Medicinal Plants Research in Asia

Volume I: The Framework and Project Workplans

PA Batugal, J Kanniah, Lee SY and JT Oliver, editors

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Foreword

In the world today, there are still a lot of people who do not have adequate access to basic needs such as food, water, education, health services and clean environment among others. This is a major concern being addressed by many governments at all levels amidst the rapidly growing population on one hand and a deteriorating environment on the other hand. Medicinal plants address not only the need for access to medicine as a component of health services but also to the need for increased income for farmers and as a significant contribution to the national economy. And, yet, a basic foundation to effectively bring about these contributions is to be able to collect, characterize, evaluate the genetic resources that a country has from animals, plants, insects and microorganisms which can serve this purpose. While there have been constraints in exchanges of materials and technology for pharmaceuticals derived from biological organisms, largely because of its very significant commercial value and questions on intellectual property rights, there is no doubt that a critical human need such as access to medicine which determines quality of life of human society will remain as a concern that will require a concerted effort among countries and peoples all over the world.

It is in this spirit that the International Plant Genetic Resources Institute (IPGRI), which is one of the 15 international research centres of the Consultative Group on International Agriculture Research (CGIAR) and the Rural Development Administration (RDA) of the Republic of Korea embarked on a joint research collaboration on "Inventory and Documentation of Medicinal Plants in the Asia Pacific Region" involving 14 countries. It is basically founded on the premise that the initial step for collaboration on this very important area among countries is not only building up confidence and familiarity with each others situation but also being able to share information on what each country has in terms of medicinal plants being actually conserved and why it was conserved. From out of this information sharing process, even without the benefit of material and technology exchanges, it is hoped that areas of common interest will be identified which can initiate a collaboration process on mutually agreeable grounds which will be beneficial not only for the countries involved but for humanity in general.

This proceedings is a result of the first stakeholder meeting of the countries and institutions involved in the project. It is a combination of reports on the framework of the project, the status report of countries on their medicinal plant programme, the agreements among the participants during this meeting in terms of priority project activities and the different country research proposals on medicinal plants.

I would like to express my appreciation to RDA of the Republic of Korea for the funding and technical support provided to this project. Also to the Malaysia Industry-Government Group for High Technology (MIGHT) of the Prime Ministers Department of the Government of Malaysia for allowing the conduct of this regional meeting to coincide and become part of the First Asia Pacific Natural Products (NATPRO) Exposition which was also hosted by the Government of Malaysia. And, most importantly to the countries participating in this very important project for their belief in the rationale behind it and the confidence for allowing RDA and IPGRI to facilitate this process of research collaboration.

Percy E Sajise
Regional Director
International Plant Genetic Resources Institute
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Introduction

Medicinal plants research in the Asia Pacific region was initiated with the signing of a research collaboration on the "Inventory and documentation of medicinal plants in the Asia Pacific Region" between the International Plant Genetic Resources Institute (IPGRI) and the Rural Development Administration (RDA) of the Republic of Korea on 5 December 2001. With this agreement, RDA provided IPGRI with the initial funding to implement the project in 14 countries over a period of four years, starting in 2002.

The original invited participants of the project include Bangladesh, India, Sri Lanka and Nepal in South Asia; Indonesia, Malaysia, the Philippines, Thailand and Vietnam in Southeast Asia; China, South Korea and Mongolia in East Asia; and Fiji and Papua New Guinea in the South Pacific. After visits and consultations with relevant institutions by the IPGRI Project Coordinator, Fiji and Papua New Guinea were deemed not ready to participate in the project. Thus, Laos and Myanmar were invited to participate instead.

Due to the need to consult with the implementing institutions and policy makers in each of the participating countries, project implementation actually started in 2002. The following countries started the work in 2002: China, Malaysia, South Korea and the Philippines; the following in 2003: Bangladesh, India, Nepal, Sri Lanka, Indonesia, Vietnam, Mongolia; and Laos in 2004. Discussions are still underway for the participation of Myanmar and Thailand.

This publication, entitled "Medicinal Plants Research in Asia, Volume I: The Framework and Project Workplans", documents the results of the first meeting of the project's stakeholders entitled "Asia-Pacific Medicinal Plants Research Meeting" which was held from 7 to 9 April 2003 as part of the Malaysian Government-sponsored Natural Products Exhibition and Conference (NATPRO) 2003 at the Putra World Trade Centre in Kuala Lumpur, Malaysia. Chapter 1 of this publication includes the background papers of the project describing the framework of the project, and the needed fundamentals and sustaining elements for a medicinal plants research. Chapter 2 includes the project proposals of each of the 12 participating countries based on the framework. Participants developed project proposals which are appropriate to their local situations and consistent with the status of medicinal plant research, and research gaps in their respective countries. Chapter 3 contains the progress reports of India, Malaysia, Korea and Philippines which started their projects before the meeting date, and the work plans of the other participating countries which have yet to initiate project-related activities. Finally, Chapter 4 gives the report containing the results and recommendations of the said project meeting as submitted by IPGRI to RDA.

It is hoped that the reader would find the information provided in this publication useful.

Pons Batugal
Project Coordinator
IPGRI-RDA Medicinal Plants Research Project

CHAPTER 1
BACKGROUND PAPERS

- Inventory and documentation of medicinal plants in 14 Asia-Pacific countries
- Rationale for conservation of medicinal plants
- Database development for medicinal plants
- Production of medicinal plants in Asia

Inventory and documentation of medicinal plants in 14 Asia Pacific countries

Pons Batugal

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Background and justification

For most of the developing world, the main issue of public health is still the acute need for basic health care, which is sadly lacking even at the most elementary level. This is true in both the rapidly growing cities and in the rural areas. The World Health Organization (WHO) indicates that more than half of the world's population does not have access to adequate health care services. This is due to the fact that poor people neither have access to nor could afford the present health care services. Therefore, innovative alternative approaches are needed to address this problem.

Medicinal plants offer alternative remedies with tremendous opportunities. They not only provide access and affordable medicine to poor people; they can also generate income, employment and foreign exchange for developing countries. Many traditional healing herbs and plant parts have been shown to have medicinal value, especially in the rural areas and that these can be used to prevent, alleviate or cure several human diseases. The WHO estimates that more than 80% of the world's population rely either solely or largely on traditional remedies for health care. Rural communities continue to rely on locally produced, plant-based remedies, some from home gardens, but many from forests, alpine pastures and other multiple-use habitats. Women and elders are the principal harvesters, marketers and healers. Recently, interest has been raised in many countries on the commercial extraction of medicine from plants that contribute to cures for major diseases such as cancer and AIDS.

Harvesting of medicinal plants by cash-needy collectors to supply the growing urban and international markets has increasingly intensified since these materials are cheaper and more accessible. These medicinal plants continue to supplement limited public health facilities, and the consequent expanding demand due to increasing population has put tremendous pressure on the natural supply. Several of these medicinal plants have also been over-exploited to provide substantial incomes to growers and processors. Hence, supplies of wild plants are constantly being threatened, resulting in serious erosion of genetic diversity.

The WHO estimates that a minimum of 20 000 plant taxa has recorded medicinal uses. It is estimated that up to 70 000 plant species are used in folk medicine and a majority of these species are found in the Asia-Pacific region. However, the use of medicinal plants is faced with many constraints. Some of these constraints include: plants with medicinal values not fully identified, inventoried and characterized, information and knowledge not being adequately documented and disseminated, many issues are not addressed and resolved (i.e. equity and sustainability), and the alarming commercial over-exploitation and consequent genetic erosion of medicinal plants.

As an initial step towards resolving these constraints, there is a need to develop a sound research strategy and programme for medicinal plants conservation, utilization and documentation, including their location, existing population, place(s) of conservation, and known traditional uses. When this documentation is achieved, it would be necessary to identify priority species for further work on characterization

and data sharing through national, regional and international collaboration. Subsequently, additional collecting, conservation and characterization of other medicinal plant species can augment these conserved species.

Recognizing these opportunities and constraints, the Rural Development Administration (RDA) of the Government of the Republic of Korea and the International Plant Genetic Resources Institute (IPGRI) agreed that currently there is inadequate information on medicinal plants in the Asia-Pacific region and that there is a need to maximize their use in a sustainable way. The two organizations thus decided to collaborate in implementing a project to inventory and document medicinal plants in the region and to promote research collaboration among countries. It was also agreed that this research collaboration would avoid unnecessary duplication of effort, promote complementation, synergy and sharing of resources to generate more outputs and achieve greater development impact. The project was designed to initially involve 14 countries in the Asia-Pacific region, namely: Bangladesh, India, Nepal and Sri Lanka in South Asia; Indonesia, Malaysia, the Philippines, Thailand and Vietnam in Southeast Asia; China, Mongolia and South Korea in East Asia; and Fiji and Papua New Guinea in the South Pacific.

The first Asia-Pacific Medicinal Plants Research meeting was held as part of the initial activities of this collaborative research project and was conducted as a satellite meeting to the Natural Products Exhibition and Conference (NATPRO) 2003 of the Malaysian Industry-Government High Technology Agency (MIGHT) sponsored by the Prime Minister's Office of the Government of Malaysia. The following were the general objectives of the meeting:

1. To discuss issues and agree on how participants can work together;
2. To develop a strategy to accelerate medicinal plants research; and
3. To develop a suitable research direction to maximize opportunities for all.

The more specific objectives of the meeting were:

1. To provide opportunities for medicinal plants researchers to share information on the status of medicinal plants in respective countries;
2. To update work plans of participants in the IPGRI-RDA project; and
3. To identify priority research areas and mechanisms for project implementation and fund generation.

The proposed project

Medicinal plants are one of the most sensitive commodity areas of research in the world today. Many countries would like to keep their information and knowledge about medicinal plants to themselves for fear of being marginalized in the race to exploit the commercial values of medicinal plants. However, through the proposed collaborative project, the region can collectively address the constraints and opportunities to make medicinal plants a progressive and sustainable industry that would benefit all participating countries. More important, the project and the designated country project leaders can do a lot to bring access and affordability of medicinal plants to poor people.

Specifically, the project aims to:

1. Document published and unpublished literature on medicinal plants;
2. Document conserved medicinal plants in 14 Asia-Pacific countries and generate information on the following:
    a. Scientific name, common and local names of conserved medicinal plants
    b. Location of genebank or collection
    c. Number of plants conserved per species
    d. Identified medicinal value or uses of each medicinal plant genus/species

   e. Photographs and general morphological description of each genus/species
3) Summarize the status of research on each medicinal plant in each country, the results and research gaps;
4) Identify priority medicinal plants per country and priority research areas;
5) Develop descriptors for medicinal plants;
6) Develop a database on medicinal plants containing passport and characterization data and uses;
7) Develop a Catalogue of Medicinal Plants containing pictures, uses and general morphological characters and cultivation methods; and
8) Develop a research network on medicinal plants.

The Korean Government, through the RDA, agreed to fund the project for a period of four years.

Initial workplan

On the first year (2002) of the project, seven countries (China, India, Indonesia, Malaysia, Korea, Philippines and Vietnam) carried out the following activities:

1) Documentation of published and unpublished literature on medicinal plants;
2) Documentation of conserved medicinal plants in their respective countries, indicating the following:
   a. Common name and scientific name
   b. Location of genebank or collection
   c. Number of accessions per species
   d. Number of plants conserved per species
   e. Identified medicinal value or uses of each medicinal plant genus/species
   f. Photographs and general morphological description of each genus/species
3) Documentation and analysis of current research on medicinal plants in each country, as well as results and research gaps; and
4) Identification of priority medicinal plants and priority research areas per participating country.

On the second year (2003) of the project, an additional seven countries undertook the same work as the first seven. These include Bangladesh, Mongolia, Nepal, Sri Lanka, Thailand, Fiji and Papua New Guinea.

On the third and fourth year (2004-2005) of the project, 14 countries (China, India, Indonesia, Malaysia, Philippines, Vietnam, South Korea, Bangladesh, Mongolia, Nepal, Sri Lanka, Thailand, Fiji and Papua New Guinea) will:

1. Develop descriptors for medicinal plants in collaboration with the other countries;
2. Develop a database on medicinal plants containing passport and characterization data and use;
3. Develop a Catalogue of Medicinal Plants containing pictures, uses and general morphological characters and cultivation methods; and
4. Develop mechanisms to enhance research collaboration among participating countries.

Due to the time needed to identify suitable research collaborating institutions and researchers and the need to clear this project with appropriate policy making bodies of proposed participating countries, the schedule was revised so that China, Malaysia, the Philippines and South Korea started their work in 2002; while

Bangladesh, India, Indonesia, Mongolia, Nepal, Sri Lanka, Vietnam, Fiji and Papua New Guinea will start work in 2003.

Expansion of the project will depend on the common interest of the participating countries. For example, on the second to third year, a research network on medicinal plants research may be established to provide a means for the participating countries to effectively carry out the mandates and objectives of the project and ensure the sustainability of the activities already initiated. It is envisioned that the project will catalyze collaboration in medicinal plants research among participating countries to promote the conservation and sustainable use of medicinal plants to benefit resource-poor producers and consumers.

Conclusion

The project will document and inventory conserved medicinal plants, identify uses, research status and gaps, priority species and priority research projects in 14 participating countries. It will also develop descriptors for medicinal plants and characterize conserved germplasm and generate information on cultivation methods.

It is envisioned that the project will catalyze collaboration in medicinal plants research among participating countries to promote the sound conservation and sustainable use of medicinal plants. It is expected that this project will help national governments and development organizations provide access and affordable medicine to poor people and provide development opportunities to help generate income, employment and foreign exchange for the participating countries.

Rationale for conservation of medicinal plants

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Introduction

Interest in the exploitation of medicinal and aromatic plants as pharmaceuticals, herbal remedies, flavourings, perfumes and cosmetics, and other natural products has greatly increased in the recent years (Anon 1994; Ayensu 1996; Salleh *et al*. 1997; Kumar *et al*. 2000). As with many other economic plants that are still being collected from the wild and exploited by humans unsustainably, threats to genetic diversity and species survival have also increased in the case of medicinal plants as a result of habitat destruction, over-exploitation, land use changes and other pressures (Arora and Engels 1993). In India alone, less than 10 % of the medicinal plants traded in the country are cultivated, about 90% are collected from the wild, very often in a destructive and unsustainable manner (Natesh 2000).

The number of organizations conducting research and other activities related to the use of medicinal and aromatic plants is large and increasing (Ayensu 1996; Sharma *et al*. 2002). Botanic gardens are particularly well distributed network of institutions with experience and expertise in this area. Work on conservation of this resource, particularly at the level of intra-specific genetic diversity, has not kept pace with advances in other areas, such as pharmacognosy and documentation of indigenous knowledge (Leaman *et al*. 1999; Kshirsagar and Singh 2001).

The medicinal plants have been used by humans from the pre-historical times. Studies have pointed out that many drugs that are used in commerce have come from folk-use and use of plants by indigenous cultures (Anon 1994). About 50 drugs have been discovered from ethnobotanical leads by translating folk knowledge into new pharmaceuticals (Attachment Table 1; Cox 1994). Some examples of medicinal plant from the Asia-Pacific region are of species such as *Rauvolfia, Hyoscyamus*, *Cassia, Atropa, Podophyllum, Psoralea, Catharanthus,* and *Papaver.* However, relatively few medicinal and aromatic plant species have been brought into cultivation worldwide and most of these species continue to be harvested from their native habitats (Gupta and Chadha 1995; Salleh *et al*. 1997; Gautam *et al*. 1998). Very little work has been undertaken on their selection and improvement, for developing suitable varieties. Much of the existing work on *ex situ* conservation of medicinal plants has been undertaken by botanic gardens, focusing more on interspecific diversity and less on intra-specific diversity. Little genetic material for research and conservation is held in genebanks, except for a handful of species that have entered into commercial products. Most of such collections are with the private sector, and the genetic diversity status of such collections is largely unknown. Although in recent years the attention given to development of propagation methods for threatened species has increased, most of such efforts proceed with little understanding of how these methods and collections can support conservation objectives overall (Natesh 2000; Tandon *et al.* 2001; Rajasekharan and Ganeshan 2002). The current focus of attention on intellectual property and benefit sharing is not sufficiently broad to include the more significant threats to conservation of these important genetic resources, which is further confounded with issues related to indigenous/ traditional knowledge and knowledge sharing (Anon 1994; Kumar *et al*. 2000).

It has been well recognized that human health and well-being are directly dependent on biodiversity. For example, 10 of the world's 25 top-selling drugs in

1997 were derived from natural sources. The global market value of pharmaceuticals derived from genetic resources is estimated at US$ 75 000–150 000 million annually. Some 75% of the world's population rely for health care on traditional medicines, which are derived directly from natural sources (UNDP, UNEP, World Bank and WRI 2000).

IPGRI has been working on medicinal and aromatic plants throughout the Institution's history, but there has been no strategic effort. A strong justification for increasing attention to medicinal and aromatic plants within IPGRI's activities is their relevance to IPGRI's mission. Medicinal plants contribute substantially to health, cultural integrity and local economies, particularly among the poor, and particularly for women, children and the elderly (Rao and Ramanatha Rao 1998; Leaman *et al*. 1999).

Traditional practices and importance of medicinal plants

People who live in rural areas of the Asia-Pacific are familiar with the medicinal properties of plants, growing close to their homes, in the open fields, water margins, waste lands, both inside and outside the nearby forest areas and under different growth conditions. Most of the plant materials collected is used fresh either to obtain the extract from the whole plant or parts there of, whether they be leaves, roots, flowers or fruits. In case of woody forms, mostly the bark, roots and other parts are used. Carminatives like ginger, cloves and coriander are also usually added as fresh or dried materials. Though dried plant parts are frequently used, often the easy availability of fresh material is a critical point and the herbal doctor in the village is well familiar with various plants he/she needs, their growth patterns, seasonality, habitat and other details. Such details were usually passed on in the past from parent to offspring in the family and uses of plants and the various combinations or mixes made were kept as a family secret. Along with the development of knowledge at family level, tremendous progress has been made at using the plant products at professional level in different societies, which have grown into branches of science in their own right. Most of the methods and uses were taught orally and through demonstration, and very few records or writings were maintained. Such professional practices are continuing even today. As villagers migrated to city, losing touch with past practices or when there was no heir apparent to the village doctor, the precious knowledge was usually lost, although there are a number of treatises that exist in different countries (Rao and Ramanatha Rao 1998).

Refinement of such practices lead to the well established Asian systems of medicines including Ayurveda and Siddha of India, Unani system of middle and Far East Asia, Ying and Yan principles of Chinese herbal medicines, Jamu of Indonesia and others (Sharma *et al*. 1998; Natesh 2000). About 400 plant species are used in regular production of Ayurvedic, Unani, Sidhha and tribal medicine (Rajasekharan and Ganeshan 2002). Recently, a regional inventory of medicinal and aromatic plants and polyherbal formulations dealing with 65 Indian medicinal plants; 10 important Indonesian and 25 medicinal plants of Malaysia, along with important traditional and polyherbal formulations used in these countries has been brought out by CIMAP and supported by the Department of Biotechnology, Government of India (Anon. 1999). It is only in the last 40 to 50 years that many of the medicines were produced industrially and sold in shops and markets with trade names. The practice of various indigenous medicinal systems is flourishing in different countries even today, with nearly 80% of the rural population still dependent on plant-based medicines for primary health care (Sasson 1996; Natesh 2000).

It is said that US$ 1 per day is enough to provide the basic nutritional needs of an individual. About 1.3 billion people in the world earn less than this and it would not

require much imagination to realize that such people can hardly afford to spend any money on modern medicines or avail of modern medical services. This stresses the importance of turning to local plants which are useful medicinally and obtained almost free of cost. Thus, the utilization of medicinal plants in traditional remedies is very important to the people in developing countries particularly the rural population.

Medicinal plant resources in nature

Though much information exists on the species diversity in medicinal plants in the Asia-Pacific region, relatively very little is known about the distribution, abundance, ecology and genetic diversity of the great majority of medicinal and aromatic plants, although some efforts have started in recent years (Chadha and Gupta 1995; Chandel *et al.* 1996; Kumar *et al*. 2000; Paisooksantivatana *et al*. 2001), including the use of molecular markers (Sharma *et al* 2000; Natesh 2000). Identifying priority species for conservation and understanding the management requirements for most of these plants are constrained by the limited capacity for and attention to basic field research. The few thorough investigations of sustainable harvest conducted to date indicate that a combination of *in situ* protection of core populations, and controls on sustainable harvest involving local management regimes, must be combined with *ex situ* cultivation and conservation of rare and endangered, popular, and economically important species (Rao and Ramanatha Rao 1998).

Out of the 350 000 plant species identified so far, about 35 000 (some estimate up to 70 000) are used worldwide for medicinal purposes and less than about 0.5% of these have been chemically investigated. The figures published vary in different reports. About 100 plant species are involved in 25% of all drugs prescribed in advanced countries (Comer and Debus 1996) and the annual market value of herbal drugs used worldwide was estimated to be US$ 45 billion in 1996 (Sasson 1996) and it must be much more by now. The global market for the medicinal plants and herbal medicine is estimated to be worth US$800 billion a year (Rajasekharan and Ganeshan 2002). More than 8000 plant species are known for their medicinal properties in the Asia-Pacific and about 10% of them are used regularly, mostly collected from wild. For example, it has been estimated that not less than 7500 species of medicinal plants exist in the Indonesian archipelago, of which only about 187 species are used as basic materials in traditional medicines industries (Hamid 1990). In China, over 4000 species of medicinal plants have been reported (Ayensu 1996). In India, about 2500 species are used for medicinal purposes, and about 90% of the medicinal plants provide raw materials for the herbal pharmaceuticals, which are collected from the wild habitats (Rajasekharan and Ganeshan 2002). About 2000 medicinal plants species are reported from Malaysia (Latif 1997), while in an another account 1200 species have been reported to have potential pharmaceutical value, some of which are being used as herbal medicines (Kadir 1997).

For the Indian Himalayan Region, a total of 1748 species of medicinal plants – 1020 herbs, 338 shrubs, 339 trees, apart from 51 pteridophytes – have been listed (Samant *et al.* 1998). These include several of the endangered medicinal plant species, using current IUCN, Red Data criteria under the Biodiversity Conservation Prioritization Project (BCPP), by Conservation Assessment and Management Plan (CAMP) workshop organized by WWF at Lucknow from 21-25 January 1997 (Samant *et al*. 1998). Some examples of the endangered Himalayan medicinal plant species include: *Aconitum balfourii, A. deinorrhizum, Acorus calamus, Angelica glauca, Atropa belladonna, Berberis kashmiriana, Coptis teeta, Dioscorea deltoidea, Gentiana kurrooa, Nardostachys grandiflora, Picrorhiza kurrooa, Podophyllum hexandrum, Saussurea costus, Sweria chirayita* and *Taxus baccata subsp.wallichiana;* and the sub-tropical/sub-

temperate species *Aquilaria malaccensis.*

The availability of fresh or dried plant materials required to prepare various medicines was not a major problem when human population was small, and plant material collected were within limits, allowing enough number of plants to regenerate or re-grow in the following years. However, the current industrial practice of manufacturing herbal products requires large quantities of plant materials resulting in over collecting leading to scarcity of materials, especially the well known and slow growing species that are in great demand, for example *Rauvolfia*, ginseng and different gingers. The depletion of resources is less in tree or woody forms when compared to the herbaceous species. Cultivation was encouraged, which also became profitable. But very soon it was discovered that in many cases the ingredients obtained from natural habitats were usually superior to the cultivated ones and the quality of products did not match in many cases.

