5.1.2 Wild nurseries

**These shall be** established for species-oriented cultivating and domesticating of endangered medicinal plants in a protected area, natural habitat, or a place that is only a short distance from where the plants naturally grow

### 5.1.3 Fences

Fenced area of plants, trees like a small private park. It is a permanent, portable or temporary constructed barrier to protect plants under conservation.

## 5.2 *Ex Situ* conservation

This shall aim to cultivate and naturalize threatened species to ensure their continued survival and sometimes to produce large quantities of planting material used in the development of drugs, and it is often an immediate action taken to sustain medicinal plant resources.

*Ex situ* conservation is not always sharply separated from *in situ* conservation, but it is an effective complement to it, especially for overexploited medicinal plants. Following are the *ex situ* conservation approaches:

### 5.2.1 Botanical gardens:

Botanical gardens shall be used to maintain the ecosystems to enhance the survival of rare and endangered plant species.

Botanic gardens shall involve a wide variety of plant species grown together under common conditions, and will contain taxonomically and ecologically diverse flora.

### 5.2.2 Herbal gardens

Herbal gardens shall specialize in cultivation and maintenance of medicinal plants. These herbal gardens can also act as experimental farms for breeding and selection of new cultivars in any specific species as also in the development of field production technology.

### 5.2.3 Seed banks conservation

This is the safest, popular and economically viable strategy for preserving plant material. The seeds which do not lose viability if dried to a moisture content of 3–7%, are expected to remain viable for 5–25 years during medium-term storage (0–5°C and 35% RH) and for 50–100 years during long-term storage (–10°C to –20°C).

Storage of seeds in a gene bank is accomplished following seed gene bank standards for germination. The Manual of Seed Handling in Gene banks (Rao et al., 2006) can be used as a reference guide.

Plant species with recalcitrant seeds shall be conserved in field gene banks for most of the tropical medicinal plants standards for laboratory germination are not yet defined.

### 5.2.4 Cultivation

Cultivation outside the natural habitat of some endangered plant species is one of the methods of *ex situ* conservation. It is carried out by collecting, germinating, multiplying and planting some seeds from some plant species that are suffering from extinction. Biotechnologies may be used in this multiplication process.

### 5.3 Good Agricultural and Collection Practices (GACP)

GACP take into consideration the following criteria in accordance to ARS 952: — Guidelines on good agricultural and collection practices (GACP) for medicinal plants

- i. Soil and climatic conditions;
- ii. Seeds and propagation material, with attention brought to quality of seeds, stem cutting and root cutting.
- iii. Cultivation Management such as field preparation, sowing and transplanting, use of manures and fertilizers and irrigation.

Where possible, agricultural practices that aim to cultivate medicinal plants as source of supply, and minimize the use of chemicals, shall be most preferable since the techniques for harvesting, storage and production are monitored.

## 6 Biotechnological approaches to medicinal plant conservation

### 6.1 *In vitro* Conservation and Cryopreservation

#### 6.1.2 *In vitro* conservation

*In vitro* conservation shall reduce frequent demand of sub-culturing through:

- culturing them under normal growth conditions or by subjecting them to growth limiting conditions by:
- The use of *in vitro* multiplication technique in species with reproductive problems and/or with extremely low population to increase number of individuals. The material thus generated can be of great value for conservation, utilization and also for plant reintroduction programmes.

Or:

- The development of *in vitro* storage techniques which that are particularly useful when conservation of seeds is not possible. *In vitro* conservation involves either normal growth or slow growth for short- to medium-term conservation, and cryopreservation for long-term conservation.



*In vitro* propagation can be accomplished by three types of regeneration pathways: -axillary bud proliferation, adventitious regeneration or somatic embryogenesis.

Usually, shoot tips or nodal segments are cultured on a nutrient medium containing specific combination of cytokines and/or auxins to stimulate bud break.

Other propagules such as leaf segments, roots, etc. can also be used for propagation.

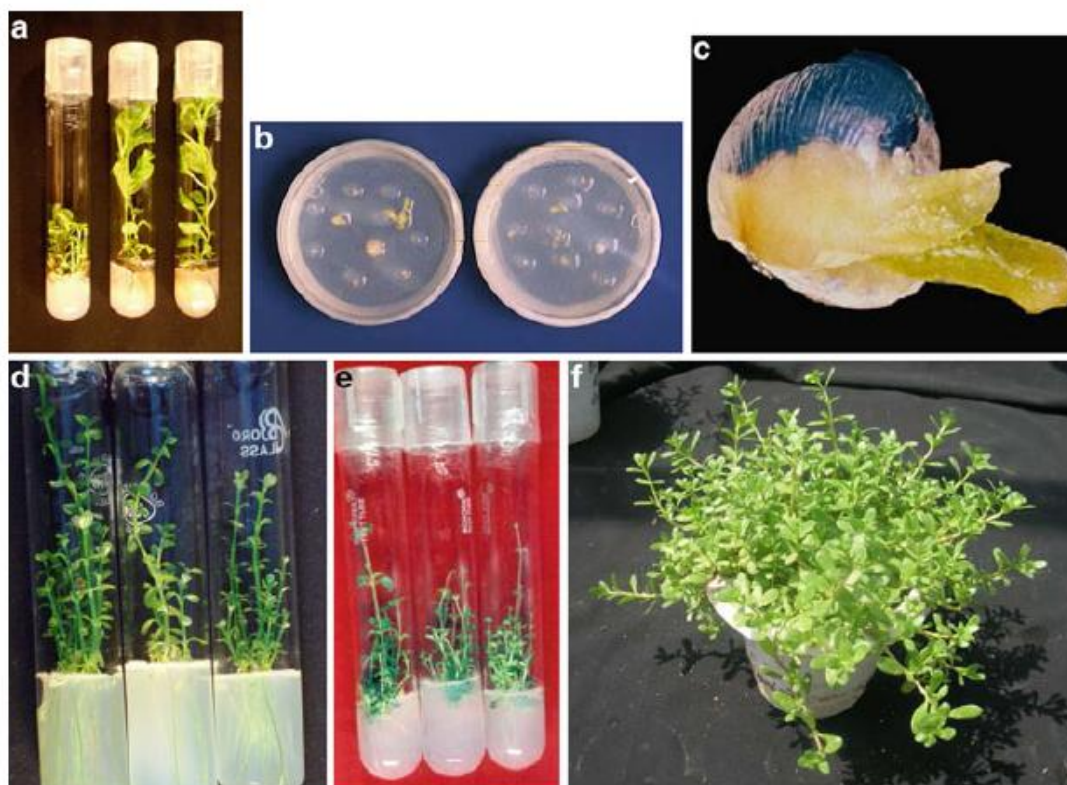


Figure 1. (a-f) *in vitro* conservation and cryopreservation of tropical medicinal plants. Illustrative image from literature (Normah *et al.*, 2013)

## 6.2 Cryopreservation

Cryopreservation is potentially the most appropriate strategy for long-term conservation of vegetative propagated plants and those with recalcitrant seeds.

It is also considered a safe method for intermediate and orthodox seeds in special cases such as those involving threatened germplasm or for those species for which very few seeds can be collected from habitats and which are on the verge of extinction

## 6.3 Pollen Conservation

Pollen preservation could complement seed storage or clonal preservation. Though not a conventional strategy for germplasm conservation, it may be used for hybridizing materials that flower at different times.

Additionally, the explorers and collectors shall at times be able to collect pollen which may be useful in future crop improvement programmes through upcoming biotechnological approaches. The preservation of pollen ensures availability of at least part of genome for future utilisation.

Techniques involved in pollen preservation are simple and require low input. However, there is very limited information regarding applicability of stored pollen in African medicinal plants. Some techniques for pollen preservation include:

- I. Short Term Pollen Storage: It includes the effect of temperature and humidity, and pollen storage in organic solvent.
- II. Long term preservation can also be done by ultralow temperature, ranging between  $-70^{\circ}\text{C}$  and  $-196^{\circ}\text{C}$ . This may include cryopreservation by deep-freezing, storage at sub-zero temperatures and freeze or vacuum drying (lyophilization).

### 1. DNA Conservation

This is particularly useful in case of species available in limited number or which may have been lost before their potential was realised. Additionally, DNA isolated from dead tissues e.g. herbarium specimens, can be a source of information that would otherwise be lost if living tissues are not available.

The strategy of conserving the genomic DNA, as back-up to the storage of living tissues, can be of high relevance in case of the endangered, endemic and threatened medicinal plants. Additionally, this technique may be useful for many undescribed or unstudied plant species whose seeds cannot be stored and genes of which would be otherwise lost if living tissues are not available.