In almost every Asian country, there is a vast indigenous knowledge on the use of medicinal plants. Although traditional and local identification systems existed for long, actual and formal scientific identification of these plants only started in the 1900's (Dymock 1890; Dragendorff 1898; Boosma 1926; Burkill 1935). However, as the availability of plant materials was not a problem, very little or no attention was paid by the earlier authors to the occurrence, growth habit, distribution and other ecological details of the plants. Only recently, publications regarding the resources of medicinal plants in Asia are becoming available; information on their relative abundance or scarcity, ecological conditions of growth, distribution patterns, etc., are being recorded (Chadha and Gupta 1995; Chandel *et al.* 1996; Samant *et al.* 1998; Kumar *et al*. 2000). Table 2 lists 27 endangered medicinal plants of global/regional importance (Ayensu 1996). More recently, the publication of red data book by IUCN as well as proceedings of a few regional meetings on this topic have helped to understand the relative abundance or scarcity of various medicinal plant species including the rare, threatened, endangered, or species about to become extinct (Salleh *et al*. 1997; Anon 1998; Gautam *et al.* 1998; Tandon *et al*. 2001). In India, the Foundation for Rehabilitation of Local Health Traditions (FRLHT), a non-government voluntary organization based at Bangalore, has compiled a list of 352 medicinal plant species of South India which require urgent conservation measures and of these, 226 are collected from the forest for their use by the pharmaceutical industries. The CAMP workshops identified 112 threatened medicinal plants in South India. These include critically endangered species such as *Coscinium fenestratum*, *Kaempferia galanga*, *Piper barberi, Trichopus zeylanicus, Valeriana leschenaultii* and V*ateria macrocarpa;* endangered species such as *Rauvolfia serpentina, Pterocarpus santalinus, Santlum album, Swertii lawii,* and *Gymnema sylvestris.* Few species were designated extinct namely: *Aerva wightii, Asparagus rottlerii, Madhuca insignis* and *Plectranthus vettivariodes.* Recent compilations by IUCN/SSC in producing medicinal plant conservation bibliography (Schippmann 1997, 2001) have provided more information on this aspect; just like some of the international conferences on medicinal plants, such as the conservation, utilization, trade and culture held at Bangalore, India in January 1996.

The number of plant species used medicinally would involve thousands of species in any one country (Ayenshu 1996). These need to be categorised in terms of both quality and quantity to assess the resource base of any particular country. This is so in case of herbal species where land degradation, transformation or clearing would wipe out the whole population. Fortunately, many of the medicinal plants have the great potential to grow as weeds that cannot be easily eradicated. In some cases, land disturbances help certain species to grow and thrive better.

Medicinal plant resources ex situ

There have been a few efforts to collect and conserve medicinal plant species. Botanic gardens are one of the main repositories of medicinal plants and good examples are set by the world renowned gardens at Kew, New York Botanic Garden, Missouri Botanic Garden, Calcutta Botanic Garden, Bogor Botanic Garden, Hangzhou Botanic Garden and others. Most of them are more than 100 years old and there are other Botanic Gardens recently established/are focusing on medicinal plant maintenance and conservation in various countries such as in Thailand (Swangpol 1995) and in India (Natesh 1997, 2000; Rajasekharan and Ganeshan 2002). Due to constraint of space, very few plants of any given species are cultivated in such gardens either on ground or in pots. The objective of such collections is to establish species diversity with short notes on medicinal value. A few of the forest research institutes also cultivate medicinal plants derived both from inside and outside the forests. A number of indigenous medical colleges/schools in Asia have their own medicinal plant gardens and maintain most commonly used medicinal plants under varied conditions of culture. Such collections in the developing countries mostly include the indigenous species. The genetic diversity of the useful species needs to be well studied to select superior plants for sustainable conservation, or cultivation and use. Most of the basic research on medicinal plants in the Asian developing countries is done in the universities and in some specific medicinal plant institutions in countries like India and China (Ayensu 1996; Natesh 2000; Krishnamoorthy *et al*. 2001). Interest of non-government organizations is also catching up, such as the good work on medicinal plants being done by the FRHLT, Bangalore, India (Anon 1997).

A few of the big pharmaceutical companies of international standing have been conducting research and development activities, although their efforts focus more on primary screening of medicinal plant materials. Thousands of tonnes of dried plant materials are sent every year to the developed countries for this purpose (Adjanohoun 1996). International export trade in medicinal plants has been dominated by China which exported 121 900 tonnes a year and India which exported 32 600 tonnes a year (Rajasekharan and Ganeshan 2002). More number of researchers and institutions need to be seriously involved in medicinal plants research and development, not only for the intellectual challenges involved but also the huge possible profits obtainable over a period of time (Latif 1984; Osman 1995; Rates 2000).

Medicinal plants exhibit diverse life forms and occur under varied ecologies practically occupying all floristic regions of the world. A systematic database needs to be established for each country, mapping the ecogeographic distribution of medicinal plant biodiversity. Geographic, ecological and taxonomic notes should be included. Presently, good database is available at the Plant Resources of South East Asia (PROSEA) at Bogor, Indonesia; National Institute of Science Communication (NISCOM), New Delhi, India; Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow; IDRC/Medicinal and Aromatic Plants Programme in Asia (MAPPA), New Delhi, India, and the Asia-Pacific Information Network on Medicinal and Aromatic Plants (APINMAP) operated from Los Baños, Laguna, Philippines. Very few studies have been made on understanding intraspecific variation (Chadha and Gupta 1995; Kumar *et al*. 2000; Prajapati *et al*. 2000) and such studies are needed urgently. Also, it is well known now that biochemical pathway as well as production and storage of substances in certain herb and tree species are different when they grow in different types of soils and conditions (Adjanohoun 1996). Periwinkle, pepper, gingers, tea, betel leaf, sandalwood tree are some of the well known examples where the required, alkaloid, oil or other components are very much varied or almost absent in plants of the same species growing under different conditions or even at adjacent locations. Existence of distinct ecotypes has been reported for such

as in *Rauvolfia serpentina* (Gupta and Chadha 1995; Ayensu 1996). How far such variations are induced or influenced by genetic or ecological conditions are yet to be scientifically clarified. The traditional practice is to select best plants from well-known localities and use them. Generally, the criteria followed while selecting the plants include: the commercial value of the species, varieties/types available, degree of domestication, whether wild or cultivated, quantity of plant materials required, the end product used and others. The species of medicinal plants used in any one country are probably prioritised intrinsically, but priorities need to be established on agreed criteria and after documenting available information on them. Nevertheless, more attention needs to be paid to species that are more commonly used by the rural poor and also those that are commercially valuable. Comparative data can be established between different communities within or between the countries to assess the total value of the resource base (Rao and Ramanatha Rao 1998). IPGRI's efforts in documenting the conserved medicinal plant species in 14 selected Asian countries covering East, South-East, South Asia and the Pacific Islands with financial support from the Republic of Korea is expected to contribute greatly to assess what is available in different national organizations that are involved in the conservation and use of medicinal plants.

Rationale for conservation of medicinal plant genetic resources

Exploration, collecting, assessing diversity and conservation collectively focus on the rationale for conservation of medicinal plants *vis-à-vis* management of these genetic resources for their utilization (Natesh 1997, 2000). In this context, the conservation and management of wild germplasm diversity in medicinal plants also needs special emphasis (Subramanian and Sasidharan 1997a, 1997b). Some of these aspects are dealt with below.

Understanding the diversity of medicinal plants

As noted earlier, the distribution and diversity of medicinal plants is not well documented and many of the collectors/botanists paid more attention to the description of the species and less attention to population parameters and intraspecific diversity. The biodiversity of medicinal plants is yet to be well studied in many Asian countries and assumes priority, in view of the extensive destruction of plant rich habitats in tropical conditions. The habit, growth form, phenology and other characteristics of medicinal plants need to be well documented. Substantial body of information has been generated in recent years through many publications such as proceedings of international meetings highlighting the importance of screening, bioprospecting and cultivation of medicinal plants (Farnsworth 1988; Akerle *et al*. 1991, Anon 1994; Sassoon 1996; Comer and Debus 1996; Adjanohoun 1996 Salleh *et al.* 1997; Gautam *et al.* 1998). Many of the Asian plant species listed that yield high value products include *Catharanthus* (*Vinca*), *Rauvolfia, Cephaelis, Coptis, Papaver, Dioscorea, Panax, Podophyllum* and others i.e. *Aloe, Commiphora, Mentha, Ocimum, Cymbopogon, Psyllium, Azadirachta, Artemisia, Cassia, Psoralea, Chlorophytum, Pogostemon, Piper, Vetiveria* (Gupta and Chadha 1995; Ayensu 1996). However, these species have to be critically studied to identify varietal differences, conserve the variation and use the superior plants or clones for sustainable use. Rehabilitation and management of natural resources with due regard for saving biodiversity are the important issues of resource management. Conserving the different but interacting ecosystems in the adjacent areas is also important to conserve medicinal plants (Natesh 2000).

Thus, exploration, collecting and conservation provide us with an opportunity to understand the plant species better and device mechanisms to sustainable

exploitation of these invaluable resources.

Understanding taxonomy and refine classification

Since the collecting and study of medicinal plant species focused mostly on the exploitation of the plant and its product, little attention has been paid to classification and grouping of the available species in relation to other species that could be genetically close. Due to this, the focus has been one or two species or types, which could be exploited to extinction. However, the plant species used medicinally are very variable in habit and their taxonomic ranks (Anon 1998). It should be possible to look into the related species for the active ingredients, so that the options available for exploitation are enhanced. In addition, taxonomic research, including the use of molecular tools, is essential to be able to exploit the medicinal plant species diversity. Plant parts used medicinally will govern the method of harvesting of medicinal plants. Plants used for bark, leaves, flowers, fruits, etc., would be damaged, partially, and their survival potential may not be affected greatly. Collecting of roots or whole plants would result in destructive harvesting. Hence, alternative ways of exploiting the resources will be needed such as, bringing the species into cultivation or better management of the recruitment in nature. Whole plant used is confined mostly to herbs. Such details should be enumerated for each country so that good directions can be worked both for cultivation and use of medicinal plants. The arboreta of research institutes should include species of medicinal trees as part of *ex situ* conservation programme.

But in countries rich with tropical flora, like Indonesia, Malaysia and India, there would be large number of tree species that require a place in the arboreta. Habitat variations of tree species would be a constraint to include different species in one location. Small and selected type of conservatoires located in different parts of the country would meet different needs.

Thus, collecting and conservation of medicinal plant species would allow the identification of a greater number of species for utilization and on a sustainable basis. It will also help in studying them at close quarters and speeding up their domestication process, so that such useful species are available to more people and in larger quantities.

Understanding of growth and other phenological requirements

Medicinal plants in any country form a very heterogeneous group in growth habit, distribution, reproduction, phenology and their ecological requirements. Many of them grow in open starting from wetlands to dry, arid conditions. They also extend from sea level to higher altitudes. The medicinal value of such plants also might vary; some important ones are mountainous forms, others bordering the desert or semi-desert areas. The quality and quantity of products they produce also vary depending on the habitat. The conservation methods that are followed need to be equally divergent. Collecting and conserving these varied forms and species will help in studying them to determine the most optimum conditions for growth, as well as extending their area of growth in suitable ecological niches.

To expand the limits of utilization, it is necessary to collect, conserve, evaluate and make available the product to people in other parts of the world. In India, the FRLHT for the past several years has been engaged in a project for the conservation and sustainable use of the medicinal plant diversity in South India, and has carried out studies through the establishment of a network of 30 Medicinal Plants Conservation Areas (MPCAs) in the states of Karnataka, Tamil Nadu and Kerala. Degraded land has been taken up for cultivation of medicinal plants (Rajasekharan and Ganeshan 2002). These are called Medicinal Plants Development Areas (MPDRs) and six such

areas have been set up within these states. Thus, collecting and conservation will become the basis for expanded utilization to benefit a larger number of people.

Designing better conservation options

Medicinal plant species show diverse forms and some of them also occur as weeds thriving under varied conditions. Much of this type of information arises from their study in nature as well as in captivity. However, current conservation efforts are limited in terms of providing optimum conditions for their continued survival. In order to conserve species that grow in the open or at the fringes of wooded areas or farms, *in situ* conservation methods should be supplemented with land use policies that would permit existence of such spots in either conservation areas or agricultural landscapes so that such specific species are conserved. Therefore, a series of interconnected conservation areas, rich in the particular species should be demarcated and if possible left undisturbed. How big the area, or how many areas within the country or even in the region to save or conserve the designated species depends on not only the genetic diversity present in the species, but also on the economic value of the species. Protecting such species in biosphere reserves and sacred grooves has been advocated (Natesh 2000; Rajasekharan and Ganeshan 2002). Also some analytical studies need to be conducted to identify the most valuable populations within the community because the quality of products produced by different populations may vary and there can be close link established between the genotypes and ecological variables under which they grow such as in *Rauvolfia*, *Heracleum*, *Cymbopogon* and *Vetiveria* (Chadha and Gupta 1995; Ayensu 1996; Gautam *et al*. 1998; Kumar *et al*. 2000). Agricultural landscapes, within which a number of herbaceous medicinal plants survive/thrive as weeds or edge/fence plants, could also be included in the strategy. Thus, the small-scale conservation of medicinal plants can lead to improved conservation strategies in the long run.

Designing complementary conservation and use strategies

The *ex situ* conservation methods may include growing the whole plants in field genebanks or by seed storage to conserve diversity. Appropriate seed storage technologies for different species have to be worked out and, at the same time, it should be made sure that the seeds planted produce plants of good quality comparable well with mother stock from which they were collected. Most of the medicinal plants that are selected and cultivated represent *ex situ* collections. While large numbers of plants are cultivated in a given area and the biomass used, it is necessary to compare once in a while, the quality of cultivated plants with those that were collected from nature. Passport details and reproductive behaviour of cultivated plants need to be properly recorded. It is well known that big pharmaceutical companies have well-established laboratories and nurseries to grow and study the economically important medicinal plants and to select the best varieties. Both physiological and ecological requirements of such plants will have been well identified before they are brought under cultivation (Chadha and Gupta 1995; Gupta and Chadha 1995). Many of the technical details may not have been made known because of economic and commercial implications. Efforts to propagate either by vegetative means or by using tissue culture which is becoming quite popular with many species (Gau *et al.* 1993), particularly those propagated vegetatively and are designated as endangered (Natesh 2000; Rajasekharan and Ganeshan 2002), requires testing of them on larger number of types of medicinal plants (or as accessions as we call them) as differences in genotypic responses exists and *ex situ* collections would be greatly useful in such situations. The development of propagation techniques (in addition to seed conservation, in cases where the seed

produced is orthodox in nature and can be conserved under dry and cool conditions) such as tissue culture etc., can open doors for modern technologies for conservation such as *in vitro* conservation and cryopreservation (Natesh 1997 2000). *In vitro* conservation protocols for about 30 species have been established (Chandel *et al.* 1996; Natesh 1997, 2000; Rajasekharan and Ganeshan 2002). These mainly include endangered species mentioned earlier and high priority species particularly from the Himalayan region. Such technologies not only increase the range of diversity that could be conserved, but also make the conservation efforts cost-effective and promote the utilization of the resources through safe exchange and propagation. The strategies available for the conservation of medicinal and aromatic plants using both *in situ* and *ex situ* approaches, and making use of biotechnology tools are shown in Figure 1 (Natesh 1997, 2000). It need to be emphasized that biotechnology has opened new vista in the conservation of medicinal plants by way of: (i) rapid multiplication and reintroduction to nature of endangered species, (ii) assessment and monitoring of biodiversity as a source of new tools for conservation, and (iii) identification of new gene product potential use. Thus, conservation of medicinal plant genetic resources will lead to better conservation and utilization of these important resources for better human well being and health.

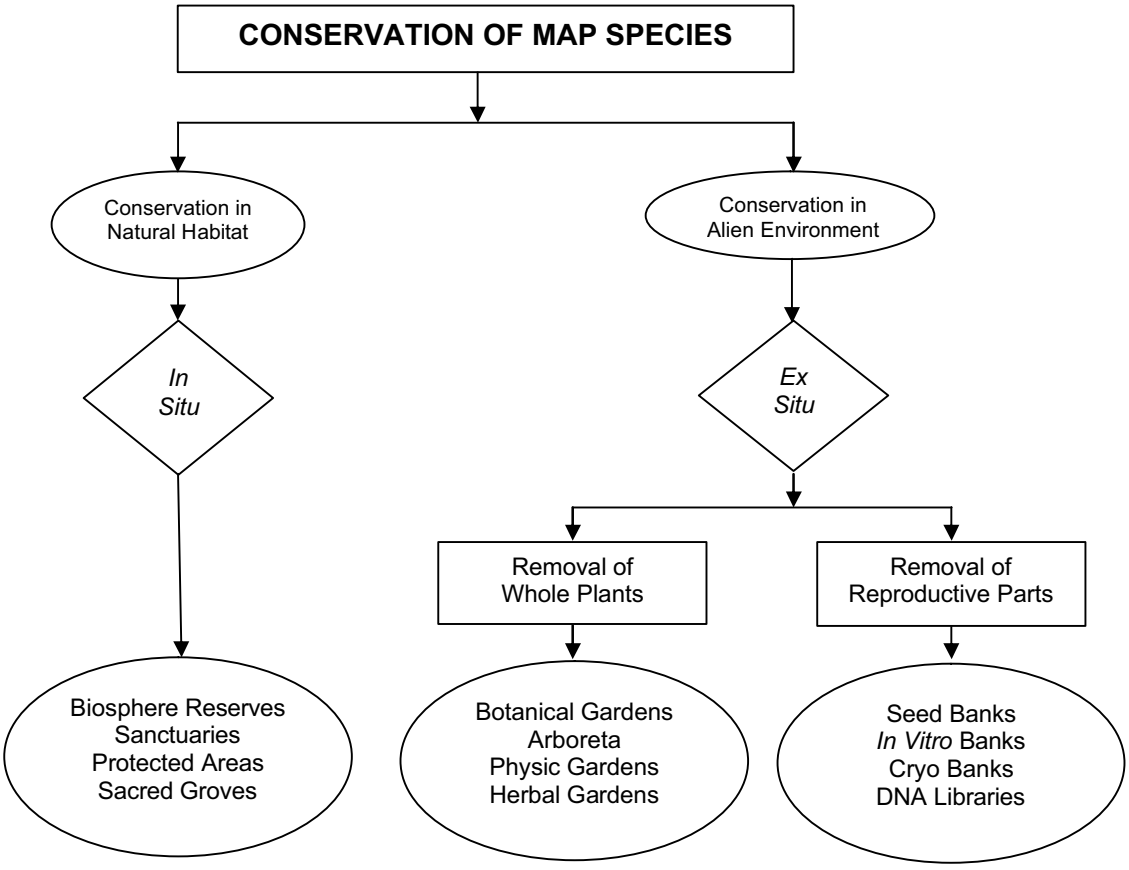

Figure 1. Methods of conserving medicinal and aromatic plants (MAP)(Source: Natesh 1997, 2000)

Promoting sustainable conservation and utilization

Many of the medicinal plants in developing countries are extracted from the wild or from fields on a contract basis and required plants are grown in their home countries. The dried materials are exported to the pharmaceutical companies in the developed countries. The quantity of materials annually exported is enormous, for e.g. Madagascar periwinkle (400 t of dried roots), *Rauvolfia vomitoria* (500 t of dried root bark), *Pygeum africanum* (300 t of dried stem bark), 900 t of *Voacanga africana* seeds, *Carica papaya* (300 t of latex produced by 600 million unripe fruits) and seeds or dried plant materials of various species. Regulated and extensive cultivation of different species are significant (Adjanohoun 1996). Selection of best plants for cultivation is the main point of the whole exercise and one wrong step would incur a loss of millions of dollars. Bringing into cultivation, provided the active chemicals continued to be produced by plants under cultivation, is an excellent method of reducing extraction from natural habitat and thus helps in the overall conservation effort (Rao and Ramanatha Rao 1998; Natesh 2000).

The general concern is with the conservation of germplasm and exchange of the medicinal plant material in the region for the economic benefit of the people. To accomplish this, a complementary conservation strategy that encompasses both *in situ* and *ex situ* conservation approaches is required (Natesh 2000). Useful suggestions and technical guidelines have been published referring to crop plants to asses the threat of genetic erosion, sampling strategies, strategies for collecting wild species, mapping the ecogeographic distribution of biodiversity, collecting the herbaceous and woody perennials, recording the data and other details (Ramanatha Rao and Riley 1994; Guarino *et al.* 1995). Same or similar details are equally well applicable to medicinal plants and these methods can be followed wherever appropriate. Relatively less emphasis has been given to such strategies specifically in case of medicinal plants (Salleh *et al.* 1997; Natesh 2000).

Conservation and exchange will result in increased evaluation of a larger number of species, genotypes of the same species for useful/desirable chemical or metabolite. Bioprospecting could be a joint venture benefiting different stakeholders and at the same time making the resource sustainable (Jenta *et al.* 2000; Natesh 2000). The experience gained during the exploration and collecting (habitat and growth conditions) combined with the efforts to grow them in *ex situ* conservation facilities can provide the cultivation details of the different species and also their genotypes. This will assist in developing cultivation techniques and practices (either *in vivo* in the field or *in vitro* in the laboratory).

Thus, an increased availability of medicinal plant products is expected to reduce the burden on the naturally occurring medicinal plants and will help in sustainable conservation of these important natural resources.

Conclusion

The above account amply points out that research and development emphasis on medicinal plants has gained momentum over the past few decades. Thus, collection and conservation of their diversity has also assumed greater importance. As envisaged above, conservation and sustainable use of medicinal plants are multidimensional problems and require urgent attention of all the stakeholders including native communities. From the different studies and observations, it is clear that there is over-exploitation of these plants in nature and relatively less effort have been made to conserve this valuable natural resource for its sustainable use. Habitat destruction is the major threat for the survival of medicinal plants. Proper documentation of indigenous and ethnobotanical knowledge in each country will help to establish the base line data and to plan for conservation programmes (Jain

1991; Anon 1994). As such, there is strong rationale for conservation of medicinal plants and these efforts will lead to an understanding of the plant species better and device mechanisms to sustainable exploitation of these invaluable resources; identification of greater number of species for utilization to speed up their domestication process; expansion of utilization and benefits to larger number of people and improvement of conservation strategies. The increased availability of medicinal plant products is expected to reduce the burden on the naturally occurring medicinal plants and will help in sustainable conservation of these important natural resources.

Better rationale on conservation would mean better management of medicinal plant resources, and this would enhance the availability of these resources to more people and in larger quantities. Considerable knowledge gained and methodologies established for crop plants conservation can be used beneficially after making some fine adjustments in the programme suitable for medicinal plants. Research emphasis on such strategies is evident in some countries in the Asia-Pacific such as India, China, Malaysia, and the Philippines, but lack in medicinal plants rich countries such as Indonesia, Nepal and Sri Lanka. Also coordinated efforts have been initiated such as for the G-15 genebanks on medicinal and aromatic plants – GEBMAP project in India under the Department of Biotechnology involving CIMAP, Lucknow, NBPGR, New Delhi, Tropical Botanical Garden and Research Institute (TBGRI), Thiruvananthapuram and Drug Research Laboratory, Jammu; for conservation of medicinal plants using diverse measures (Natesh 1997, 2000). The national programmes need to promote and strengthen such conservation initiatives for better management and utilization of their medicinal plant resources for healthcare, income generation and environmental sustainability.

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Attachment Table 1

Fifty drugs discovered from ehnobotanical leads
(Source: Cox 1994)

Drug	Medical Use	Plant Source
Ajmaline	For heart arrhythmia	*Rauvolfia* spp.
Aspirin	Analgesic, anti-inflammatory	*Filipendula ulmaria*
Atropine	Pupil dilator	*Atropa belladonna*
Benzoin	Oral disinfectant	*Styrax tonkinensis*
Caffeine	Stimulant	*Camellia sinensis*
Camphor	For rheumatic pain	*Cinnamomum camphora*
Cascara	Purgative	*Rhamnus purshiana*
Cocaine	Ophthalmic anaesthetic	*Erythoxylum coca*
Codeine	Analgesic, antitussive	*Papaver somniferum*
Colchicine	For gout	*Colchicium autumnale*
Demecolcine	For leukaemia, lymphomata	*C. autumnale*
Deserpidine	Antihypertensive	*Rauvolfia canescens*
Dicoumarol	Antithrombotic	*Melilotus officinalis*
Digoxin	For atrial fibrillation	*Digitalis purpurea*
Digitoxin	For atrial fibrillation	*D. purpurea*
Emetine	For amoebic dysentery	*Psychotria ipecacuanha*
Ephedrine	Bronchodilator	*Ephedra sinica*
Eugenol	For toothache	*Syzygium aromaticum*
Gallotanins	Haemorrhoid suppository	*Hamamelis virginia*
Hyoscyamine	Anticholinergic	*Hyoscyamus niger*
Ipecac	Emetic	*Psychotria ipecacuanha*
Ipratropium	Bronchodilator	*H. niger*
Morphine	Analgesic	*Papaver somniferum*
Noscapine	Antitussive	*Papaver somniferum*
Papain	Attenuator of mucus	*Carica papaya*
Papaverine	Antispasmodic	*Papaver somniferum*
Physostigimine	For glaucoma	*Physostigma venenosum*
Picrotoxin	Barbiturate antidote	*Anamirta cocculus*
Pilocarpine	For glaucoma	*Pilocarpus jaborandi*
Podophyllotoxin	For condyloma acuminatum	*Podophyllum peltatum*
Proscillaridin	For cardiac malfunction	*Drimia maritima*
Protoveratrine	Antihypertensive	*Veratrum album*
Psedoephedrine	For rhinitis	*E. sinica*
Psoralen	For vitiligo	*Psoralea corylifolia*
Quinine	For malaria prophylaxis	*Cinchona pubescens*
Quinidine	For cardiac arrhythmia	*C. pubescens*
Rescinnamine	Antihypertensive	*R. serpentia*
Reserpine	Antihypertensive	*R. serpentia*
Sennoside A, B	Laxative	*Cassia angustifolia*
Scopalamine	For motion sickness	*Datura stramonium*
Sigmasterol	Steroidal precursor	*Physostigma venenosum*
Strophanthin	For congestive heart failure	*Strophanthus gratus*
Tubocurarine	Muscle relaxant	*Chondrodendron tomentosum*
Teniposide	For bladder neoplasms	*Podophyllum peltatum*
Tetrahydro-cannabinol	Antiemetic	*Cannabis sativa*
Theophylline	Diuretic, antiasthmatic	*Camellia sinensis*
Toxiferine	Relaxant in surgery	*Strychnos guianensis*
Vinblastine	For Hodgkin's disease	*Catharanthus roseus*
Vincristine	For paediatric leukaemia	*C. roseus*
Xanthotoxin	For vitiligo	*Ammi majus*

Attachment Table 2

Endangered plants of actual or potential use in traditional medicine
(Source: Ayensu 1996)

Species	Common Name	Family	Threatened Range	Use
Acorus calamus	Vacha	Araceae	India	Sedative
Alpinia galanga	Khulanjan	Zingiberaceae	India	Drug
Arbutus canariensis	Madrono	Ericaceae	Canary Is.	Vitamin C
Artemisia granatensis		Asterceae	Spain	Infusion
Catharanthus coriaceus	Periwinkle	Apocynaceae	Madagascar	Alkaloids
Commiphora wightii	Guggal	Burseraceae	India	Drug
Dendrobium nobile		Orchidaceae	India	Dendrobine
Dendrobium pauciflorum	Picotee dendrobium	Orchidaceae	India	Alkaloids
Dioscorea deltoidea	Kins	Dioscoreaceae	Afghanistan to Vietnam	Cortisone
Diplomeris hirsuta	Snow orchid	Orchidaceae	India	Alkaloids
Dracaena draco	Dragon tree	Liliaceae	Canary Is. Cape Verde Is. Madeira	Gum resin
Gentiana kurroo	Kadu	Gentianaceae	India	Drug
Lodoicea maldivica	Double coconut	Arecaceae	Seychelles Is.	Drug
Nelumbo nucifera	Lotus	Nymphaeaceae	India	Drug
Paeonia cambessedesil		Paeoniaceae	Balearic Is	Epilepsy
Panax quinquefolius	American ginseng	Araliaceae	United Stated	Tonic tea
Paphiopedilum druryl		Orchidaceae	India	Alkaloids
Pelagodoxa henryana	Enu, Vahane	Arecaceae	Marquesas Is.	Endosperm
Podophyllum hexandrum	Indian podophyllum	Berberidaceae	India	Drug
Rauvolfia serpentine	Sarpagandha	Apocynaceae	India	Drug
Rheum rhaponticum	Wild rhubarb	Polygonaceae	Bulgaria, Norway	Medicine
Rumex rothschildianus		Polygonaceae	Israel	Medicine
Ruta pinnata	Tedera salvaje	Rutaceae	Canary Is.	Balsam like properties
Santalum album	Sukhad	Santalaceae	India	Drug
Saussurea lappa	Kuth roots	Asteraceae	India	Various
Sisymbrium cavanillesianum		Brassicaceae	Spain	Mustard-like properties
Toxocarpus schimperianus		Asclepiadaceae	Seychelles	Pharmacology

Database development for medicinal plants

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Introduction

Information exchange is important for the conservation and use of medicinal plants and for networking in the Asia-Pacific region. It keeps researchers up-to-date on work carried out on medicinal plants and thus helps to avoid unnecessary duplication of research for efficient utilization of limited resources in participating countries. The database development and information compilation for the project will need to cover the following areas:

1. Bibliography of published and unpublished literature on medicinal plants;
2. Documentation of conserved medicinal plants in participating countries;
3. Current conservation and use efforts;
4. Research conducted in the country, results and research gaps;
5. Priority medicinal plants per country and priority research areas;
6. National policies on use of medicinal plants; and
7. Name of agencies working on conservation of medicinal plants.

This paper discusses issues in database development for the project and at the same time suggests methodologies for simplifying the process.

Bibliographic databases

The bibliographic database will be developed from articles that are published and unpublished, both in English and those in the national languages or dialects of each country.

The suggested fields for the bibliographic database will follow closely those used for the PlantGene CD published by the Centre for Applied Biosciences International (CABI). The suggested descriptors are shown in the table below:

Content for Bibliography	PlantGene CD Codes	Remarks
ID number / Accession number	AN	Assigned by information provider
Author(s)	AU	
Title	TI	
Type of publication	PT	Include unpublished publications. Add word "Unpublished" (e.g. Unpublished dissertation) in type description
Publisher/presented at	PB	For unpublished articles, provide organization name/ meeting name
Year of publication	PY	
Journal/Name of publication Volume No. of pages	SO	For unpublished articles, give title of project reports
Language	LA	Language of publication
Author's Address	AD	The main author's address
Author's Telephone No.	TE*	If available
Author's Facsimile No.	FA*	If available
Author's Email Address	EM*	If available
Author's URL/ website	HT*	If available

Content for Bibliography	PlantGene CD Codes	Remarks
Country	CT*	Use ISO 3166 country code
Compiled by genebank / organization	GB*	Use genebank code from medicinal plants database

* Not used in PlantGeneCD. Details of PlantGeneCD codes used are in Attachment 1.

The information that is already present in bibliographic databases such as PlantGeneCD and AGRIS will be made available. Participants will have to pay more attention to compiling "grey" literature from unpublished reports and institutional reports. Compiling bibliography of traditional knowledge (TK) on medicinal plants requires that TK documentation be well organized. TK documentation methodology will also be discussed in this paper.

Database of plants conserved in genebanks

The database to be developed will initially look at medicinal plants that are conserved by various organizations in the participating countries. Based on initial review of databases with medicinal plants, the suggested list are as follows:

1. Family, common name and scientific name;
2. Accession identification number and genebank code;
3. Location of genebank or where collections are conserved;
4. Status of conservation at genebanks;
5. Number of plants conserved for each species;
6. Identified medicinal value or uses of each medicinal plant species;
7. General morphological description of each species; and
8. Photographs of each medicinal plant species.

The data are grouped into four categories and links made among them to avoid duplication of data. The suggested database to be developed based on information supplied by participating countries will contain the following descriptors for the first phase of the project:

Genebank/ Organization	Conservation Status	Plant Data	Usage
Genebank code#	***Genebank code#***	***Plant ID number****	***Plant ID number****
Genebank name	Plant ID number*	Accession No.	Parts used
Genebank address	Conservation type	Scientific name	Minimum growth periods before use
Country	Conservation size	Family	
Curator		Genus	
Telephone	***Collection number***	Species	Steps in preparation
Fax	Number of accessions	Sub spp. or var.	Effects (Action)
URL	Date of collecting	Authority	Indications
	Year of planting	English name	Caution
	Location of collection	Local name	Chemical components
	Donor	Habitat	
	Origin	Morphological characters	Other information
	Research priority	Plant type	
	Acreage of cultivation in the country	Photograph	
		Other information	

*See Attachment 2 for detailed description.

The data under the categories GENEBANK / ORGANIZATION, CONSERVATION STATUS and PLANT DATA will be the first information to be documented. The list of genebanks will expand to include all organizations working in medicinal plants.

The outcome is the development of catalogues for medicinal plants conserved in each country and organizations involved. This information will form the basis of networking for medicinal plants and development of priority species for each country and in the region. Uses and characterization data will be compiled next.

Database development process

The development of project databases requires data to be provided by participating countries. A concern that participants will raise is the amount of work needed for providing data in format that differs from their original databases. This can be a discouraging factor for information providers. Such valuable time is seen to be better spent on updating and acquiring new data rather than just reformatting data. With this in mind, the authors are proposing that the database be developed using minimal effort. The data exchange format is therefore very important both for information providers as well as information compilers and users. Data interchanges between genebanks have to overcome various obstacles such as the differences in languages, incompatibility of computer hardware and software systems and various data compilation standards (Cao *et al.* 1995).

The data interchange protocol (DIP) was introduced to facilitate the development of interfaces to link different documentation systems, to enable information and data exchange, and to facilitate the re-used of data. The DIP format is described in a separate DIP manual. Assistance will be provided by IPGRI to participating organization on the development of the interface for export to DIP format if needed. The format was included for data sharing from the Coconut Genetic Resources Database and data exchange by the Taro Genetic Resources Network (TAROGEN) in the Pacific. Using the DIP format allows organizations to produce electronic catalogues without much effort by importing DIP formatted files into the DIPVIEW software or a customized interface. DIPVIEW and DIP manual can be down loaded from the Internet at http://www.ipgri.cgiar.org/regions/apo/dip.html.

Providing data

It is important that data is provided in data format and not in a report format except in cases where a format is predefined, e.g. the DIP format. Data in a report format is information and requires considerable work and time to convert the information into data again. To avoid having to spend time initially in compiling the database, the participating genebanks and organizations should export the requested data from their documentation system and bibliographic database in DIP in any of these formats:

- Access database tables
- Comma delimited text files (CSV)
- Tab delimited text files
- Fixed length ASCII files
- Spreadsheets and Tables in word processing software

Below are examples of data listing in various formats:

A. DIP format in a single column:

ACCENUMB: HELP
CROPNAME: RICE
GENEBANK: CAAS GeneBank
DONONUMB: Donor name
FAMILY: Family name
SCIENAME: Scientific name
CULTNAME: Cultivar name

ACQUDATE: Acquisition date

ACCENUMB: WD-10001
DONONUMB: JING 0525
FAMILY: Gramineae
SCIENAME: Oryza sativa L.
CULTNAME: QIAN LI MA 1 HAO
ACQUDATE: 26 Nov 87

ACCENUMB: WD-10002
DONONUMB: JING 0526
FAMILY: Gramineae
SCIENAME: Oryza sativa L.
CULTNAME: QIAN LI MA 2 HAO
ACCENUMB: End

B. The same data as presented in a table format:

ACCENUMB	CROP NAME	GENEBANK	DONONUMB	FAMILY	SCIENAME	CULTNAME	ACQUDATE
WD-10001	RICE	CAAS GENEBANK	JING 0525	GRAMINEAE	ORYZA SATIVA L.	QIAN LI MA 1 HAO	26-Nov-87
WD-10002	RICE	CAAS GENEBANK	JING 0526	GRAMINEAE	ORYZA SATIVA L.	QIAN LI MA 2 HAO	

C. As a report format in a catalogue:

Accession number - WD-10001 Acquisition date - 26-Nov-87 Donor Code - JING 0525
Family and Scientific name - GRAMINEAE / ORYZA SATIVA L. Cultivar - QIAN LI MA 1 HAO

Accession number - WD-10002 Acquisition date - Donor Code - JING 0526
Family and Scientific name - GRAMINEAE / ORYZA SATIVA L. Cultivar - QIAN LI MA 2 HAO

The catalogue represents a report and to re-extract data from such a report is time consuming. In the case of the table format, the data remains as data and hence can be re-used easily with minimal effort. The DIP format looks like a report but in essence it is a fixed length text file that has the data dictionary and data included in a single file. The format is also well suited for electronic catalogues development and for data exchange. It is also suited for migration to XML format in the future. So, data if correctly stored in databases or as tables or in formatted ASCII text files such as the DIP format can be re-used to generate reports but data already stored in a report format as information is difficult to access electronically for re-use.

Another issue in providing data is data representation of descriptor states for similar descriptors in different databases hosted by different genebanks. Example, the descriptor states for flower colour can be very different in different genebanks' documentation systems as shown in the table below.

Genebank	Descriptor States	Genebank	Descriptor States
A	1 – white 2 – red 3 – green 9 – others	B	1 – red 2 – light green 3 – white 4 – others

Information providers will face difficulties when they are required to comply with a standard. If the descriptor states from Genebank A are regarded as the standard, then Genebank B will have to convert its data and this requires time, effort and increases the chances of introducing errors into the database in the conversion process. The suggestion is to retain each genebanks descriptor states as it is, so that data can be exported from them without change and with minimal effort. If every

genebank exports data in their own standard then how do we develop a central database?

In the proposed database we will only combine what is common, examples are the descriptors mentioned in the FAO and IPGRI list of multi-crop passport descriptors (MCPD). The MCPD can be found at http://www.ipgri.cgiar.org/publications/pubfile+.asp?ID.PUB+124 which provides international standards to facilitate germplasm passport information exchange. These descriptors aim to be compatible with IPGRI crop descriptor lists and with the descriptors used for the FAO World Information and Early Warning System (WIEWS) on plant genetic resources (PGR). In most instances, these basic passport data would be available in genebank documentation system.

The first output we mentioned to achieve is a list of medicinal plants conserved in each country and the organizations involved. These cover mainly passport data that are common. After developing the list of medicinal plant accessions held by each genebank we would have a good idea on each participant's capacity and can further fine-tune the data exchange process. This is important when we look at characterization data in the second phase. Training and capacity building will be developed in collaboration with information officers from participating organizations.

Developing catalogues

Catalogues are a means to exchange data. For electronic catalogues, we would like to suggest using the method developed for DIP and the DIPVIEW software. The DIP format allows the individual organization databases to retain their own data. It allows for data to be sent directly from the genebank documentation system without the need for changes in the descriptor states. Only common descriptors as listed in the MCPD will be combined. All other data will be kept as data from different genebanks documentation system. The argument for a common information system implemented in all genebanks for easy information exchange can only be made if all genebanks are starting a new database. Forcing a new database into genebanks especially multi-crop genebanks will result in genebanks having to maintain different databases for different crops or projects. This will require the information staffs to learn how to operate the different database software. Where staff mobility is high or staff time is limited then the databases will not be maintained and hence the activity not sustainable. For medicinal plants, the number of accessions is large and requiring that all genebanks use the same descriptor states is like asking the genebank to redo their documentation system. If every project does that, then genebank staff will waste a lot of time moving one database format to another instead of spending time to capture information to improve the databases.

Information sources for medicinal plants

Surfing the internet reveals a number of sites where medicinal plant information could be gathered. Information for medicinal plants is available from the GRIN database in US (http://www.ars-grin.gov/cgi-bin/npgs), the Multiscript Plant Name Database in Australia (http://www.grm.landfood.unimelb.edu.au/plantnames) and Vedic Life Sciences Herbal Consultancy and Research (http://www.ayuherbal.com). An analysis of the medicinal plant data available on the GRIN database for seven participating countries showed 723 species of medicinal plant from 441 genus and 125 families with information for scientific name, family name, common name, local name and distribution. The table below shows the breakdown of the GRIN database information by country:

Country	Family	Genus	Species
China	113	346	583
India	91	255	318
Indonesia	43	76	85
Malaysia	44	76	86
Philippines	36	63	73
Republic of Korea	53	108	130
Vietnam	56	113	292
TOTAL	**125**	**441**	**723**

Traditional Knowledge (TK) documentation

In compiling the uses of medicinal plants, genebanks and conservation organizations would eventually need to document TK. In this regard, concerned genebank information staff should be well-informed on the documentation methods that are community-friendly. A method being used to assist communities to document their knowledge and to provide recognition for TK in terms of citation rather than just acknowledgement is the "IK Journal" concept (Quek and Zhang 1997; Padulosi *et al*. 2002) (Indigenous knowledge, or IK, is used to include TK). When the TK documented is citable then compilation of TK in bibliographic databases will be possible providing for recognition and ownership by the information provider.

The IK Journal

The concept of IK Journal (Attachment 3) is to provide a mirrored process as in scientific journals so that the TK papers can be cited. TK papers can be in any media such as audio tapes, videos, written articles and other forms or presentations that are in the community's own language. By assisting the community to document their knowledge on medicinal plants and registering the TK paper with the institute or a national register for TK, scientists can make citations to the TK paper in their own scientific paper. The scientific paper provides an interpretation of the TK rather than the source of TK. The TK papers provide the possibility of compiling the TK documented in bibliographic databases. IPGRI information staff can assist participating countries to develop the TK documentation activities if needed.

Conclusion

Compilation of information is a priority activity in the project to provide an overall view of the current status on medicinal plant research. The bibliographic database especially of unpublished or "grey" literature is an important resource that will assist the project participants to identify common and priority research areas among the network members. The medicinal plant databases will cover materials conserved in the genebanks and with organizations within participating countries. In developing the databases, there is a need to take into account the work of various regional networks such as APINMAP (Asian Pacific Information Network on Medicinal and Aromatic Plants) and PROSEA Foundation (Plant Resources of South-East Asia) to avoid duplication and to re-use available data.

References

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Attachment 1

Bibliographic Fields

The following fields from PlantGeneCD are suggested:

AD Address of Author

The AD field primarily contains the organization and address where the work was done, not the author's present address if he or she has moved. If more than one organization were involved in the work, the first named author will be given. The basic form is Name of Institution, Town and then Country. Abbreviations and acronyms are often used in this field, so allow for all variations.

AN Accession Number

The Accession Number is an identifying number for each record within the database. The AN field can be used as a quick way to retrieve a particular record.

AU Author

The name(s) of all personal authors of the paper appear in the AU field. Editors are also included and will be followed by "(ed)". Names appear last name first and given names are reduced to initials.

PB Publisher

The PB field contains the name, country and location of the publisher.

PT Publication Type

The PT field contains the description of the type of publication. All records are assigned to one or more of the following categories:
Book; Book-chapter; Journal-issue; Journal-article; Conference-proceedings; Conference-paper; Annual-report; Annual-report-section; Thesis; Patent; Standard; Bulletin; Abstract-only; Correspondence; Editorial; Bulletin-article; Miscellaneous.

PY Publication Year

The PY field contains the four-digit year in which the original document was published. Some records may contain "unda" in the PY field. This indicates that the original document is undated.

SO Source (Bibliographic Citation)

The SO field may contain any of the following: document title; conference title, date and location; date of publication; volume, issue, and page numbers; and any other applicable bibliographic information.)

TI Title

The TI field contains, in English, the title of the original item being abstracted. The item may be a complete book, a specific chapter from a book, an individual research paper from a scientific journal, etc.

LA Language

Language of publication

Attachment 2

Suggested list of information for the catalogue

Genebank	
Genebank code or Institute code	Code of the institute where the accession is maintained. The codes consist of the three-letter ISO 3166 code of the country where the institute is located plus a number. The current set of Institute Codes is available from FAO's website at http://apps3.fao.org/wiews/
Genebank name	Official name
Site Address	Site address
Postal Address	Postal address
Country	Country's name in full
Curator	Full name
Telephone number	
Fax number	
Email address	
URL (website)	
Conservation Status	
Genebank code	Refer to Genebank Code above
Plant ID number	Refer to Plant Descriptors List
Conservation type	Seed or vegetative
Conservation size	In case of seeds - by grams (g); In case of vegetative – *rare* (less than 10), *medium* (10 to 100), *common* (more than 100 plants)
Area of cultivation	In hectares (ha)
Plant Descriptors	
Plant ID number	Seven-character code beginning with "P", followed by the ISO country code and a three-digit serial number
Accession number	As used in genebank's documentation system
Genebank code	Please refer to Genebank Descriptors List
Scientific name	
Family	
Genus	
Species	
Authority	
English name	Common name
Local name	Common name
Habitat	
Morphological characters	For discriminating characters
Plant type	
Photograph	
Other information	Natural distribution, etc
Usage	
Plant ID number	Refer to Plant ID number above
Parts used	e.g. root, leaves, young leaves, seed, etc
Minimum growth period before use	e.g. 4 months (in the case of annuals); 3 years; 30 days after flowering, etc
(Steps in) preparation	e.g. dry under the sun; steam
Effects (Action)	
Indications	e.g. for cough, fever, headache, etc
Caution	Adverse effects, precautions, warnings, contradictions, etc (e.g. not fragrant; not for under 12 years etc; do not mix with some material)
Chemical Components	
Other information	Combination; clinical trails; concentration/amount; bioactivity, etc

Attachment 3

Documenting Indigenous Knowledge (IK): The Need for an "IK Journal"

(Source: Quek, Paul and Zhang Zongwen. IPGRI-APO Newsletter No. 23, August 1997)

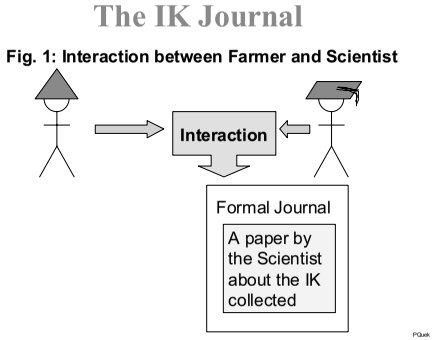

Figure 1 shows the process of IK documentation by the scientist who makes a paper of the collected IK, giving it scientific basis and/or interpretations.