## 6.5 Tissue Culture

Tissue culture (TC) is the cultivation of plant cells, tissues, or organs on specially formulated nutrient media. Under the right conditions, an entire plant can be regenerated from a single cell. Tissue culture is seen as an important technology for developing countries for the production of disease-free, high quality planting material and the rapid production of many uniform plants.

## 6.6 Micro-propagation

Micropropagation, which is a form of tissue culture, increases the amount of planting material to facilitate distribution and large scale planting. In this way, thousands of copies of a plant can be produced in a short time. Micropropagated plants are observed to establish more quickly, grow more vigorously and are taller, have a shorter and more uniform production cycle, and produce higher yields than conventional propagules.

## 6.7 Synthetic Seed technology

Synthetic seeds are artificially encapsulated plant propagation material. This material could be somatic embryos, shoot buds, cell aggregates, or any other tissue that we can use as a seed for propagation. Synthetic seed technology primarily involves encapsulating somatic embryos in a protective coating. These seeds have the potential to develop into a whole plant in vitro as well as ex vitro conditions. They retain this potential even after storage.



## 6.8 Molecular marker - based approach

## 7. Stakeholders and experts required for Sustainable use of medicinal plant resources

**Table 1. outlines the experts needed to ensure sustainable use of medicinal plants in a country or region.**

<b>Experts</b>	<b>Axes of Intervention for sustainable use of medicinal plants</b>
Agronomists:	To improve techniques for cultivating medicinal plants
Conservation Campaigners	To persuade the public of the need to conserve medicinal plants
Ecologists:	To understand the ecosystems in which medicinal plants grow
Ethnobotanists	To identify the use of plants as medicines in traditional societies Health
Health Policy-makers	To include conservation and utilization of medicinal plants in their policy and planning
Horticulturists	To cultivate medicinal plants
Legal Experts	To develop effective legal mechanisms that ensure that collection of medicinal plants is at levels that are sustainable
Park Managers	To conserve medicinal plants within their parks and reserves
Park Planners	To ensure the park and reserve system contains the maximum diversity of medicinal plants
Pharmacognosists	To study the application of medicinal plants
Plant breeders	To breed improved strains of medicinal plants for cultivation
Plant Genetic Resource	To assess and map the genetic variation in medicinal plants and maintain seed banks of Specialists
Plant Pathologists	To protect the cultivated medicinal plants from pests and diseases without using dangerous chemicals
Religious Leaders	To promote a respect for nature
Resource Economists:	To evaluate the patterns of use and the economic values of medicinal plants
Seed Biologists:	To understand the germination and storage requirements of the seed of different medicinal plants
Taxonomists	To identify the medicinal plants accurately
Traditional Medicine Practitioners	To provide information on the uses and availability of medicinal plants

**Table 1. The experts most needed for a programme of conservation and sustainable utilization of medicinal plants (C' 1 766, n.d.)**

## 8. Factors that affect sustainability of medicinal plant resources

In working towards sustainable use of medicinal plant resources, the following factors contribute greatly to the success or failure of programs implemented and need to be considered at local, national and regional level.

- i. Policies/Guidelines/ regulations/ code of practice for harvesters. National, international, regional.

- ii. Communication, education and public awareness through social media, school programs and clubs, and botanical gardens around schools
- iii. Establishment of cooperatives/ associations for traditional healers
- iv. Having an inventory of plants in the endangered plants
- v. Making borders less porous
- vi. Capacity building for traditional healers and harvesters:
- vii. Financial/ material support e.g. drying facilities, PPEs),
- viii. training on resource management skills to ensure sustainable practices
- ix. Building capacity of customs and boarder officers
- x. Establishing and strengthening Institutions, Networks and Partnerships for plant conservation
- xi. Need to establish a vulnerability index (VI) for medicinal plants. This index identifies which indigenous plant species have restricted distributions and life history characteristics that make them vulnerable to over-harvesting. Species that score high on the VI should not be picked
- xii. Restoration of degraded echo systems
- xiii. Fighting pests and plant diseases
- xiv. Conservation through re-introduction
- xv. Benefit sharing based on Nagoya protocol/ Royalties

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Good Wild Collection Practices for Non- Timber Forest Products (NTFPs) / Medicinal Plants

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