Farmer's contribution is only acknowledged and hence not cited in subsequent reuse of information from the scientist's paper.

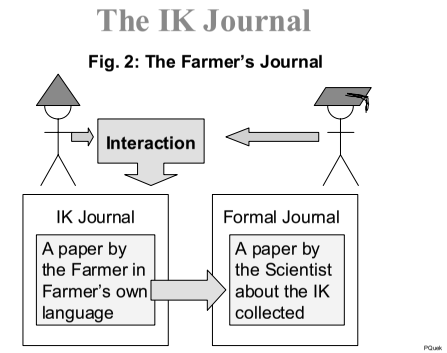

Figure 2 shows the IK Journal process where a farmer's paper, authored by the farmer and acknowledging the scientist's assistance, is produced first. The scientist then develops his interpreted IK paper and cites from the farmer's paper.

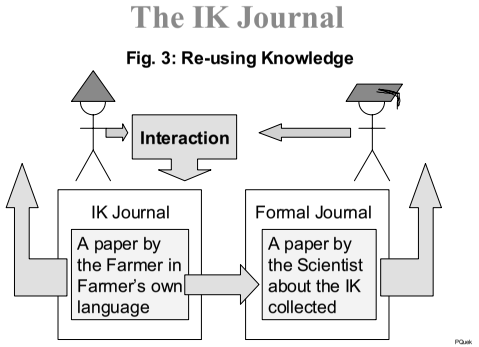

Figure 3 shows how IK communities can reuse their knowledge as how scientific knowledge communities reuse their knowledge.

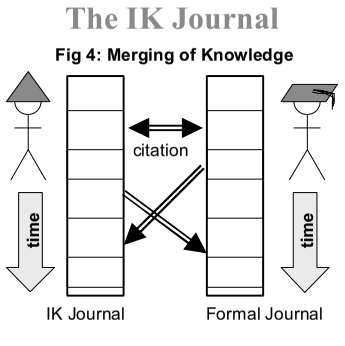

Figure 4 shows the possibility of the two systems becoming one with citations accepted by both systems. The setting up of IK Journal as a mirror to the scientific journal promotes ease of merging both systems.

Production of medicinal plants in Asia

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Introduction

Medicinal plants (MPs) played a significant role in various ancient traditional systems of medication such as Ayurvedic and Unanic in India, Chinese traditional medicine and their derivatives. Today, MPs still plays an important role in developing countries in Asia, both in preventive and curative treatments, despite advances in modern western medicine. People of many Asian countries earn a living from selling collected materials from the forest, or from cultivation on their lands.

The development of modern medicine with the introduction of modern drugs produced by pharmaceutical companies, has dealt harshly with traditional medicine which was accused of being inefficient, laborious in preparation and unavailable due to scarcity of raw material. This is exacerbated by the lack of traditional doctors who cannot earn a living without basic material (MPs) and demand (customers).

The high cost of modern medicines (mostly imported), their unavailability in remote areas and, most importantly, the serious side effects of certain drugs, have resulted in a significant return to traditional medicine. The importance and value of traditional and indigenous herbal medicine were the subject of the World Health Organization's (WHO) campaign in the '70s for all its member countries to preserve their national heritage of ethno-medicine and ethno-pharmacology and to re-include the use of known and tested MPs and derivatives into their primary health care system in rural areas and as an alternative when modern medicine is not readily available. Since large portions of pharmaceutical drugs are derived from MPs, the demand for these raw materials is steadily rising. Such demand is met by either obtaining MPs from their natural habitats, albeit indiscriminately, or by cultivating them.

Medicinal plants available In Asia

The vast number of species known to Asians makes listing all MPs found in Asia difficult and impracticable. Thus, in order to provide a meaningful list of MPs, we have categorized promising species in the following groups:

1. **Medicinal plants that are collected from the wild** - It has been estimated that four out of five MPs used by man are collected from the wild (Srivastana *et al*. 1995) (see Attachment 1);
2. **Medicinal plants that are cultivated** - Due to higher demand of raw materials for drug manufacture and to meet other requirements such as standard quality, reliable supply and reasonable price, many MPs are now being cultivated (see Attachment 2); and
3. **Major medicinal plants-producing countries in Asia** - Although most countries are capable of acquiring MPs for their traditional uses, only China, India, Indonesia, and Nepal produce them in commercial quantities. A few countries are able to produce MPs on a commercial scale, but the quantity produced is still quite small and are mainly for domestic consumption (see Attachment 3).

Collecting naturally occurring medicinal plants

The present status

As the result of population explosion and forest clearing for food production, most Asian countries, which until recently collected MPs from the wild, have almost completely ceased such practice as MPs are becoming scarce or have been wiped out due to over extraction. Nepal, Bhutan and Lao PDR, and to a lesser extent, Bangladesh, China, India, Indonesia and Pakistan, maintain considerable natural forest cover and are still able to collect MPs from the wild (Attachment 1).

Objectives of collecting

1. **For use in traditional medicine.** For native people in remote areas and those who cannot afford to buy expensive western drugs, traditional medication (e.g. Ayurvedic, Unanic, Jamu) are the only means to cure illnesses. Such systems depend almost exclusively on MPs, with about 90% being collected from the forest.
2. **For processing into pharmaceutical products.** Due to the scarcity of MPs occurring naturally, transportation costs, the variability and irregular supply of collected material, very few countries are able maintain the practice. Nepal is the exception to this predicament, processing and exporting wild MPs.

Measures to conserve naturally occurring medicinal plants

Realizing that naturally occurring MPs are threatened, several conservation measures have been undertaken, such as:

1. **Systematic and reasonable collecting.** Sustainable collecting can be achieved if it is done appropriately, as in Nepal, where proper harvesting techniques and appropriate methods of post-harvest treatment (Rawal 1996) mutually benefit the collector and local processor providing incentives for conservation of species for future collection.
2. **Reduction of pressure on collecting.** Cultivation, whether small or large scale, backyard garden or subsistence, can reduce the pressure on collecting MP in the wild.
3. **National legislations.** A few countries have formulated legislation to conserve MPs. Some examples include: (i) Administrative regulation for "Protection of Wild Medicinal Plant Resources", in China since 1987 (Chen 1996); (ii) An "Action Plan for Conservation of Biodiversity", in Sri Lanka including conservation of MPs as a project (Arambewela 1996); and (iii) All wild MPs have been banned for export from India since 1993 (Uniyal 1993).
4. **International regulations.** It is a common practice of international conferences to come up with a "Declaration" or "Resolution", within which measures to conserve MPs are included. Examples can be seen in: (i) the "Washington Convention of 1973" which includes a statement "The trade and use of some of the MPs collected from wild sources are restricted" (Hussain 1996); and (ii) the "Chiang Mai Declaration" exhorted governments and the public to pay attention to the potential inherent in MPs (Henle 1996).

Cultivation of medicinal plants In Asia

Characteristics of medicinal plant cultivation

At present, cultivation of MPs is characterized by the following traits:

1. **Subsistence cropping systems.** As cultivation is new for MPs, most are grown by smallholders in subsistence or mixed cropping systems with low yield and quality.
2. **Scattered farming areas.** With few exceptions, most growing areas are widely scattered resulting in difficulty in collecting harvested raw materials by the middlemen.
3. **Poor quality.** This is due to various factors including the use of unimproved cultivars, poor cultural techniques and poor post-harvest handling.
4. **Lack of integration.** In some areas, MPs are grown commercially as inter-crops. There is no systematic integration between primary crops and MPs. Even in China, where total production of MPs is high, monoculture (usually by industrial enterprises) is very small.

Advantages of commercial cultivation of medicinal plants

Commercial cultivation may become increasingly popular among farmers as naturally occurring MPs diminish and demand increases. Advantages of cultivation include:

1. **Endangered species are conserved in their natural habitat.** Many species are listed as endangered due to indiscriminate collecting for the pharmaceutical industry.
2. **Uniform material is produced.** Commercial cultivation of selected clones or improved cultivars should produce uniform material resulting in consistent, standard MPs of high quality, a pre-requisite for successful pharmaceutical industrial use.
3. **Provides a good source of income to farmers.** MPs are high-valued crops and should bring higher income to the growers if improved, high-yielding clones or cultivars are used.
4. **Provides opportunities for value adding through processing.** Processing technology is available in many developing countries. Commercial cultivation would provide raw material for local processing where cultivation takes place.
5. **Provides a better environment; utilize waste and unproductive land.** As MPs yield high incomes to the growers, costly inputs can be used for their cultivation.
6. **Continuity of supply is assured.** Cultivation is less risky for supply of raw material allowing manufacturers to set production targets well in advance.

Genetic improvement

Compared to other economic crops, MPs receive much less attention in their genetic improvement - evident in the low number of named cultivars used in commercial cultivation. This is due to the lack of germplasm conservation, facilities, breeders and demand for large-scale cultivation.

Cultural improvement

Cultural improvement contributes significantly to the success of commercial cultivation of any economic crops including MPs. High yield and desirable quality of the products can be achieved by good agricultural practices such as: proper soil preparation and fertilizer application; the use of good planting material; correct plant spacing; control of weeds, insects and diseases; timing and correct techniques of harvesting and post-harvest treatment.

Summary and conclusion

Medicinal plants have played a significant role in many ancient traditional systems of medication and still do today in both developed and developing countries in Asia. They generate incomes via sale of collected, wild products or cultivated products. Collection of naturally occurring MPs has been practiced in Asia since prehistoric time for use in traditional medicine or for processing into pharmaceutical products. Cultivation of MPs in Asia is characterized by subsistence cropping systems, scattered farming areas, poor quality and lack of integration.

Compared to other economic crops, MPs received much less attention in their genetic and cultural improvement. Cultivation techniques are quite primitive, resulting in poor yield and quality of the materials. Due to higher demand of raw material for industrial processing, coupled with the loss of natural habitats of most MPs, large-scale cultivation of promising species has recently been attempted in several countries.

MPs are man's best friend in time of need. As technology and development advance, the need for them is much greater and the chance to collect them from the forest is receding. Rural property and constant demand for cultivated land are threatening the forests homes of uncountable numbers of species of valuable MPs. The only solution to save this inheritance is to cultivate them systematically providing socioeconomic benefits to rural people and satisfying the need of urban people who want to go 'back-to-nature' with the use of MPs as raw material for pharmaceutical manufacture.

MPs continue to play a significant role in the peoples' welfare as they have been for several millennia. Collecting in the wild will cease due to over-exploitation, unless the campaign to conserve biodiversity is successful. MPs have not been subjected to intensive breeding programmes so yield and quality are quite low. To start any breeding programme, germplasm collecting and conservation are most essential. As most natural habitats are on the verge of being destroyed, there is an urgent need to collect and conserve valuable germplasm of MPs before they become extinct, and initiate breeding programmes. They should be supplemented with research and development on agrotechnology to obtain optimum yield and quality source of raw materials for pharmaceutical products.

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Attachment 1

List of medicinal plants collected from the wild in Asia

(Source: Papers presented at the First Asian Symposium on Industrial Processing and Utilization of Medicinal and Aromatic Plants, 1996)

Species	Family	Country(ies) of collection
Aesculus indica	Sapindaceae	PAK
Alocasia macrorrhiza	Araceae	LAO, VIE
Alstonia scholaris	Apocynaceae	LAO, VIE
Amomum	Zingiberaceae	LAO, VIE
Amorphophallus rivieri	Araceae	LAO, VIE
Artemisia maritima	Compositae	PAK, VIE
Artocarpus lakoocha	Moraceae	LAO, VIE
Blumea balsamifera	Compositae	LAO, VIE
Catharanthus roseus	Apocynaceae	LAO, VIE
Cassia alata	Leguminosae	PHI, VIE
Cinchona ledgeriana	Rubiaceae	LAO, VIE
Coscinium usitatum	Menispermaceae	LAO, VIE
Costus speciosus	Zingiberaceae	LAO, VIE
Dioscorea deltoidea	Dioscoraceae	PAK, VIE
Drymaria fortunei	Caryophyllaceae	LAO, VIE
Embelia ribes	Euphorbiaceae	LAO, VIE
Ephedra gerardiana	Gnetaceae	PAK
Glycyrrhiza glabra	Leguminosae	PAK, CPR
Kaempferia galanga	Zingiberaceae	LAO, VIE
Lagerstroemia speciosa	Lythraceae	PHI, VIE
Leonurus heterophyllus	Labiatae	LAO, VIE
Moringa oleifera	Moringaceae	PHI, VIE
Rauvolfia serpentina	Apocynaceae	IND, NEP, LAO, THA, VIE
Schefflera elliptica	Araliaceae	LAO, VIE
Smilax glabra	Liliaceae	LAO, VIE
Stephania rotunda	Minispermaceae	LAO, VIE
Sterculia lygnophora	Steculiaceae	LAO
Styrax tonkinensis	Styracaceae	LAO, VIE
Swietenia macrophylla	Meliaceae	PHI
Vitex negundo	Verbenaceae	PHI, VIE
Xanthium strumarium	Compositae	LAO, VIE

Attachment 2

List of medicinal plants cultivated on a commercial scale in Asia

(Source: Papers presented at the First Asian Symposium on Industrial Processing and Utilization of Medicinal and Aromatic Plants, 1996)

Species	Family	Country(ies) of cultivation
Aconitum napellus	Ranunculaceae	NEP
Adhatoda vasica	Acanthaceae	NEP, VIE
Alisma orientale	Alismataceae	CPR
Allium domesticum	Liliaceae	THA
Aloe barbadense	Liliaceae	THA
Ammi majus	Umbelliferae	NEP, VIE
Andrographis paniculata	Acanthaeae	THA, INS, VIE
Angelica gigas	Umbelliferae	ROK
Areca catechu	Palmae	THA, VIE
Angelica acutiloba	Umbelliferae	VIE
Artemisia annua	Compositae	CPR, THA, VIE
Astragalus membranaceus	Leguminosae	CPR, VIE
Atractylodes macrocephala	Compositae	CPR, ROK,VIE
Atropa belladonna	Acanthaceae	IND, NEP, VIE
Baleriana lupilina	Acanthaceae	THA, VIE
Cassia angustifolia	Leguminosae	IND, THA, VIE
Catharanthus roseus	Apocynaceae	IND, VIE, PHI
Cephaelis ipecacuanha	Rubiaceae	IND
Chrysanthemum cineraria	Compositae	IND, VIE
C. morifolium	Compositae	CPR, THA, VIE
Cinchona ledgeriana	Rubiaceae	IND, THA, VIE
Cinnamomum camphora	Lauraceae	CPR, THA, VIE
Clinacanthus nutans	Acanthaceae	THA, VIE
Coptis chinensis	Ranunculaceae	CPR, VIE
Cornus officinalis	Cornaceae	CPR
Corydalis yanhusua	Papaveraceae	CPR
Costus speciosus	Zingiberaceae	NEP
Croton sublyratus	Euphorbiaceae	THA
Curcuma domestica	Zingiberaceae	IND, INS, PAK, SRL, THA, VIE
Cymbopogon winteriamus	Gramineae	IND, INS, NEP, SRL, THA
Dendranthema morifolium	Asteraceae	CPR
Dioscorea deltoidea	Dioscoreaceae	IND
Dioscorea opposita	Dioscoreaceae	CPR
Dioscorea vomitoria	Dioscoreaceae	IND
Hibiscus sabdariffa	Malvaceae	THA, VIE
Isatis indigotica	Cruciferaceae	CPR
Kaempferia galanga	Zingiberaceae	INS, VIE
Lonicera japonica	Caprifoliaceae	CPR
Lycium barbarum	Solanaceae	CPR
Magnolia officinalis	Magnoliaceae	CPR
Matricaria chamomile	Compositae	NEP
Mentha arvensis var. *piperascens*	Labiatae	CPR, IND, NEP, PAK, THA, VIE
Morinda officinalis	Rubiaceae	CPR, VIE
Ophiopogon japonicum	Liliaceae	CPR, VIE
Paeonia lactiflora	Ranunculaceae	ROK, VIE
Panax ginseng	Araliaceae	CPR, ROK
Panax notoginseng	Araliaceae	CPR

Species	Family	Country(ies) of cultivation
Panax pseudoginseng	Araliaceae	CPR, VIE
Panax quinquefolia	Araliaceae	CPR
Panax vietnamensis	Araliaceae	VIE
Papaver somniferum	Paperveraceae	IND
Philodendron chinense	Rutaceae	CPR, VIE
Piper betel	Piperaceae	SRL, THA, VIE
Piper nigrum	Piperaceae	IND, INS, MAL, SRL,THA,VIE
Piper retrofractum	Peperaceae	IND, INS, SRL, THA
Plantago ovata	Plantaginaceae	IND
Platycodon grandiflorum	Campanulaceae	ROK
Rauvolfia serpentina	Apocynaceae	IND, NEP, VIE
Solanum khasianum	Solanaceae	NEP
Solanum laciniatum	Solanaceae	NEP
Solanum trilobatum	Solanaceae	THA
Solanum viarum	Solanaceae	IND
Sophora japonica	Leguminosae	VIE
Swertia chirata	Gentianaceae	NEP, PAK
Syzygium aromaticum	Myrtaceae	IND, INS, MAL, SRL
Tinospora crispa	Menispermaceae	IND, PHI
Trichosanthas bracteata	Cucurbitacea	NEP
Valeriana jatamansi	Valerianaceae	IND, NEP
Valeriana officinalis	Valerianaceae	NEP, PAK
Vitex negundo	Verbenaceae	PHI
Withania somnifera	Solanaceae	IND
Zingiber purpureum	Zingiberaceae	THA
Zingiber officinalis	Zingiberaceae	CPR, IND, INS, ROK, SRL, THA

Attachment 3

Major medicinal plants-producing countries in Asia

(Source: Papers presented at the First Asian Symposium on Industrial Processing and Utilization of Medicinal and Aromatic Plants, 1996)

Species	CPR	IND	INS	NEP	PAK	PHI	SRL	THA	VIE	Others
Aconitum carmichaeli	•									
Aloe barbadensis		o					o	o		
Alisma orientale	•									
Allium sativum	•	•	o		o			•		ROK
Amomum villosum	o									
Andrographis paniculata						o		o		
Angelica sinensis	•							o		
Areca catechu								•		
Artemisia annua	•							o	o	
Astragalus membranaceus	•									
Aulandia lappa	•									
Atractylodes macrocephala	•									
Atropa belladonna		o		o	o					
Cassia angustifolia		•						o		
Catharanthus roseus	•									
Chrysanthemum cinerariefolium		•		o	o					
Chrysanthemum morifolium	•							o		
Cinchona ledgeriana		o	o							
Clinanthus nutans								o		
Codonopsis pilosula	•									
Coptis chinensis	•									
Cornus officinalis	o									
Corydalis yanhusuo	o									
Croton sublyrata								o		
Curcuma domestica		•	•		o		o	•		
Dendranthema morifolium	•									
Dioscorea deltoidea		o								
Dioscorea floribunda		•								
Dioscorea opposita	•									
Dioscorea vomitoria		o								
Ecommia ulmoides										
Ganoderma lucidum	•							o		
Glycyrrhiza glabra	•									
Isatis indigotica	•									
Lycium barbarum	•									
Magnolia officinalis	•									
Morinda officinalis	o									
Ophiopogon japonicus	•									
Panax ginseng	•									ROK•
Panax notoginseng	•									
Panax quinquefolia	•									ROKo
Papaver somniferum		•								
Piper betel							o	•		
Piper nigrum		•	•				o	o		MAL•
Plantago ovata		•			•					
Pogostemon cablin	o	•								MALo
Rauvolfia serpentina		•		•			o			
Solanum viarum		•								

Species	CPR	IND	INS	NEP	PAK	PHI	SRL	THA	VIE	Others
Swetia chirata				•	•					
Syzygium aromaticum		•	•				•			MALo
Tinospora crispa		•				o				
Trichosanthes palmatum				•						
Valeriana wallichii				o	o					
Vitex negundo							o			PHIo
Zingiber officinalis	•	•	o		o	•	•			ROKo

Legend:

• = Major producer

o = Minor producer

CHAPTER 2
COUNTRY PROJECT PROPOSALS

- Bangladesh
- China
- India
- Indonesia
- Korea
- Lao PDR
- Malaysia
- Mongolia
- Nepal
- Philippines
- Sri Lanka
- Vietnam

Inventory and documentation of medicinal plants in Bangladesh

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Introduction

When a plant is designated as 'medicinal' it is implied that it is useful as a therapeutic agent or an active ingredient for a medicinal preparation. Medicinal plants are rich sources of bioactive compounds and thus serve as important raw materials for drug production. They constitute a precious natural wealth of a country. Judicious and scientific exploitation of this wealth can significantly improve the general health of the people. And being a valuable commercial item, a country can also earn a good amount of foreign exchange by exporting this natural wealth to other countries.

Bangladesh is a country considered to be rich in medicinal plants genetic resources. By virtue of its favourable agroclimatic condition, it has a large genetic resources base of agri-horticultural crops as well as medicinal plants. About 5000 species of phanerogams and pteridophytes grow in the country's forests, wetlands, farms and even roadsides as indigenous, naturally-occurring or cultivated plants. Of these, more than a thousand have been claimed to possess medicinal or curative properties. Recently, 546 species have been identified as having medicinal properties and therapeutic use, 257 of which are effective remedies for diarrhoea and 47 for diabetes.

Although a good number of medicinal plants are indigenous to Bangladesh, the country imports a large amount of pharmaceutical raw materials including medicinal plants and semi-processed plant products almost annually to supply its various drug manufacturing industries. The government spends a significant amount of foreign exchange for importing chemicals, raw materials and semi-processed drugs of plant origin, the import value of which is ever increasing. Serious efforts should be made to derive maximum economic benefit and save much needed foreign exchange from indigenous medicinal plants by using them as raw materials for the drug manufacturing industries. In order to achieve these goals, it is necessary to make an inventory of existing medicinal plants in the country, which includes data on species, family, morphological description and photographs. This could be done by carrying out a systematic nationwide survey to collect available published and unpublished literature, listing institutions/agencies that deal with medicinal plants and reviewing their activities.

Globally, medicinal plant genetic resources are in danger of being lost due to loss of habitat, deforestation, natural calamities, over extraction, etc. There is overwhelming documented evidence indicating that plant genetic diversity, including medicinal plants, is drastically being eroded in many parts of the world. This situation is aggravated in areas where high human population density, unplanned urbanization and massive deforestation are common, which is especially true in the South and Southeast Asian regions. Countries which hold native medicinal plant genetic resources should take efforts to collect and maintain these existing available genetic resources and conserve them for research and eventual use.

Project objectives

1. To survey and prepare an inventory of medicinal plants found in Bangladesh including species, family, morphological description and photographs;
2. To document available published and unpublished literature on medicinal plants;
3. To make a list of the addresses of agencies / institutions, NGOs or individuals working on medicinal plants;
4. To prioritize medicinal plants and related research areas;
5. To document the current research status and conservation situation of medicinal plants;
6. To document available information on the medicinal value and uses of medicinal plants; and
7. To document national policies on the conservation and use of medicinal plants.

Methodology or approach

Phase-wise, the entire country would be surveyed and explored to conduct an inventory and collection of all available information on medicinal plants. An interview questionnaire shall be prepared for the respondents. Interviewees would be mainly the rural *Kabiraj Hekim* (those who use plants to treat rural people). Ethnic peoples are usually very reluctant to go to doctors for treatment, preferring instead to use the plants in their immediate environments and consult the community's elders. These ethnic people are a rich source of relevant and useful information (i.e., local name of medicinal plants, parts used, usages, etc.) as they have been using medicinal plants for a long time. Contact will also be made with pharmaceutical companies, herbal physicians and policy makers to collect additional relevant information on medicinal plants.

A survey would be conducted with the public and private sector institutions/agencies where medicinal plants are conserved to make an inventory, including species, family, morphological description, photographs, etc. A survey would also be conducted to come up with a list of available published and unpublished literature on medicinal plants in the country.

Expected outputs

1. An inventory of medicinal plants including data on species, family, morphological description, photographs and number of plants conserved for each species/family;
2. A bibliographic report of published and unpublished literature on medicinal plants;
3. Names and addresses of public and private sector agencies/institutions, NGOs and individuals working on medicinal plants;
4. Report on status of research on medicinal plants including results, gaps, national policies and uses; and
5. Relevant data on conserved medicinal plants in Bangladesh.

Workplan for Year 1 (March 2003 – March 2004)

March-April Develop a list of the addresses of public and private sector agencies/institutions, NGOs and individuals working on the conservation and use of medicinal plants

May-June Collect published and unpublished literature on medicinal plants

July Document national policies and uses of medicinal plants

August	Document current research and conservation status of medicinal plants in the country
May 2003 to February 2004	Make an inventory of medicinal plants in Bangladesh, including data on species, family, morphological description, photographs, etc.
March 2004	Prepare and submit final country project report

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	Country/Institute counterpart funds*	Total
Personnel/professional fee	-		-
Materials and supplies	100		100
Travel	1200		1200
Others	200		200
TOTAL	**1500**		**1500**

* Counterpart funds would be in the form of needed logistic support (i.e., staff, use of vehicles, etc)

Inventory and documentation of medicinal plants in China

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Introduction

There is documented evidence that medicinal plants have been used to prevent, alleviate and cure human disease for thousands of years in China. Medicinal plants play a critical role within the framework of a formal health service. China is endowed with abundant resources of medicinal plants. However, forest destruction, industrial expansion, urbanization, as well as excessive collecting of medicinal plants have decreased the natural base of these vital resources. Therefore, there is an urgent need to draw up plans for medicinal plants resources conservation and utilization. The government of China has initiated the conservation of medicinal plants through the establishment of special medicinal plant gardens in its provinces and communities.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants in China, including information on:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of genebank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant species
   - General morphological description of each species
   - Photographs of these medicinal plants
3. To summarize the status of research, results and research gaps on major medicinal plant species in China; and
4. To identify priority medicinal plants and priority research areas on the conservation and use of medicinal plants.

Expected outputs

1. A list of published and unpublished literature on medicinal plants;
2. A summary status of research on major medicinal plants in China;
3. A list of conserved medicinal plant species in China, including information on where these are conserved, how they are managed and their known uses;
4. A priority listing of medicinal plant species based on economic value and priority research needs at national levels;
5. National policies affecting the conservation and use of medicinal plants; and
6. List of agencies/ institutions working on conservation and use of medicinal plants.

Workplan for Year 1 (2002-2003)

1. To document published and unpublished literature on medicinal plants;
2. To document 150 species of medicinal plants in China, including information on:
   - Common name and scientific name
   - Location of genebank or collection
   - Number of accessions per species
   - Number of plants conserved per species

- Identified medicinal value or uses of each medicinal plants species
- General morphological description of each species

3. To conserve 150 identified medicinal plants in China;
4. To document and analyze research results and gaps on medicinal plants' conservation and use;
5. To identify priority medicinal plants and priority research areas on the conservation and use of medicinal plants in China; and
6. To prepare and submit a project country report.

Year 1 budgetary requirements (in US$)

Items	Funding from IPGRI	National counterpart funds
Personnel/professional fee	500	500
Travel	500	800
Supplies and materials	1000	1500
Others	-	200
TOTAL	**2000**	**3000**

Inventory and documentation of medicinal plants in India

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Introduction

Medicinal plants, as a group, comprise approximately 8000 species and account for about 50% of all the higher flowering plant species in India. A large number of the country's rural population depend on medicinal plants for treating various illnesses. About 1.5 million practitioners of the Indian Systems of Medicine and Homeopathy (ISM&H) use medicinal plants for preventive, promotive and curative applications. Furthermore, there are 7843 registered ISM pharmacies and 851 of homoeopathy as well as a number of unlicensed small-scale units. Besides meeting national demands, India caters to 12% of the global herbal trade. In recent years, trade in herbal-based products has quantum leaped, particularly in the volume of plant material traded within and outside the country. Estimates by the EXIM Bank put medicinal plants-related international trade at US$ 60 billion per year and still growing at a rate of 7% annually.

India is blessed with two mega centres of biodiversity: the Hindustan Centre of Origin and the Central Asia Centre of Origin. This biodiversity is mainly distributed in Western Ghat, North Eastern India and the Himalayan Region. Floristically rich, India has about 141 endemic genera of 5150 species belonging to 47 families of higher plants. Among the different endemic species, 2532 species are distributed in Himalayas, 1788 species in the peninsular region and 185 species in the Andaman and Nicobar Islands. About 43 000 plant species are said to exist in India, of which 7500 plant species are referred to in Indian folklore but only about 1700 plant species have actually been documented in old literature.

The vast degree of diversity present in this country is directly related to the highly divergent ecosystem and altitudinal variations. The agro-biodiversity in India is distributed in eight very diverse phytogeographical and 15 agroecological regions. The range of distribution of these plants varies from the wet evergreen forests in the Western Ghats to the Alpine scrubs of the Himalayas; from the arid deserts of Rajastan to the mangroves along the east coast; from the vast deciduous forests of the Decan to the Shoals of the high ranges; from the swamps of the Ganges to the moss laden tree trunks of the Silent Valley. The indigenous diversity of plant species of medicinal and aromatic value in the region is also unique. This is reflected from the Arogyapacha (*Trichopus zeylanicus*) of the Agastiar Hills to the Saalam Panja of the Himalayas; from the tiny Drosera of the Sholas to the huge Dipterocarps of the Western Ghats; from the xerophytic Aloes to the marshy land Brahmis; from the wild turmeric to the cultivated peppers. Over 7000 species belonging mainly to the families Fabaceae, Euphorbiaceae, Asteraceae, Poaceae, Rubiaceae, Cucurbitaceae, Apiaceae, Convolvulaceae, Malvaceae and Solanaceae have been used from ancient times by various indigenous peoples in the country. This number corresponds to more than 25% of the world's known medicinal plants, estimated to be at around 30 000 species. Analyses of these plants show that they include all the major life forms (i.e., trees, shrubs, climbers and herbs), with the proportion of ferns and lichens being much smaller compared to flowering plants.

Although India has rich biodiversity and one among the 12 mega diversity centres, the growing demand for medicinal plants is putting a heavy strain on the existing resources, causing a number of species to be either threatened or endangered. The 2000 report of the International Union for Conservation of Nature

and Natural Resources (IUCN) revealed that India ranked fifth in the case of threatened plant species and birds. Recently, some rapid assessment of the threat status of medicinal plants using the IUCN-designed CAMP methodology revealed that about 112 species in Southern India, 74 species in Northern and Central India and 42 species in the high altitudes of the Himalayas are threatened in the wild.

However, these materials have not been fully identified, inventoried and characterized. To develop a sound research strategy and programme for medicinal plant conservation and utilization, there is a need to fully document the medicinal plant species, where they are located, their existing population, place(s) of conservation and their known traditional uses. When this documentation is achieved, it would be necessary to identify priority species for further work on characterization and data sharing through national, regional and international collaboration. Subsequently, these conserved species can be augmented by additional collecting, conservation and characterization.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants and to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of genebank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species
3. To summarize status of research on major medicinal plant species in India, the results and research gaps; and
4. To identify priority medicinal plants for the country and priority research areas.

Expected outputs

At the end of the project's first year, a report containing the following information would be made available:

1. A bibliographic database of published work on medicinal plants;
2. A summary status of research on major medicinal plants in India;
3. A list of conserved medicinal plant species in India, including information on where these are conserved and how they are managed as well as their known uses; and
4. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan for Year 1 (2003-2004)

1. Documentation of published and unpublished literature on medicinal plants;
2. Documentation of conserved medicinal plants in the country, including information on:
   - Common name and scientific name
   - Location of genebank or collection
   - Number of accessions per species
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;

3. Documentation and analysis of research to date on medicinal plants in the country, results and research gaps;
4. Identification of priority medicinal plants and priority research areas; and
5. Preparation and submission of country project report.

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	Country/Institute counterpart funds	Total
Personnel/professional fee	1200	-	1200
Materials and supplies	600	600	1200
Travel	150	200	350
Others	50	-	50
TOTAL	**2000**	**800**	**2800**

Inventory and documentation of medicinal plants in Indonesia

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Introduction

Indonesia is ranked as the second largest in terms of biodiversity, with 30 000 flowering plant species (Bappenas 1993). About 7000 of these species are recognized as medicinal plants (Eisai 1986), with 950 known to have medicinal properties; 283 species are registered, being cultivated and used by traditional medicinal industries (Sampoerno 1999) and another 250 species directly harvested from forests as raw material by these industries (Zuhud *et al*. 2001).

The use of medicinal plants in Indonesia has always been a part of culture that has been passed down from generation to generation. By trial-and-error, the country's early inhabitants learned how to distinguish useful plants with beneficial effects from those that were either toxic or non-active. They picked, kept and used medicinal plants to satisfy their basic needs and even experimented on combinations of plants or processing methods to gain optimal results. Throughout the centuries, Indonesia's indigenous people developed traditional medicines from plants identified by their forefathers for curing illnesses and keeping their health. This empirical knowledge may have contributed substantially to the development of traditional medicines in the country.

The global trend towards the use of herbal and natural medicines has been increasing in recent years. More attention from the world community has been given to the tropical rainforest, which is believed to contain 50% of the world's biodiversity. Farnsworth *et al*. (1985) indicated that 74% of the 121 active compounds used for the development of important modern medicines in the United States, such as digitoxin, reserpin, tubocucorin and ephendrin, are derived from medicinal plants growing in and gathered from tropical forests.

Medicinal plants in Indonesia have high economic and health values in both indigenous and modern communities. The number of industries dependent on it have increased in recent years, with the market value of traditional medicine industries jumping from US$ 12.4 million in 1996 to US$ 130 million in 2002 (Sampoerno 2002). The number of traditional medicine manufacturers has also increased - from 578 in 1996 to 810 in 2000, with 87 manufacturers considered as large-scale industries (Pramono 2002).

Research activities geared towards the development of traditional medicines like "Jamu" as standardized extracts, phytopharmaca, etc. have been initiated and some of these products have been marketed. There is also great public interest for finding herbal medicinal plant species to cure major diseases such as cancer, hepatitis and heart disease. Other researches such as medicinal plant-based cure for diabetes and hyperlipidemie, as well as for food supplement and aphrodisiac, have also been initiated.

Despite their recognized importance, the existence of medicinal plants in their natural habitats is threatened by the destruction of natural ecosystems. The condition continues to worsen with the opening of large forest areas for transmigration and farming (Bapedal 2001). A large number of medicinal plant species have been depleted from their natural habitats (Rifai *et al.* 1992; Zuhud *et al.* 2001). Most novel species' identities and potential benefits would remain unknown as these have been lost due to genetic erosion without being properly documented.

To protect and sustain the development of herbal medicinal plants and its industries, there is a need to inventory, conserve and document Indonesian medicinal plants and their ethno-pharmacological and ethno-medicinal data.

Objectives

1. To document published and unpublished literature on medicinal plants in Indonesia;
2. To document conserved medicinal plants to generate information on the following:
   - Scientific name, common and local names
   - Location of genebank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;
3. To summarize the status of research on major medicinal plant species in Indonesia, their results and research gaps; and
4. To identify priority medicinal plants and priority research areas in the country.

Expected outputs (Year 1)

1. A bibliographic database of published and unpublished information on medicinal plants in Indonesia;
2. A summary status of research on major medicinal plants in Indonesia;
3. A list of conserved medicinal plants species in Indonesia, giving information on where these are conserved and how they are managed, and their known uses;
4. A priority listing of medicinal plants species based on economic value and priority research needs at the national level; and
5. List of agencies, organizations and institutions working on medicinal plants in Indonesia.

Workplan (Year 1)

1. Documentation of published and unpublished literature on medicinal plants in Indonesia. This will be done by collecting reports from published journals, bulletins, seminar and workshops that were held in the country;
2. Documentation of conserved medicinal plants in Indonesia, indicating the following:
   - Common name and scientific name
   - Location of genebank or collection
   - Number of accession per species
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph and general morphological description of each genus/species;
3. For the above stated activities, the initial step would be to document the medicinal plants conserved in the Indonesian Spices and Medicinal Crops Research Institute (ISMECRI). This would be followed by collections at other government institutes such as the Balai Penelitian Tanaman Obat (BPTO or the Ministry of Health), Indonesian Institute of Sciences, state universities and the Institute of Plant Breeding. Questionnaires will be developed and

sent to these institutes and organizations to gather the needed data;
4. Documentation and analysis of research to date on medicinal plants and research gaps in concerned government institutions and universities;
5. Identification of priority medicinal plants and priority research areas in several governmental institutions and universities. Data and information will be gathered through questionnaires to be sent to a number of institutes undertaking research on medicinal plants (ISMECRI, Ministry of Health, and state universities, etc); and
6. Preparation and submission of country project report to IPGRI.

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	Country/Institute counterpart funds
Personnel/professional fee	400	1000
Travel	300	300
Materials and supplies	800	400
Others	500	300
TOTAL	**2000**	**2000**

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Inventory and documentation of medicinal plants in Korea

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Introduction

Korea is known for its long history of medicinal plants' use. Based on literature and traditional knowledge, oriental medicine is not only used as a cure for diseases and ailments but also for maintaining good health. However, the genetic diversity of medicinal plants is being threatened with the over-harvesting of medicinal plant materials/species from their natural habitats, especially from the forests. The effective management of these resources and their corresponding habitats, therefore, are deemed important and necessary to meet the rising demand for its use by an equally increasing population. As an initial step towards the sustainable use and management of medicinal plants, it is imperative to undertake inventory and documentation of these valuable resources. The proposed conduct of the project "Inventory and Documentation of Medicinal Plants of Korea" is a case in point. Through the collection of information from both published and unpublished literature regarding medicinal plants, various species could be protected and preserved through the establishment of an exhaustive database or a repository of information accessible to both targeted and other interested users.

Objectives

1. To document published literature and unpublished knowledge on medicinal plants;
2. To document conserved medicinal plants and generate information on the following:
   - Scientific, common, and local names
   - Location of genebank or collection
   - Number of conserved plants per species
   - Identified medicinal value or uses
   - Photograph(s) and general morphological description of each genus/species;
3. To provide information regarding the status of research on major medicinal plant species in Korea; and
4. To identify priority medicinal plants and related research areas.

Workplan (2001-2002)

1. Bibliographic search and documentation of published and unpublished literature on medicinal plants to include those in English and in the national language or dialect;
2. Documentation of conserved medicinal plants to include information on genus, family, common and scientific names, genebank/ conservation site(s), general morphological description as well as photographs of the plants;
3. Documentation of current national conservation efforts for medicinal plants;
4. Documentation of the status of research on medicinal plants in Korea, research results and gaps, priority research areas and priority medicinal plants; and
5. Documentation of national policies affecting the conservation and use of medicinal plants in the country.

Budgetary Requirement: US$ 3000

Expected outputs (Year 1)

Accomplishment and submission of a country project report containing:

1. Bibliographic database of published and unpublished literature on medicinal plants in Korea;
2. Summary of the status of research on major medicinal plants in Korea;
3. List of conserved medicinal plants in Korea, including information on where these are conserved and how they are managed as well as their known uses;
4. Priority listing of medicinal plants based on economic and medicinal values; and
5. List of priority research areas related to the conservation and effective use of medicinal plants in Korea.

Inventory and documentation of medicinal plants in Lao PDR

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Introduction

Lao PDR is a landlocked country located in the heart of the Indochinese Peninsula in Southeast Asia. The country has an abundance of natural resources that include plants and other forest resources. It has a total land area of 236 800 sq km, 47% of which is covered by forests.

The Laotian government supports the use of medicinal plants and traditional medicine, particularly in rural areas where modern treatment is not affordable and regularly accessible. The World Health Organization estimated that approximately 80% of the world's inhabitants rely on traditional medicines (derived largely from plants) for their primary health care. Plant products play an important role in the health care systems of the remaining 20% of the population, mainly in developed countries.

Though the country's early inhabitants have been known to have used medicinal plants to prevent and treat various illnesses for a very long time, only few data concerning medicinal plants in the country have actually been documented and made available. Silavanh (1993) indicated that there are more than 10 000 species of plants and animals found in Lao PDR, of which 1400 are medicinal plants.

Herbs have been widely used for their medical properties in the country since time immemorial, but no comprehensive record was available on the medicinal plants of Laos until Alfred Petelot compiled and published his work entitled "*Archives des Recherches Agronomiques au Cambodge, au Lao et au Vietnam*" between 1952 to 1954. However, the data in these archives may not be suitable to the present situation because ecological patterns in many provinces have changed due to slash and burn cultivation by farmers living in mountainous areas. This is the main reason why Laos' government launched a campaign to completely stop slash and burn cultivation by 2010, parallel to the government's effort of alleviating poverty by that time.

Pottier (1971) stated that Lao' people have sufficient knowledge of about 4000 medicinal plants, while the Lao Pharmacopeia contains information on about 3000 plants. The best traditional healers in the rural countryside know more than 1000 plants but commonly use less than 500. The current project provides a good opportunity to know what kind of plants can be found and used in the concerned locations, particularly in the Xaythani District of Vientiane Municipality. The inventory of medicinal plants in this district is just the initial step in establishing new and updated inventory of medicinal plants in the country.

Objectives

1. To survey and inventory the economically valuable and commonly used medicinal plants in Xaythani District of Vientiane Municipality;
2. To collect herbarium specimens of medicinal plants to enhance the number of Herbaria in the Traditional Medicine Research Centre (TMRC); and
3. To create a database of medicinal plants found in the Xaythani District of Vientiane Municipality, which will be part of the database of medicinal plants of Lao PDR in the near future.

Methodology and approach

Field trips and interviews

The main objective of the project is to investigate what medicinal plants can be found and used by the local people in Xaythani district of Vientiane Municipality. Since the local name of the plants may differ from village to village, concerned field staff has to interview the villagers, especially the healers, in order to get the accurate local name of the plants from each village.

At the beginning of each field work at the village, small community meetings will be held between the concerned authorities and the local people to explain the objectives of the survey and to get the necessary information regarding their use of medicinal plants and the status of the forest around the village from where most of the medicinal plants come from. The project team would also orient the community members regarding the preservation of medicinal plants. This community education is very important and necessary for such activity, which requires active participation of the people living in the concerned areas.

Voucher specimen documentation

During the field trips, herbarium specimens will also be collected as standard vouchers of the ethnomedical finding. These will be labeled in the local language and all relevant collection data and medicinal use data will be recorded for eventual entry in the Natural Product Information System (NAPIS) database.

For each plant species, three herbarium specimens will be pressed. Alcohol will be used for the preservation of the herbaria at the end of each collecting day.

No plant samples will be collected during the field trips because chemical identification would not be conducted in this project.

Processing and drying

The herbarium specimens, macerated in alcohol in plastic bags, will be processed at the TMRC. Each herbarium specimen will be labeled in collection number.

Identification, computerization of data and storage of herbarium specimens

Identification of herbaria at TMRC would be carried out. Vidal's book (1962) and relevant literatures will be used as references for identifying scientific names and families of the collected plants. The NAPIS database system will be computerized.

All dried herbaria will be properly grouped according to their genus and families, and then stored in suitable herbarium cases at TMRC.

Expected outputs

1. A complete inventory of medicinal plants of Xaythani District of Vientiane Municipality developed, which includes local name, scientific name, medicinal uses, part used, morphological description, photographs and number of plants conserved for each species/family;
2. New herbarium specimens collected and classified into appropriate families;
3. NAPIS database of the collected herbaria established;
4. List of published and unpublished articles, reports and books on medicinal plants of Lao PDR developed;
5. A list of conserved medicinal plants at the country level developed;
6. Names and addresses of public and private sector agencies/institutions, NGOs and individuals dealing with medicinal plants developed;
7. Report on the status of medicinal plants research, including research results

and research gaps, national policies and uses of medicinal plants; and

8. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan

The proposed schedule of activities is shown in the following timetable:

Schedule of Activities	Duration
Field Survey: - Field works and herbarium collection	1 month
Processing and drying of herbarium	1 month
Medicinal plants' databank: - Identification of collected specimens - Computerized data entry	 2 months 2 months
Outputs: - Final report writing	 1 month

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	Country counterpart funds	Total
Personnel/professional fee	800	200	1000
Materials and supplies	250	300	550
Travel	400	600	1000
Others	50	100	150
TOTAL	**1500**	1200	**2700**

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Inventory and documentation of medicinal plants in Malaysia

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Introduction

Utilization of medicinal plants in traditional remedies is very important to the people in developing countries, in particular the rural population. This is clearly indicated by the estimate from the World Health Organization (WHO) indicating that 80% of the world population still relies on plant-based traditional remedies.

Even though the research on medicinal plants in Malaysia has been in existence for the past few decades, there are still gaps in the understanding of medicinal plants in this country. With inadequate documented information, it is difficult to formulate an effective conservation strategy for medicinal plants. However, this project will help to overcome this inadequacy and eventually provide sufficient information to identify priority species and research areas for future studies.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants in Peninsular Malaysia to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of genebank or collection
   - Number of plants conserved per species
   - Identified medicinal values or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;
3. To summarize the status of research on major medicinal plant species in Peninsular Malaysia, the results and research gaps; and
4. To identify priority medicinal plants and priority research areas in Malaysia.

Approaches/ Methodology

For bibliographic documentation

1. Collaborate with regional networks such as the Plant Resources of South East Asia, Asia Pacific Association of Forestry Research Institutions and others to obtain more information on related literature in the public domain;
2. Explore other sources including annual research reports of public research institutions such as Malaysian Agricultural Research and Development Institute, the Malaysian Palm Oil Board; honorary, master and PhD theses in state universities such as University Malaysia, University Kebangsaan Malaysia, University Putra Malaysia and other similar academic institutions;
3. Establish contact with various national professional societies such as the Natural Products Society of Malaysia, Malaysian Plant Protection Society, etc. to obtain published (proceedings) and unpublished (abstract book and others) literature on medicinal plants research; and
4. Tap the Forest Research Institute Malaysia library to provide technical support in the search of information in the public domain.

For conserved medicinal plants

Contacts would be established with various herbal gardens established within Peninsular Malaysia in order to obtain relevant information on conserved medicinal plants.

Expected outputs

1. A bibliographic database of published and unpublished information on medicinal plants in Peninsular Malaysia;
2. A summary of the status of research on major medicinal plants in Peninsular Malaysia;
3. A list of conserved medicinal species in Peninsular Malaysia, containing information on where they are conserved, how they are managed and their known uses; and
4. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan (Year 1)

Activities	Q1	Q2	Q3	Q4
• Documentation of published and unpublished literature on medicinal plants	x	x	x	x
• Documentation of conserved medicinal plants in Peninsular Malaysia	x	x	x	x
• Documentation and analysis of research to date on medicinal plants		x	x	x
• Documentation of research gaps		x	x	x
• Identification of priority medicinal plants and priority research areas		x	x	x
• Preparation and submission of country project report			x	x

Year 1 budgetary requirements (in US$)

Items	Funding from IPGRI	National counterpart funds	Total
Personnel/professional fee	400	400	800
Travel	200	200	400
Supplies and materials	200	200	400
Others	200	200	400
TOTAL	**1000**	**1000**	**2000**

Inventory and documentation of medicinal plants in Mongolia

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Introduction

Mongolians have ancient practices of utilizing various medicinal plant species to prevent and cure various human and animal diseases as well as for improving the health and fertility of livestock, to augment farm incomes. Medicinal plants contain various biologically-active components that could help sick patients recover. Ancient literatures indicated that Mongolians used more than 200 traditional medicines derived from plants, animal parts and minerals.

According to current studies, the country has more than 5100 plant species. These include 2823 species of vascular plants belonging to 662 genera and 128 families, out of which, 845 are medicinal plant species. About 150 of these have been found to be rich in vitamins, 200 with essential oils, 250 could be used as tanning matter, more than 200 with dye, 231 with flavanoids, 280 with alkaloid, 65 with cumarin and 68 species for sand movement (erosion) control. At present, about 72% of Mongolian traditional medicines are derived from plants and the rest are from animals and minerals.

Droughts during the last several years and illegal mass harvesting of medicinal plants in the wild caused a drastic decline in major medicinal plant resources. Recent studies indicated that about 45% of total pasture was seriously affected by drought, grass yield decreased by 5-10 times and desertification expanded by 20 000-30 000 ha. Harvesting of medicinal plants by cash-needy collectors is increasingly intensified since these materials have high economic value in both the domestic and foreign markets. An average of 2000 tonnes of medicinal plant materials belonging to 100 species are being harvested illegally every year. Hence, the genetic base of wild medicinal plants in Mongolia is being eroded at an alarming rate, leading to loss of genetic diversity and ecological instability. To address this situation, the government launched a programme on the "Conservation and Sustainable Use of Rare Plants of Mongolia" in 2002 to rehabilitate major medicinal plant resources through sustainable use.

Although a lot of separate activities were carried out on existing populations, locations, chemical composition and traditional uses of major medicinal plants by Mongolian researchers, there is no adequate system to link and integrate the information on these medicinal plants to make them available for other communities and policy makers.

Thus, there is an urgent need to inventory and document the existing medicinal plant species in the country to include all information on their location, populations, places of conservation and their known traditional uses. This documentation would be necessary to identify priority medicinal plant species and to set up priority activities and policies on conservation, characterization and data sharing through national, regional and international collaboration.

Objectives

1. To document published and unpublished literature on medicinal plants in Mongolia;
2. To document conserved medicinal plants in Mongolia to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of genebank or collection sites
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;
3. To summarize status of research on major medicinal plant species in the country, their results and research gaps; and
4. To identify priority medicinal plants and priority research areas in Mongolia.

Expected outputs

A country project report containing the following information would be developed:

1. A bibliographic database of published and unpublished information on medicinal plants in Mongolia;
2. A summary of the status of research on major medicinal plants in Mongolia;
3. A list of conserved medicinal plant species in the country giving information on location, management of conservation and their known uses; and
4. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Activities and approach

Table 1. Work plan for the medicinal plants project in Mongolia

Activities	Participating Institutions
1. Documentation of published and unpublished literature on medicinal plants in Mongolia 2. Documentation of conserved medicinal plants in the country, indicating the following: • Common and scientific names • Location of genebank or collection • Number of accessions per species • Number of plants conserved per species • Identified medicinal value or uses of each medicinal plant genus/species • Photograph(s) and general morphological description of each genus/species 3. Documentation and analysis of research on medicinal plants in Mongolia, results and research gaps 4. Identification of priority medicinal plants and priority research areas in Mongolia 5. Preparation of report by each participating institution to the country project leader 6. Preparation and submission of the final report by the Country Project Leader to IPGRI	Plant Science and Agricultural Research Training Institute, Darkhan Institute of Botany, Ulaanbaatar

The Mongolian State University of Agriculture will implement the project through the collaboration of cooperating institutions, particularly the Plant Science and Agricultural Research Training Institute (PSARTI) in Darkhan and the Institute of Botany in Ulaanbaatar.

The project cooperators will submit the report containing information on bibliographic information, research and conservation activities on medicinal plants to the Country Project Leader. The Country Project Leader, in turn, will synthesize the data as indicated by the expected outputs of the project and submit a final report to IPGRI.

The Country Project Leader will coordinate and participate in all project activities and will be in charge of managing the project funds necessary for implementing the project.

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	Country/Institute counterpart funds	Total
1. Personnel/professional fee	1200	-	1200
2. Materials and supplies	300	700	1000
3. Travel	-	600	600
4. Others	-	200	200
TOTAL	**1500**	**1500**	**3000**

Inventory and documentation of medicinal plants in Nepal

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Introduction

Medicinal plants are important natural resources for primary health care as well as commercial commodities for income generation activities for a vast majority of the rural people in Nepal. It is estimated that only 15-20% of the population living in and around the urban areas has access to modern medical facilities, the majority (80-85%) depend on traditional medicine. The use of these medicinal plants in traditional medical care in the rural areas of the country is an age-old practice, with many of the ethnic groups having their own system of traditional and indigenous healing methods. Though modern medical science is making its way to the grassroots, a vast majority of the rural people of Nepal are still dependent on traditional healers and medicinal plants for their primary health care.

Nepal is rich in plant genetic diversity. Of the estimated 7000 vascular plants naturally occurring in the country, about 700 are considered as medicinal plants. The continuous over-exploitation of these resources has accelerated its depletion in the wild. Population growth and expanding trade practices locally and internationally have further deteriorated the natural condition of these important natural resources. For this reason, conservation and rational utilization of medicinal plants are considered to be current national key issues.

The Ministry of Forests and Soil Conservation (MFSC) of Nepal has endorsed the development and the management of Medicinal and Aromatic Plants (MAPs) as one of its six primary programmes under its Forestry Sector Master Plan which was prepared in 1988. The MFSC aims to increase the supply of medicinal and aromatic plants and other minor forest products, facilitate their conservation and sustainable use, convert them into useful commodities and promote their distribution to local and foreign markets. The 10th Five Year Plan (2003–2008) of the Government of Nepal greatly emphasizes the development of MAPs as a programme for poverty reduction. Rare and high-priced medicinal herbs are top priority for domestication, cultivation, processing and marketing. It has also called for the amendment of existing rules, laws and by-laws that are creating uncertainties and obstructions for the development of this sector. Despite all these, medicinal plants in Nepal have not been fully identified, documented and conserved. Therefore, a project to document and identify Nepal's medicinal plants would be highly beneficial to effectively manage these natural resources.

Objectives

1. To document published and unpublished literature on medicinal plants of Nepal;
2. To document conserved medicinal plants of Nepal to generate information on:
   - Scientific, common and local names of conserved medicinal plants
   - Location of genebank or collection sites
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;

3. To summarize the status of research on major medicinal plants, document results and identify research gaps; and
4. To identify priority medicinal plants and priority research areas on medicinal plants conservation and use in Nepal.

Methodology

To meet the above objectives, the following activities will be undertaken:

1. Survey and listing of all published and unpublished articles, reports and books in the research and management of medicinal plants in the country;
2. Survey institutions, which have been involved in the research, development and management of medicinal plants; and
3. Survey localities where medicinal plants are being conserved and study the details of the conservation status and efforts.

Expected outputs

At the end of year one, a report containing the following information will be accomplished:

1. A list of published and unpublished articles, reports and books on medicinal plants of Nepal;
2. A list of conserved medicinal plants in the country with their corresponding relevant information and known uses;
3. Present status of research on medicinal plants in the country; and
4. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan (March 2003 – March 2004)

Activities	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Literature survey													
Institutional survey													
Visit to conservation sites													
Data compilation													
Report preparation													

Year 1 budgetary requirement (in US$)

Items	Funding from IPGRI	National counterpart funds*	Total
Personnel/Professional fee	800	-	800
Travel	500	-	500
Supplies and materials	100	-	100
Others	100	-	100
TOTAL	**1500**		**1500**

* In the form of physical facilities, personnel and other logistical support to be provided by the implementing institution

Inventory and documentation of medicinal plants in the Philippines

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Introduction

Majority of the rural people in the tropical countries depend on around 20 000 plant species for their medicines (Philippine National Museum 1999). Some of these have been proven to have immense value to the advancement of health care. In the USA, about 25% of prescriptions dispensed by pharmacies contain a drug that is derived mainly from plants, or with at least one or two main ingredients derived from plants (Fernando 2001). The World Health Organization (WHO) listed about 20 000 plants that can be used for medicinal purposes.

In the Philippines, proponents of alternative medicine have been creating greater awareness on the use of herbs to treat various ailments. Republic Act 8423 or the Traditional and Alternative Medicine Act (TAMA) of 1997 made local herbal medicine part of the country's health care delivery system. However, research and development as well as funding have been limited. In 1977, the National Integrated Research Programme on Medicinal Plants (NIRPROMP) was formulated. NIRPROMP is a multidisciplinary programme participated in by researchers from the University of the Philippines' College of Medicine and College of Agriculture. Other institutions such as Ateneo University-Philippine Institute of Pure and Applied Chemistry, University of Santo Tomas, Central Luzon State University and Jose Reyes Memorial Medical Center were involved in the past. NIRPROMP has the following R&D components: pharmacologic/toxicologic studies; mutagenicity and clastogenecity potential of drug preparations; establishment of quality control bioassay standard procedures; dosage forms from Philippine medicinal plants constituents; clinical screening and validation studies of traditional folk medicine; and development of appropriate cultural management practices to improve yield and quality of selected medicinal plant species. Some studies outside NIRPROMP are also conducted by other institutions and cater to the needs of their localities.

The drug development process takes an average of 12 years (Pecson 2001). Thus, getting a new drug to the market is a long process, costly and demanding. It involves seven major stages that include pre-clinical testing, investigational new drug application, three-phase clinical trials, new drug application and approval.

Developing new drugs derived from plants, as well as conserving and managing the country's plant genetic resources, would require solid scientific data, such as proper documentation, identification and understanding of the plant species found in the diverse ecosystems.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants in the Philippines, to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of gene bank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species

- Photograph(s) and general morphological description of each genus/species;

3. To summarize the status of research on major medicinal plant species in the Philippines, the results and research gaps; and
4. To identify priority medicinal plants in the Philippines and priority research areas.

Methodology

During the first and second years of project implementation, literature search of published and unpublished works on medicinal plants will be done through the libraries, the Consortium Operation Office of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) a well as available Department of Science and Technology (DOST) databases. The state of knowledge in medicinal plants R&D will be assessed and analyzed, with assistance from the national medicinal plants R&D sub-sector of the PCARRD-based team. Identification of priority medicinal plants in the Philippines will be done in cooperation with the Philippine Council for Health Research and Development (PCHRD). The information generated will be packaged into a country report. Visits to major genebanks/germplasm collections *in situ* will be conducted.

On the third year of the project, researchers and scientists active in medicinal plants R&D will be convened in a workshop concerning development of a database. A smaller group will be created to develop the descriptors for medicinal plants.

In the last year of project implementation, the results of the workshop and group discussions will be documented and packaged in a pictorial catalogue, identifying the plants, their uses and characters. A research network on medicinal plants will also be created to foster collaborative undertakings.

Expected outputs

1. Bibliographic database of published and unpublished information on medicinal plants in the Philippines;
2. Summary status of research on major medicinal plants in the Philippines;
3. List of conserved medicinal plant species in the Philippines, with information on where these are conserved and how they are managed, and their known uses; and
4. Priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Year 1 Documentation of published and unpublished literature on medicinal plants												
Documentation of conserved medicinal plants in the Philippines												
Year 2 Documentation of conserved medicinal Plants in the Philippines												

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Documentation and analysis of research to date on medicinal plants in the Philippines, results, and research gaps												
Identification of priority medicinal plants in the Philippines and priority research areas												
Preparation and submission of country project report												

Year 3

1. Development of descriptors for medicinal plants.
2. Development of a database on medicinal plants containing passport and characterization data and uses.

Year 4

1. Publication of a catalogue of medicinal plants containing pictures, uses and general morphological characters and cultivation methods.
2. Development of a research network on medicinal plants.

Year 1 budgetary requirements (in US$)

Items	Funding from IPGRI	National counterpart funds**	Total
Personnel/Professional Fee One Project Coordinator @ US$ 76.92 per quarter x four quarters (1 year)	307.69	-	307.69
Travel (fuel, per diem, toll fees, etc)	201.92	-	201.92
Supplies and materials	-	430.00	430.00
Others/Sundries			
Other services	899.45*	-	899.45
Reproduction	50.00	50.00	100.00
Communication	40.94	-	40.94
TOTAL	**1500.00**	**480.00**	**1980.00**

Exchange rate: US$ 1 = P 50.00 (as of 01 October 2002)

* Includes consultative meeting with experts

** In addition, PCARRD will provide support, in kind, at an estimated amount of US$ 5000 per year (e.g. light and water utilities, internet connection, use of vehicle, etc.) plus technical and administrative support on part-time basis.

References

Philippine National Museum. 1999. http://www.pnh.com.ph

Fernando, SE. 2001. Green medicine: The value of plant taxonomy in herbal drug research and development. Paper presented during the NRCP-PCARRD Multi- disciplinary Seminar Towards an Integrated Approach to National Drug Development. PCARRD, Los Baños, Laguna, July 6, 2001.

Pecson, BD. 2001. Drug development in the Philippines: where do we go from here? Paper presented during the NRCP-PCARRD Multi-disciplinary Seminar Towards an Integrated Approach to National Drug Development. PCARRD, Los Baños, Laguna, 6 July 2001.

Inventory and documentation of medicinal plants in Sri Lanka

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Royal Botanic Gardens, Peradeniya, Sri Lanka

Introduction

Sri Lanka has the highest plant diversity per unit area than any other country in Asia, with over 3 700 species of flowering plants and over 350 species of ferns. Over 28% of this flora is endemic, as much as 28.5% are flowering plants, 18% are ferns, and 16% are terrestrial vertebrates that are endemic to the country. Medicinal plants are important part of the plant resources of Sri Lanka. This island is well-endowed with many species of medicinal plants. Among the native flora of Sri Lanka, there are well over 500 species that have been and are still being used in traditional medicine. Apart from that, there are over 900 non-indigenous medicinal plants used in native medicine. Over 10% of all the medicinal plants used in Sri Lanka are endemic to the island and of these, 79 species are threatened. These 79 species are either endemic to the island or have a limited distribution over the Indian sub-continent. Conservation of these plants will secure the continued existence of these rare and endemic species of plants. The populations of medicinal plants are adversely affected by over harvesting and lack of care to their habitat when collecting plants from the wild. Over harvesting of plants is mainly due to the high demand for Ayurvedic medicines. Currently, 60% of the demand for medicinal plants is supplied through imports. Since most of the domestic supply for plants is from the wild, this has led to over harvesting of wild populations of species. In addition, increased demand for agricultural land and unsustainable cultivation practices such as shifting cultivation and "Chena" or slash and burn cultivation destroy habitats of medicinal plants.

Scarcity of comprehensive and authoritative information on medicinal plants hinders an assessment of their status, implementation of activities necessary for preserving their habitat and monitoring the effect of rehabilitative efforts. At present, either the sources of knowledge are contradictory (e.g. several plants are identified under different names and uses by practitioners of traditional medicine) or are scattered and fragmentary. Dearth of skills on ethnobotany has also hindered effective conservation strategies. Sri Lanka is fortunate to have a rich reserve of indigenous knowledge on medicinal plants due to a large number of practitioners of traditional medicine. However, this important source of knowledge is currently under threat as little effort has been made to understand and document their knowledge. As a result, the death of a practitioner signifies a net loss to the pool of this important source of information. Unless a concerted effort is made to record the knowledge of plants used by practitioners of indigenous medicine, it is very likely that vital information on plant uses, their characteristics and habitats will be lost.

One of the main contributions of the project will be the preservation of knowledge on medicinal plants. The preservation of traditional knowledge on medicinal plants will ensure that practitioner's knowledge of plants and their uses are globally recognized and that the source of this knowledge is easily identifiable. Laboratory research on plants and their uses will also augment existing information on this subject. Research on identification of methods and levels of sustainable extraction will help to improve global knowledge on medicinal plants.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants in Sri Lanka, to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of gene bank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;
3. To summarize the status of research on major medicinal plant species in Sri Lanka, the results and research gaps; and
4. To identify priority medicinal plants in Sri Lanka and priority research areas.

Methodology or approach

The inventory of medicinal plants used in Sri Lanka will be prepared by using the published literature, and a questionnaire distributed among the practitioners of indigenous medicine. The authenticity of botanical names will be verified by referring to botanical literature at the National Herbarium of Royal Botanic Gardens, Peradeniya. Field trips will be made to the different parts of the country to visit medicinal plant gardens, nurseries and other sites to record the medicinal plant species and their numbers in cultivation.

Literature on medicinal plants will be collected using library listings and personal contacts/ interviews with government officials, medical practitioners and others who are actively involved in research, cultivation, trade or use of medicinal plants. This information will be stored in a computer database.

Expected outputs

The project will produce authentic information base on medicinal plants and their *ex-situ* conservation in Sri Lanka. The following are the project's expected outputs:

1. An inventory of medicinal plants existing and used in Sri Lanka. This inventory will be in the form of an annotated checklist giving authentic botanical information, uses and ecology of the species in an abbreviated form;
2. A list of conserved medicinal plant species in Sri Lanka, giving information on where these are conserved, how they are managed and their known uses;
3. A bibliographic database of published and unpublished information on medicinal plants in Sri Lanka;
4. A summary status of research on major medicinal plants in Sri Lanka; and
5. A priority listing of medicinal plant species based on economic value and priority research needs at the national level.

Workplan (Year 1)

During the first year of the project, the following activities will be undertaken:

1. Documentation of published and unpublished literature on medicinal plants in Sri Lanka;
2. Documentation of conserved medicinal plants in the country, indicating the following:
   - Common and scientific names
   - Location of collection
   - Number of accessions per species
   - Number of plants conserved per species

- Identified medicinal value or uses of each medicinal plant genus/species
- Photograph and general morphological description of each genus/species;

3. Documentation and analysis of research to date on medicinal plants in Sri Lanka, their results and research gaps;
4. Identification of priority medicinal plants and priority research areas; and
5. Preparation and submission of country project report.

Year 1 budgetary requirements

The documentation process will involve extensive internal travel to medicinal plant nurseries and other *ex situ* conservation sites. A digital camera will be used to take photographs of identified medicinal plants. Funds will be necessary to purchase stationery and other materials for communication. Existing office and computer facilities will be used for these purposes.

Table 1. Project budgetary requirements (Year 1, in US$)

Items	IPGRI funding	National counterpart funds	Total
Personnel/professional fee	150	100	250
Materials and supplies	500	200	700
Travel	750	100	850
Others	100	100	200
TOTAL	**1500**	**500**	**2000**

Inventory and documentation of medicinal plants in Vietnam

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Introduction

Vietnam is a tropical country rich in plant genetic resources, with more than 3300 plant species classified as medicinal plants. Throughout its history, Vietnamese traditional healers have used medicinal plants to prevent and cure certain types of diseases through indigenous medical procedures.

In 1987, the Government of Vietnam approved a national programme entitled "Conservation of Medicinal Plant Genetic Resources". After 15 years of implementation, the programme is largely considered to be a success, although it had many difficulties with funding, international collaboration and information sharing. In order to continue with the achievements of this programme as well as to develop and preserve the country's abundant experiences in traditional medicine, the project entitled "Inventory and Documentation of Medicinal Plants in Vietnam" will be implemented in coordination with the International Plant Genetic Resources Institute (IPGRI). With this undertaking, it is envisioned that medicinal plants in the country that are in danger of disappearing due to over-exploitation and commercialization would be inventoried and conserved for the future generations.

Objectives

1. To document published and unpublished literature on medicinal plants;
2. To document conserved medicinal plants in Vietnam, to generate information on the following:
   - Scientific name, common and local names of conserved medicinal plants
   - Location of gene bank or collection
   - Number of plants conserved per species
   - Identified medicinal value or uses of each medicinal plant genus/species
   - Photograph(s) and general morphological description of each genus/species;
3. To summarize the status of research on major medicinal plant species in Vietnam, the results and research gaps; and
4. To identify priority medicinal plants in the Vietnam and priority research areas.

Expected outputs

1. Bibliographic database of published and unpublished information on medicinal plants in Vietnam;
2. Summary status of research on major medicinal plants in Vietnam, which would include research results, research gaps, national policy and known uses of medicinal plants;
3. List of conserved medicinal plant species in Vietnam, with information on where these are conserved, how they are managed and their known uses;
4. Priority listing of medicinal plant species based on economic value and priority research needs at the national level; and
5. Names and contact information of agencies and institutions working on the conservation and use of medicinal plants.

Year 1 workplan (2002-2003)

Activities	M	A	M	J	J	A	S	O	N	D	J	F	M
Documentation of published and unpublished literature on medicinal plants													
Documentation of conserved medicinal plants in Vietnam													
Documentation and analysis of research to date on medicinal plants in Vietnam, their results and research gaps													
Identification of priority medicinal plants in Vietnam and priority research areas													
Preparation and submission of country project report by project leader to IPGRI													

Year 1 budgetary requirements (in US$)

Items	IPGRI funding	National counterpart funding	Total
Personal/ professional fee	500	-	500
Travel	300	330	630
Supplies and materials	500	200	700
Others	200	200	400
TOTAL	**1500**	**730**	**2230**

CHAPTER 3
INITIAL COUNTRY PROJECT REPORTS and WORKPLANS

- India
- Indonesia
- Korea
- Malaysia
- Mongolia
- Nepal
- Philippines
- Sri Lanka
- Vietnam

Inventory, documentation and status of medicinal plants research in India

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Introduction

Medicinal plants, as a group, comprise approximately 8000 species and account for about 50% of all the higher flowering plant species in India. A large number of the country's rural population depend on medicinal plants for treating various illnesses as well as a source of livelihood. About 1.5 million practitioners of the Indian Systems of Medicine and Homeopathy (ISM&H) use medicinal plants for preventive and curative applications (Attachment 1). Furthermore, there are 7843 registered ISM pharmacies, 851 homoeopathy units as well as a number of unlicensed small-scale enterprises. Besides meeting national demands, India caters to 12% of the global herbal trade. In recent years, trade in herbal-based products has quantum leaped, particularly in the volume of plant materials traded locally and internationally. Estimates by the EXIM Bank put medicinal plants-related international trade at US$ 60 billion per year and still growing at a rate of 7% annually.

India is blessed with two mega centres of biodiversity: the Hindustan Centre of Origin and the Central Asia Centre of Origin. This biodiversity is mainly distributed in Western Ghat, North Eastern India and the Himalayan Region. Floristically rich, India has about 141 endemic genera of 5150 species belonging to 47 families of higher plants. Among the different endemic species, 2532 species are distributed in Himalayas, 1788 species in the peninsular region and 185 species in the Andaman and Nicobar Islands. About 43 000 plant species are said to exist in India, of which 7500 plant species are referred to in Indian folklore but only about 1700 plant species have actually been documented in old literature.

The vast degree of diversity present in this country is directly related to the highly divergent ecosystem and altitudinal variations. The agro-biodiversity in India is distributed in eight very diverse phytogeographical and 15 agroecological regions. The range of distribution of these plants varies from the wet evergreen forests in the Western Ghats to the Alpine scrubs of the Himalayas; from the arid deserts of Rajastan to the mangroves along the east coast; from the vast deciduous forests of the Decan to the Shoals of the high ranges; from the swamps of the Ganghes to the moss laden tree trunks of the Silent Valley. The indigenous diversity of plant species of medicinal and aromatic value in the region is also unique. This is reflected from the Arogyapacha (*Trichopus zeylanicus*) of the Agastiar Hills to the Saalam Panja of the Himalayas; from the tiny Drosera of the Sholas to the huge Dipterocarps of the Western Ghats; from the xerophytic Aloes to the marshy land Brahmis; from the wild turmeric to the cultivated peppers. Over 7000 species belonging mainly to the families Fabaceae, Euphorbiaceae, Asteraceae, Poaceae, Rubiaceae, Cucurbitaceae, Apiaceae, Convolvulaceae, Malvaceae and Solanaceae have been used from ancient times by various indigenous peoples in the country. This number corresponds to more than 25% of the world's known medicinal plants, estimated to be at around 30 000 species. Analyses of these plants show that they include all the major forms (i.e., trees, shrubs, climbers and herbs), with the proportion of ferns and lichens being much smaller compared to flowering plants.

Although India has rich biodiversity and is one of the 12 mega diversity centres, the growing demand for medicinal plants is putting a heavy strain on the existing resources, causing a number of species to be either threatened or endangered

(Attachment 2). The 2000 report of the International Union for Conservation of Nature and Natural Resources (IUCN) revealed that India ranked fifth highest in the number of threatened plant species and birds globally. Recently, some rapid assessment of the threat status of medicinal plants using the IUCN-designed CAMP methodology revealed that about 112 species in Southern India, 74 species in Northern and Central India and 42 species in the high altitudes of the Himalayas are threatened in the wild.

Distribution of medicinal plants

Macro analysis of the distribution of medicinal plants showed that they are distributed across diverse habitats and landscapes. Around 70% of India's medicinal plants are found in tropical areas mostly in the various forest types spread across the Western and Eastern ghats, the Vindhyas, Chotta Nagpur plateu, Aravalis and Himalayas. Although less than 30% of the medicinal plants are found in the temperate and alpine areas and higher altitudes, they include species of high medicinal value. The studies also showed that a larger percentage of the known medicinal plants could be found in the dry and moist deciduous vegetation as compared to the evergreen or temperate habitats.

Analysis of medicinal plant types indicated the about 34% are trees, another 34% are shrubs and the remaining 32% are composed of herbs, grasses and climbers. A very small portion of medicinal plants belong to lower plants like lichens, ferns algae, etc. while majority are classified as higher flowering plants.

Of the 386 families and 2200 genera of medicinal plants recorded in India, the families Asteraceae, Euphorbiacae, Laminaceae, Fabaceae, Rubiaceae, Poaceae, Acanthaceae, Rosaceae and Apiaceae comprise the largest proportion of medicinal plant species, with the highest number of species (419) falling under Asteraceae.

About 90% of medicinal plants used by related industries are collected from the wild. While over 800 species are used in industries, less than 20 species of plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting practices as virtually all parts of the plants like the roots, bark, wood, stem and the whole plant (in the case of herbs) have known uses. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants if they are not sustainably harvested and used.

Medicinal plants resource base

Medicinal plants are living resources, exhaustible if overused but sustainable if used with care and wisdom. At present, 95% of medicinal plants collected are from the wild. Current practices of harvesting are unsustainable and many studies have highlighted depletion of resource base. Many medicinal plants-based industries are still being managed using traditional methods and practices. A number of studies have confirmed that pharmaceuticals companies are also responsible for inefficient and opportunistic marketing of medicinal plants. As a result, the raw-material supply situation is shaky, unsustainable and exploitative. There is a vast, secretive and largely unregulated trade in mainly wild medicinal plants which continues to grow dramatically in the absence of a national policy addressing environmental planning. Confusion also exists in the identification of plant materials where the origin of a particular drug is assigned to more than one plant, sometimes having vastly different morphological and taxonomic characters. There are few others where the identity of plant sources is doubtful or still unknown; therefore, in such cases, adulteration is very common.

The other main source of medicinal plant materials is from cultivation. Cultivated materials (Attachment 3) are definitely more appropriate to produce plant raw materials for drugs. Indeed, standardization, whether for pure products or extracts, are critical and becoming increasingly so as quality requirements continue to become more stringent.

Given the higher cost of cultivated material, cultivation is often done under contract. In majority of cases, companies would cultivate only those plant species which they use in large quantity or in the production of derivatives and isolates, for which standardization is essential and quality is critical. More recently, growers have set up cooperatives or collaborative ventures in an attempt to improve their negotiating power and get higher prices.

Collection and conservation efforts undertaken

Collection of Non-Timber Forest Products (NTFP), which includes most of the medicinal plants, is associated with the livelihood of tribal and rural communities in and around the forest in India. Since the prices paid to collectors are usually low, they often over extract to generate more income.

Several medicinal plants have been assessed as endangered, vulnerable and threatened due to indiscriminate harvesting and habitat destruction due to deforestation. To address this situation, the Government of India has identified and banned the export of 29 species of medicinal plants which are believed to be threatened in the wild (Attachment 4).

In situ conservation

The implementation of Joint Forest Management Scheme in the areas could be a logical approach, given the viability of medicinal plants for generating income as well as rehabilitating degraded lands.

Ex situ conservation

Efforts have been made to consolidate and link up the existing herbal gardens and genebanks as well as reference specimens in herbaria to ensure that the 540 important species in the major classical systems of medicine, as well as those supplied to the international market, are protected in *ex situ* reserves. This requires strategic planning since the range of germplasm obtained for each species must be representative. Plant collections need to evolve from being species reference collections to being genetic resources collections.

Botanical gardens

The Tropical Botanical Garden and Research Institute at Thiruvananthapuram is one of the first such garden established in 1979. It has a genepool of more than 850 species in the garden spread over 20 hectares. About 350 species are maintained in the Medicinal Plants Garden and Herbarium of the Central Council of Research in Ayurveda and Siddha located at Pune. High priority has also been given to Botanical gardens maintained by the Botanical Survey of India.

Herbal gardens in India

Several herbal gardens have been established and several others are in the process of development. These include those that are maintained by the following organizations/ institutions:

1. National Research Center for Medicinal and Aromatic Plants, Boriavi, Anand
2. Assam Agricultural University, Jorhat

3. NG Ranga Agricultural University, Hyderabad
4. Haryana Agricultural University, Hisar
5. YS Parmar University of Horticulture and Forestry, Solan, Shimla
6. University of Agriculture Sciences, Bangalore
7. Kerala Agricultural University, Trichur, Kerala
8. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur
9. Mahatma Phule Agricultural University, Rahuri
10. Orissa Agricultural University, Bhubaneshwar
11. Punjab Agricultural University
12. Rajasthan Agricultural University, Bikaner
13. Tamil Nadu Agricultural University, Coimbatore

A. N Dev University of Agricultural Sciences and Technology, Faizabad

14. Gujarat Agricultural University, Gujarat
15. Regional Medical Research Cenre, North-Eastern Region (ICMR), Dibrugarh, Assam
16. Council of Haryana Institute of Alternative Medicine & Research Panchkula, Haryana
17. Director of Ayurveda, Govt. of Himachal Pradesh Shimkla, Himachal Pradesh (For Herbal Garden at Neri District Hamirpur)
18. Government of Rajasthan, Ajmer, Rajasthan (for Herbal Garden at Kishangarh, District of Ajmer)
19. West Bengal Pharmaceutical & Phytochemical Development Corporation Ltd, Calcutta
20. Central Council for Research in Unani Medicines (CCRUM), 61-65, Institutional Area, D- Block, Janak Puri, New Delhi
21. Bundelkhand Government Ayurvedic College, Jhansi, Uttar Pradesh
22. Government Ayurvedic College, Mangal Nath Road, Ujjain, Madhya Pradesh
23. Central Council for Research in Ayurveda and Siddha (CCRAS), Janak Puri, New Delhi (for Regional Centre (Ay.), Itanagar, Arunachal Pradesh)
24. Sh. Krishna Government Ayurveda College, Kurukshetra, Haryana
25. Govt. Ayurvedic College, Patiala
26. Rajiv Gandhi Government Ay. College, Paprola, District of Kangra (HP)
27. Kaviraj Ananta Tripathi Sharma Ay. College Ankuspur, Ganjam, Orissa
28. Sh. Narayan P Awasthi Government College, Raipur (MP)
29. Government Ay. College, Gorakhpur, Jabalpur, (MP)
30. Aligarh Muslim University, Aligarh (UP) (for Department of Adviya AK Tibbia College)
31. MMM Government Ay. College, Udaipur (Rajasthan)
32. Government Ay. College, Guwahati, Assam
33. Gopabandhu Ay. Mahavidyalaya, Puri (Orissa)
34. Government Ay. College, Kannur, Pariyaram, Kerala
35. State Ay. College and Hospital, Varanasi (UP)
36. Directorate of Ay, Government of Rajasthan, Ajmer (Raj.)
37. Pharmaceutical Corporation, Indian Medicine Kerala Ltd, Trissur
38. Government Ay. Unani Pharmacy, Nanded, Maharashtra

List of medicinal plants with their known uses proposed to be included in the rural herbal gardens

Name of Medicinal Plant	Known Use(s)
1. *Acacia arabica* (Lamk) Wild	Dental hygiene, conjunctivitis
2. *Acacia catechu* Wild	Sore throat
3. *Adhatoda vasica* Nees	Cough, asthma
4. *Aegle marmelos* Correa	Colitis, diarrhoea
5. *Aloe indica* Royle	Skin allergies, liver tonic
6. *Andrographis paniculata* Wild	Viral hepatitis, drug abuse
7. *Asparagus racemosus* Wild	Reduced lacatation, eye infections
8. *Azadirachta* India Linn	Eczema, dental care, fever
9. *Boerhaavia diffusa* DC	Fluid retention, eye infections
10. *Bombax malabaricum* DC	Acne vulgaris
11. *Boswsellia serrata* Robx.	Arthritis
12. *Butea frondosa* Koen ex Roxb	Eye inflammation, aging
13. *Cassia angustifolia* Vahl	Constipation, body odour
14. *Cassia fistula* Linn	Skin fungal infection, constipation
15. *Centella asiatica* (Linn) Urban	Anxiety, memory lapses
16. *Cissus quadrangularis* Linn	Fractures
17. *Citrus medica* Linn	Indigestion
18. *Clerodendrum serratum* (Linn) Moon	Sinusitis, asthma
19. *Commiphora mukul* (Hook ex Stocks) Engl.	Arthritis, high cholesterol
20. *Curcuma longma* Linn	Urtcarial sore throats, cuts and wounds
21. *Cyperus rotundus* Linn	Conjunctivitus, colitis
22. *Eclipta alba* Hassk	Hair hygiene, memory lapses
23. *Embelia ribes* Burm	Intestinal parasites, immuno deficiency
24. *Eugenia aromatica* Kuntze	Tooth ache, nausea
25. *Evolvulus alsinoides* Linn	Learning disorders
26. *Ficus bengalensis* Linn	Weakness, burning
27. *Ficcus religoua* Linn	Arthritis, vaginal infections
28. *Hemidesmus indica* R.BR.	Diarrhoea, fever
29. *Hemidesmus rosa-sinensis* Linn	Menorrhagia, weakness
30. *Holarrhena antidysenterical* Wall	Diarrhoea, dysentery
31. *Lasonia inermus* Linn	Athlete's foot, skin fungal infections
32. Leptadenia reticulata	Reduced lacation
33. *Mesua ferrea* Linn	Hemorrhoids, menorrhagia
34. *Mimosa pudica* Linn	Cuts and wounds, menorrhagia
35. *Mucuna pruriens* Bak	Parkinson's Disease, impotence
36. *Ocimum sanctum* Linn	Common cold, weakness, stress
37. Operculina turpetheum	Fever, flatulence, anoxeria
38. *Phyallanthus emblica* Linn	Anti-pectic diseases, aging
39. *Phyllanthus amarus* Linn	Viral hepatits
40. *Piper longum* Linn	Recurrent respiratory infections, indigestion
41. *Punica granatum* Linn	Diarrhoea, tape-worms
42. *Ricinus communis* Linn	Arthritis, jaundice
43. *Solanum indicum* Linn	Post-partum weakness, cough
44. *Terminalia artjana* (Roxb.) Wight & Arn	Angina pectoris
45. *Terminalia chebula* Retz	Constipation, obesity
46. *Tinospora cordifolia* Wild	Hepatitis, cancer
47. *Tribulus terrestris* Linn	Urinary stones, infections
48. *Trigonell foenum-graecum* Linn	Diabetes mellitus
49. *Vitex negundo* Linn	Local inflammation
50. *Withania sommifera* Dunal	Stress and anxiety

Estimated domestic demand for selected medicinal plants in India (Top 20 medicinal plants, quantity-wise)
(Source: Centre for Research Planning and Action, 2001)

Botanical Name	Common Name	Demand (1999-2000)	
		Qty. (tonnes)	Share (%)
Emblica officinalis Gaertn.	Amala	13661.1	11.7
Asparagus racemosus Willd.	Shatawar/Satawar	7963.2	6.8
Withania somnifora Dunal.	Aswagandha/Asgandh	5702.4	4.9
Terminalia chebula Retz.	Harar/Halela Zard	5227.6	4.5
Aegle marmelos Corr.	(1) Bael (Bark), (2) Belgiri	4326.0	3.7
Cassia angustifolia Vahl.	Sonapatri/Sana	4206.7	3.6
Saraca asoca (Roxb.) DC Wilde	Ashok	4183.1	3.6
Adhatoda vasica Nees	Adusa/Vasa	4067.3	3.5
Boerhaavia diffusa Linn.	Punarnava	3073.1	2.6
Solanum nigrum Linn.	Mokoya/Inab-US-Salab	2901.9	2.5
Piper longum Linn.	Pippali, Filfildaraz	2850.5	2.4
Sida cordifolia Linn.	Bala	2585.9	2.2
Bacopa monnieri (Linn.) Pannel	Brahmi	2559.1	2.2
Andrographis paniculata Nees	Kalmegh	2304.3	2.0
Ocimum sanctum Linn	Tulsi	2290.3	2.0
Bambusa bambos Druce	Vansalocnan/Tabaksheer	2079.6	1.8
Azadirachta indica A. Juss	Neem	1969.6	1.8
Woodfordia fruticosa Kurz.	Dhataki, Dhai	1945.2	1.7
Syzygiu aromaticum Merr. and LM Perry	Long/Lavang	1900.3	1.6
Tinospora cordifolia (Willd) Miers.	Giloe, Guudchi	1832.2	1.6
Sub-Total		**77 629.1**	**66.6**
Others		39 5254	33.4
TOTAL		**117 154.5**	**100.00**

Summary of research carried out on medicinal plants

Under the All-India Coordinated Research on Medicinal and Aromatic Plants and National Research Center for Medicinal and Aromatic Plants

Crop improvement

Plant Genetic Resource (PGR) Management
The importance of PGR-related activities was recognized in the project and was taken up on priority at all the AICRP centers for exhaustive collection, evaluation, conservation and documentation of germplasm of medicinal and aromatic plants. This activity has also been included in the mandate of the ongoing National Agricultural Technology Project of Plant Biodiversity. Valuable genetic stocks of Aswagandha (48), Geranium (6), Isabgol (47), Khasi kateri (7), Long pepper (64), Liquorice (5), Periwinkle (8), Valeriana (40), Vetiver (37), Guggal (50), Henbane (14), Kacholam (12), Mucuna (44), Safed musli (52), Aloe (72), Asparagus (9), Gentiana (12), Tinospora (12), Heracleum (10), Jasmine (109), Patchouli (7), Sylibum (10) and Coleus (13) are maintained at various AICRP centers and NRC for Medicinal and Aromatic Plants (Table 1). The evaluation and characterization of these accessions are in continuous process.

Table 1. Germplasm maintained in the field genebank of NRCMAP

Name of Plant	No. of Accessions
1. *Aloe* spp. (Aloe)	53
2. *Andrographis paniculata* (Kalmegh)	25
3. *Asparagus* spp. (Satavari.)	50
4. *Cassia angustifolia* (Senna)	5
5. *Chlorophytum borivilianum* (Safed musli)	56
6. *Commiphora wightii* (Guggal)	67
7. *Ocimum* spp. (Tulsi)	41
8. *Plantago ovata* (Isabgol)	12
9. *Phyllanthus* spp.(Bhui avla)	12
10. *Tinospora cordifolia* (Gilo)	38
11. *Tribulus terrestris* (Gokhru)	6
12. *Withania somnifera* (Aswagandha)	11
TOTAL	**376**

Varietal Development

Multilocation evaluation trials conducted under the AICRP on Medicinal and Aromatic Plants have resulted in the identification and release of 25 new improved varieties of medicinal plants of 14 species and 7 varieties of aromatic plants of 6 species.

Table 2. List of improved varieties of medicinal plants

Name of Medicinal Plant	Variety	Developed by	Year of Release
Cassia angustifolia (Senna)	Anand Late Selection	Anand	1989
Diascoria floribunda	FB(C)-1	Banglore	1974
Diascoria floribunda	Arka Upakar	Banglore	1980
Digitalis lanata (Foxglove)	D.76	Solan	1991
Glaucium flavum (Yellow Horned Poppy)	H47-3	Solan	1991
Glycyrrhiza glabra (Liquorice)	Haryana Mulhatti-1	Hisar	1989
Hyoscyamus muticus (Egyptian Henbane)	HMI-80-1	Indore	_
Lepidium sativum (Cress)		Anand	1998
Rauvolfia serpentina (Sarpagandha)	RI-1	Indore	_
Papaver somniferum (Opium Poppy)	Jawahar Aphim 16	Mandsur	1984
Papaver somniferum (Opium Poppy)	Kirtiman	Faizabad	1990
Papaver somniferum (Opium Poppy)	Jawahar Opium 539	Mandsur	1997
Papaver somniferum (Opium Poppy)	Jawahar Opium 540	Mandsur	1998
Papaver somniferum (Opium Poppy)	Chetak Aphim	Udaipur	1994
Papaver somniferum (Opium Poppy)	Trisna	Delhi	_
Piper longum (Long Pepper)	Viswam	Trichur	1996
Plantago ovata (Isabgol)	Gujarat Isabgol- 1	Anand	1976
Plantago ovata (Isabgol)	Gujarat Isabgol-2	Anand	1983
Plantago ovata (Isabgol)	Haryana Isabgol-5	Hisar	1989
Plantago ovata (Isabgol)	Jawahar Isabgol-4	Mandsur	1996

Name of Medicinal Plant	Variety	Developed by	Year of Release
Solanum laciniatum	NH 88-12	Solan	1991
Solanum viarum (Khasi Kateri)	Arka Sanjeevani	Banglore	1989
Solanum viarum (Khasi Kateri)	Arka Mahima	Banglore	1992
Withania somnifera (Aswagandha)	Jawahar Asgand-20	Mandsur	1989
Withania somnifera (Aswagandha)	Jawahar Asgand-134	Mandsur	1998
Cymbopogon flexuosus (Lemon Grass)	NLG-84	Faizabad	1994
C. martinii (Palmarosa)	Rosha Grass-49	Hisar	1989
C.martinii (Palmarosa)	CI-80-68	Indore	_
Jasminum grandiflorum (Jasmine)	Arka Surabhi	Banglore	1993
Mentha spicata (Spearmint)	Punjab Spearmint-1	Solan	1991
Valeriana jatamansi (Mushakbala)	Dalhousi Clone	Solan	1994
Vetiveria zizanioides (Vetiver)	Hyb-8	Delhi	_

Crop production

Isabgol (*Plantago ovata* Forsk.). The crop requires cool and dry climate during the growing season. Sowing of seeds at 4.0-7.5 kg/ha at 0.25-0.50 cm depth between November 20 and December 20 was recommended. Broadcasting of seeds followed by light sweeping with broom gave uniform germination. Response of chemical fertilizers was found low. However, a fertilizer dose of 25 kg/ha each of N and P_2O_5 as basal dose and 25 kg/ha N as top dressing at 40 days after sowing (DAS) was recommended for commercial cultivation in Gujarat. Three irrigations viz. first at the time of sowing and subsequently at 30 and 70 DAS proved to be beneficial. Chemical weed control was found to be economical and a pre-sowing or pre-emergence application of Isoproturone (0.5 kg ai/ha) was recommended for weed control.

Opium poppy (*Papaver somniferum* Linn.). The optimum time for sowing is the first fortnight of November. Delay in sowing causes poor growth. A seed rate of 6-7 kg /ha is recommended in case of broadcasting and 5-6 kg /ha for line sowing. Seed inoculation with *Azotobacter* culture (M-4/W-5) reduces the nitrogen requirement up to 40 kg /ha. A fertilizer dose of 90 kg/ha N, 50 kg /ha P_2O_5 and 40 kg /ha K_2O was reported to maximize the latex and seed yield. Weed is one of the important problems in opium poppy cultivation. An integrated approach with Isoproturone (0.37 kg ai/kg + hand weeding at 30 DAS) showed very good control without any phyto-toxic effects. Ten to fourteen light irrigations are required in sandy soils at an interval of 10 days. Lancing is usually started on developing capsules about 15 days after flowering. Each capsule produces a maximum yield of latex in first lancing which decreases at subsequent lancings. Early morning is the best time for collection of latex. Latex yield ranges between 35 and 55 kg/ha and seed yield between 8 and 12 q/ha (q stands for *quintal*, which is equivalent to 100 kg). Crop rotations such as maize-opium poppy; urd-opium poppy and groundnut-opium poppy are profitable. Intercropping with garlic gave higher profit compared to sole crop without affecting the latex yield in Mandsur area.

Senna (*Cassia angustifolia* Vahl): The crop prefers sandy loam to laterite soils. However, it is grown in marginal and sub marginal lands with 7.0-8.5 pH. It is

sensitive to water logging and therefore requires well-drained soil. The sowing time recommended for rainfed crop in Western India is June-July. Whereas, third week of June was reported to be the most suitable time for sowing irrigated crop in Delhi. Line sowing at 30 cm x 30 cm or 45cm x 30 cm gives higher yield. However, 70 000 - 75 000 per ha plant populations are recommended for optimum yield. Application of Farm Yard Manure (FYM) at 10 t/ha and 60 kg/ha N in split doses, at sowing, 30 days after sowing (thinning), after first and second pickings of leaves are recommended for better yield. Watering the plants seven days after sowing is very crucial. Two hand weedings followed by hoeing at 25-30 and 50 DAS are essential. Harvesting is recommended in dry season to avoid leaf fall due to fungal infection during storage. A well-managed irrigated Senna crop yielded about 15-20 q/ha dry leaves and 7-10 q/ha dry pods. On the other hand, rainfed crops recorded an average about 10 q/ha of dry leaves and 4-5 q /ha dry pods. Sun drying of leaves and pods is advisable. Crop rotations such as Senna-mustard and Senna-coriander were found profitable in All India Coordinated Research Project (AICRP) experiments.

Periwinkle (*Catharanthus roseus* (Linn.) G. Don.). Tropical and subtropical climates are found most suitable for its cultivation. However, waterlogged or highly alkaline soils may be avoided. A plant population of 75 000/ha is recommended to get higher yield. Fertilizers rationed 15t/ha FYM + 80 kg N/ha under irrigated and 15t/ha FYM + 40 kg N/ha under rainfed conditions are recommended. Detopping of plants by 2 cm at 50% flowering improves the root yield and alkaloid content. Fluchoraline 0.75 kg ai/ha as pre-emergence application was found to be very effective as weed control. The crop requires 4-5 irrigations. Intercropping with groundnut in 1:1 ratio was found to give highest monetary benefit. This crop is not suitable as inter-crop under shade condition, since plant growth, root and alkaloid contents are observed to develop poorly under such condition. On the average, 1.8 t/ha dried leaves and 0.8 t/ha dried roots are harvested.

Safed musli (*Chlorophytum* spp Ker.). The crop is grown in Kharif season in places with warm and humid climate and adequate soil moisture throughout the crop growth. Optimum time for planting is middle of June under irrigated conditions and onset of monsoon for rainfed condition. Fleshy roots of 2.5 - 3.0 q /ha are planted in ridges at 30 cm row to row and 15 cm plant to plant distance. Application of FYM at 20 t/ha is recommended for good root formation. Ten q/ha fresh root yield was recorded in the experimental field at Udaipur.

Liquorice (*Glycyrrhiza glabra* Linn.). Liquorice grows well in rich, fertile sandy loam soil with pH 5.5-8.2. The best time for planting is in mid-November and following a spacing of 90 cm x 45 cm. Underground stem cuttings of 15-25 cm having 2-3 buds are most suitable for planting. However, root-cutting treatment with Seradix-B enhances sprouting. At the time of soil preparation, 10 t/ha FYM and 40 kg/ha each of N and P_2O_5 as basal dose and 20 kg/ha N as top dressing are recommended application for every year. The crop is harvested after two to three years. Root yield of 70-80 q/ha was recorded at Hissar. However, under Anand condition crop of 18-20 months produced an average yield of 20-25 q/ha.

Sarpagandha (*Rauvolfia serpentina* Beth. ex Kurz): Frost-free tropical to subtropical humid climate with irrigation facilities are found to be the most suitable for its cultivation. Root and stem cuttings have been recommended for vegetative

propagation. Transplanting should be done towards the end of April. A fertilizer dose of 30 kg/ha N and 60 kg /ha P_2O_5 was found to increase the total alkaloid yield. Water requirement is very high in this crop, about 15-16 irrigations are required to get good crop. Intercropping of soybean (1:1) in *kharif* and garlic (1:3) in *rab*i were reported to be most suitable crop combinations.

Foxglove (*Digitalis purpurea* Linn. *and D. lanta* Ehrh). The crop requires 20-30^{0}C temperature for seed germination and subsequent plant growth. Well-drained loams to clay loam soils rich in organic matter are suitable for the crop. However, the optimum soil pH for higher yield of glycoside differs from species to species. It was reported that *Digitalis purpurea* thrives well in acid soil whereas *D. lanta* in neutral soil. Transplanting of seedlings at 45x30 cm is recommended. The most suitable time for transplanting of seedling is in April. Nitrogen requirement of foxglove is high. A fertilizer dose of 100 kg /ha N, 50 kg/ha P_2O_5 and 25 kg/ha K_2O along with 30-40 t/ha FYM was found to be optimum for good crop. Five to six weedings followed by hoeings increased the foliage yield. Three to four irrigations are needed during April to June. One harvesting in first year at rosette stage and three harvestings in second year starting from August are recommended. However, harvesting in the month of February-March contains almost double the glycoside than in August cutting. About 28-Q/ha dry leaf yield is harvested. Sun drying of leaves at 30-40^{0}C is recommended to maintain quality.

Aswagandha (*Withania somnifera* Danunal). The plant grows well in well-drained sandy-loam to red soil having pH 7.5-8.0. The crop is sown in late *kharif* in 2nd or 3rd week of August. On an average, 60 to 75 cm rainfall is best suited for rainfed crop. Line sowing at 25 cm in rows facilitates better cultural practices. One weeding and thinning at 25-30 days after sowing are sufficient in sub-marginal lands. Raised bed condition has been reported to yield higher quantity of root. Crop is harvested for roots at 150-170 DAS. The whole plant is uprooted and roots are separated. About 3-4 Q/ha dry root and 50-75 kg /ha seeds are harvested.

Khasi Kateri (*Solanum viarum* Dunal). The crop is grown in various agroclimatic and soil types in India. Seeds are sown in nursery bed for raising seedlings for transplanting. Forty-five-day old seedlings, with 4-6 leaves, give the highest survival rate after transplanting. Although higher yield of dry berries and solasodine per hectare were obtained in close spacing (45x60 cm), 90x150 cm spacing is recommended to avoid difficulties in inter-culture and harvesting operations due to spiny stems. However, a less spiny variety, Arka Sanjeevini recorded higher berry yield per hectare under high density planting (10 989 – 13 889/ha). The variety showed about three-fold increase in dry berry and solasodine yield. Top dressing of N delayed flowering whereas combination of N and CCC induced early flowering. Application of 250 ppm GA_3 increases solasodine content in diploid and 250 and 1000 ppm in tetraploid. Further, foliar spraying with CCC at 1600 ppm was reported to increase solasodine content significantly. Turning yellow stage was found to be the most ideal for berry harvesting. Berry yield varies from 3.0-14.0 t/ha depending on the variety and soil status.

Long pepper (*Piper longum* Linn.). Hot humid climate with 20-25% partial shade is ideal for its cultivation. Well-drained and nutrient rich soil is recommended. Three- to five-node rooted vine cuttings are best planting materials for establishment. The best time for raising nursery is during March to April. Light irrigation, once in a

week is needed, starting from January till onset of monsoon. Harvesting is done eight months after planting and 3-4 pickings are usually done in a year. About 400 kg/ha dried spikes in first year and 1000 kg/ha in second and third years are harvested. Harvested spikes are dried under the sun for 4-5 days. Dried spikes are stored in moist proof containers. Besides spike, thicker stem and roots are cut and dried and used in Ayurvedic drug preparations. About 500 kg/ha roots are harvested.

Henbane (*Hyoscyamus niger* Linn.). Northwestern hilly tracts are most suitable for this crop. About 2-3 kg/ha seeds are recommended for direct seeding. In the first week of October, 4 to 5-week old seedlings are transplanted in a spacing of 35 x 15 cm. A fertilizer dose of 80 kg/ha N, 40 kg/ha K_2O and 15-20 t/ha FYM is recommended for optimum crop yield. Two-three weedings and 5-7 irrigations are needed. Crop rotations such as Senna - Henbane and Basil - Henbane were reported to be most profitable. The crop is harvested after 125 to 145 DAS. The older leaves at the base of the plant touching the ground are picked up first which is followed by picking of leaves from the upper portion, twigs and branches at 50% flowering. The biomass is thereafter thoroughly sun dried. This procedure of harvesting is quite economical and fetches higher market rate.

Palmarosa (*Cymbopogon martinii* var. Motia). Sowing time for raising nursery is from end of April to mid of May. Transplanting is done in the last week of June to mid August with a spacing 45x30 cm or 60x60 cm depending on soil fertility and climatic conditions. Optimum dose of fertilizers was 75 kg/ha and 40 kg each of P_2O_5 and K_2O to get higher herbage and oil yield. Recently, an integrated nutrient management - trial was conducted in Palmarosa. It was found that FYM at 10 t/ha, nitrogen and phosporus at 20 kg each/ha and Azospirillum or Azotobacter favoured higher productivity and oil yield. Frequent light irrigations are required during rain free period. Harvesting inflorescence is done at 7-10 days after opening of flowers. Crop is harvested 10-15 cm above the ground level. During the first year, 2-3 harvests and in subsequent years 3-4 harvests are taken. On an average, 80 kg/ha oil yield from rainfed crop and up to 220 -250 kg/ha oil yield from irrigated crop are achieved in the second year and onwards.

Vetiver (*Vetiveria zizanioides* (l.) Nash). As a commercial crop, vetiver flourishes over rich sandy - loam soils having 6-8 pH under warm and humid weather conditions. Earthing up operation increases the root yield. Irrigation at 0.4 IW/CPE ratio showed maximum root yield (14.2 q/ha). However, eight irrigations are required within 15 months. A fertilizer dose of 80 kg N and 30 kg each of P_2O_5 and K_2O increases the root yield without affecting the oil quality. Cowpea, cluster bean and black gram as intercrops generate additional income. The best time for harvesting of roots is 15 months after planting.

Mints (*Mentha* spp). The crop prefers well-drained soil rich in organic matter having 6-7.5 soil pH. This group of plants needs very high amount of nutrients particularly nitrogen. Optimum response in terms of yield is recorded with application of 120 kg N/ha, 40-60 kg/ha each of P_2O_5 and K_2O as basal dose. Zinc deficiency is observed very common in Indo-Gangetic plains. The crop responses best at 20 kg /ha Zn applied at the time of planting. Iron and Boron deficiencies are also reported. Two to three weedings and hoeings are essential in mint farming. Pre-emergence application of Terbacil (2.0 kg ai/ha) is effective in controlling weeds. Six to nine irrigations are required during dry seasons. The first crop is harvested at 105-

110 DAS and subsequent harvest takes about 90 days. On an average, 30 t/ha of herbage yield in Japanese mint and 20-25 t/ha of Bergamot mint herbage are harvested, which yield about 150 and 100 kg/ha of oil, respectively.

Crop protection

Limited work on disease and insect pest management was taken up in the project. Initially, recommendations for management of important diseases and insect pests are as follows:

Crop	Known Disease(s)	Etiology	Findings and Recommendations
Medicinal plants			
Opium poppy (*Papaver somniferum*)	Downy mildew	*Peronospora arborescens*	Seed treatment with metalaxyl and four sprays of metalaxyl @ 0.2% at 35, 55, 75 and 95 days after sowing were found most effective in reducing primary and secondary disease incidence. It also increased latex yield (26.7%) and seed yield (24.7%) over control. Jawahar Opium poppy - 540 showing some resistance against the disease has been recommended for MP
Senna (*Cassia angustifolia*)	Leaf spot	*Alternaria alternata*	Spraying of Bordeaux mixture, benomyl, captafol and copper oxy chloride is recommended.
Isabgol (*Plantago ovata*)	Downy mildew	*Peronospora alta P. plantaginis Psendoperonospora plantaginis*	Seed treatment with metalaxyl at 4g/kg seed and 3 sprays of metalaxyl (0.2%) at 15 days interval starting from first appearance is best for disease control. December sown crops are mostly disease-free.
Sarpagandha (*Rauvolfia serpentina*)	Leaf blight and bud rot	*Alternaria tenuis*	Spraying of maneb (0.3%) or rovaral (0.2%). Seed treatment with contact fungicides.
Liquorice (*Glycyrrhiza glabnra*)	Leaf spot	*Cercospora cavarae*	Maneb or zineb spray at 0.2%.
Long pepper (*Piper longum*)	Leaf spot and rotting	*Colletotrichum* & *Cercospora* spp.	Spraying of Bordeaux mixture - one during May and 2-3 sprays during rainy season.
Khasi kateri (*Solanum viarum*)	Wilt	*Fusarium oxysporum*	Direct sowing of seeds instead of transplanting of seedlings can reduce the disease incidence
Palmarosa & Lemongrass (*Cymbopogon* spp.)	Red leaf spot	*Collectorichum graminicola*	Two sprays of carbendazim (0.1%) or 3 sprays of maneb (0-.3%) starting from first appearance of disease at 20 days or 10-12 days intervals, respectively.
Rose (*Rosa damascena*)	Die back	*Diplodia rosarum*	Pruned ends of the shoots should be treated with copper fungicides.
Ambrette seeds (*Abelmoschus moschatus*)	Anthracnose	*Collectotrichum hibiscicum*	Seed treatment with contact fungicides and spray of Bordeaux mixture are recommended.

Agencies/ Organizations working on medicinal plants in India

1. Indian Council of Agricultural Research
    a. All India Coordinated Research Project on Medicinal and Aromatic Plants
    b. National Research Centre for Medicinal and Aromatic Plants
    c. National Bureau of Plant Genetic Resources
    d. Indian Institute of Horticultural Research
2. Council of Scientific and Industrial Research
    a. Central Institute of Medicinal and Aromatic Plants
    b. Central Drug Research Institute
    c. National Botanical Research Institute
    d. Regional Research Laboratories (Jammu, Bhubaneswar, Jorhat, Palampur, Bhopal, Thiruvanthapuram)
3. Botanical Survey of India
4. Forest Research Institute
5. G.B. Pant Institute of Himalayan Environment and Development
6. State Agricultural Universities (about 24 universities)
7. Ayurveda University
8. State Funded Research Institutes
    a. Tropical Botanical Garden and Research Institute
    b. Regional Plant Resource Research Center
    c. Jawaharlal Nehru Ayurvedic Medicinal Plants Garden & Herbarium
    d. Medicinal Plants Garden-cum-Demonstration Center
    e. Tropical Forest Research Institute
9. NGOs (about 50), foremost of which are the Foundation for Revitalization of Local Health Traditions, Arya Vaidyasala and the Zandu Foundation

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Attachment 1

Medicinal plants commonly used in ISM

A

Abies webbiana
Abroma Augusta
Abrus fruticulosus
A. precatorius
A. pulchellus
Abutilon hirtum
Abutilon indicum
Acacia arabica
A. catechu
A. farnesiana
A. leucophloea
A. suma
Acalypha indica
Acampe papillosa
Achyranthes aspera
Aconitum chasmanthum
A. elwessii
A. falconeri
A. ferox
A. heterophyllum
A. lethale
A. napellus
Acorus calamus
Actiniopteris dichotoma
Adenanthera pavonina
Adhatoda vasica
Adiantum capillus
A. caudatum
A. lunulatum
Adina cordifolia
Aegle marmelos
Aeschynomene aspera
A. indica
Aganosma caryophyllata
Aganosma dichotoma
Agjiricus albus
Agaricus campestris
A. ostreatus
Aglaia roxburghiana
Ailanthus excelsa
Alangium lamarchii
A. salvifolium
Albizzia lebbeck
Alhagi camelorum
A. maurorum
A. pseudalhagi
Allium ampeloprasum
A. cepa
A. sativum
Alocasia indica
Aloe abyssinica
A. barbadensis
A. indica
A. vera
Alpinia galanga
Alstonia scholaris
Alternantbera philoxeroides
Alternanthera sessilis
Altingia excelsa
Amanita muscaria
A. phalloides
Amaranthus Atropurpureus
Amaranthus blitum var. oleracea
A. fasciatus
A. gangeticus
A. lanceolatus
A. livid us
A. polygamous
A. spinosus
A. tenuifolus
A. tristis
A. viridis
Amomum aromaticum
A. subulatum
Amorphophallus campanulatus
A. sylvaticus
Anacardium latifolium
A. occidentale
A. officinarum
Anacyclus pyrethrum
Ananas comosus
Anchusa strigosa
Andrographis paniculata
Andropogon citratus
A. jwarancusa
A. schoenanthus
Anethum sowa
Arum trilobatum
Arundo donax
Asparagus racemosus
A. sarmentosus
Asterocantha longifolia
Astragalus candolleanus
A. leucocephalus

Atalantia missionis
Averrhoa carambola
Azadirachta indica
A. vulgaris
Artocarpus heterophyllus
A. integrifolia
A. lakoocha
Anogeissus latifolia
Anona reticulata
A. squamosa
Anthocephalus cadamba
A. chinensis
A. indicus
Aphanamixis polystachya
Aquilaria agallocha
Areca Catechu
A. gacilis
A. triandra
Argemone mexicana
Argyreia speciosa
Aristolochia indica
Artemisia maritime

B

Bacopa monnieri
Balanites aegyptiaca
Baliospermum axillare
B. montanum
Balsamo dendron mukul
Bambusa arundinacea
B. balcooa
B. bambos
B. spinosa
B. tulda
B. vulgaris
Barleria cristata
B. cristata var. dichotoma
B. lupulina
B. prionitis
B. strigosa
Barringtonia acutangula
B. racemosa
Basella alba
B. rubra
Bassia latifolia
B. longifolia
Bauhinia purpuria
B. racemosa
B. tomentosa
B. variegata
Benincasa hispida
Berberis aristata
B. asiatica
Berginia ligulata
Betula bhojpattra
B. utilis
Bixa orellana
Blepharis edulis
Blumea lacera
Boerhaavia diffusa
Bombax malabaricum
Borasus flabellifer
Boswellia carterii
B. floribunda
B. serrata
Brassica campestris
B. juncea
B. napus
Bryonia laciniosa
Bryonopsis laciniosa
Buchanania lanzan
B. latifolia
Butea monosperma

C

Caesalpinia bonducella
C. crista
Caesalpinia pulcherrima
C. sappan
Cajanus indicus
Calamus draco
C. viminalis
Callicarpa macrophylla
Calophyllum inophyllum
Calotropis gigantia
C. procera
Camellia drupifera
C. japonica
Camellia kissi
C. sasanqua
C. sinensis
C. thea
C. theifera
Canabis sativa
Canscora decussata
Cantharellus cibarius
Capparis decidua
C. jeylanica
Capsicum annum
C. frutescens
Cardiospermum halicacabum
Careya arborea
Carica papaya
Carissa carandas
Carthamus tinctorius
Carum carvi

C. copticum
Cassia absus
C. alata
C. fistula
C. occidentalis
C. sophera
C. tora
Catharanthus pusillus
C. roseus
Cedrella toona
Cedrus deodara
C. libani
Ceiba pentandra
Celastrus paniculatus
Celosia argentea
C. cristata
Centella asiatica
C. japonica
Centipeda minima
Centratherum anthelminticum
Cephalandra indica
Chenopodium album
C. ambrosioides
C. purpurascens
Cicer arietinum
Cimicifuga foetida
Cinnamomum camphora
C. cassia
C. tamala
C. zeylanicum
Cissampelos pareira
Cissus quadrangularis
Citrullus colocynthis
C. vulgaris
Citrus aurantifolia
C. decumana
C. limetoides
C. limon
C. maxima
C. medica
C. reticulata
C. sinensis
Cleome icosandra
C. pentaphylla
C. viscosa
Clerodendrum indicum
C. infortunatum
C. phlomidis
C. serratum
Clitoria ternatea
Coccinia cordifolia
C. indica
Cocculus hirsutus
Cochlospermum religiosum
Cocos nucifera
Coix aquatica
C. gigantea
C. lachryma -jobi
Commelina benghalensis
C. salicifolia
Convolvulus arvensis
Coptis teeta
Corchorus capsularis
Cordia dichotoma
C. rothii
C. wallichii
Ceriandrum sativum
Costus speciosus
Cress a cretica
Crocus sativus
Crotalaria juncea
Croton tiglium
Cucumis melo
C. sativa
C. utilissimus
Cuminum cyminum
Curculigo orchioides
Curcuma amada
C. aromatica
C. domestica
C. longa
C. zedoaria
Cuscuta reflexa
Cymbopogon caesius
C. citratus
C. jwarancusa
C. martini
C. schoenanthus
Cynodon dactylon
Cyperus rotundus
Cyperus scariosus

D

Desmodium gangeticum
Desmodium triflorum
D. bipinnata
Desmotrichum fimbriatum
D. macraei
Dichrostachys cinerea
Dillenia indica
Dioscorea bulbifera
D. jacquemontii
D. pentaphylla
D. triphylla
Diospyros peregrina
Dolichos biflorus

D. lablab
D. uniflorus
Drynaria quercifolia
Daemia extensa
Dalbergia sissoo
Datura metel
Daucus carata var. sativa
Delonix regia
Delphinium zalil
Dendrocalamus hamiltonni
Dendrocalamus strictus
Dendrophthoe falcata

E
Echinochloa frumentacea
Echium amoenum
Eclipta alba
Egbolium linneanum
Elaeocarpus ganitrus
E. tuberculatus
Elephantopus scaber
Elettaria cardamomum
Embelia ribes
Emblica officinalis
Enhydra fluctuans
Ephedra gerardiana
E. vulgaris
Eriodendron anfractuosum
Ervatamia coronaria
Erythrina variegata
Eupatorium ayapana
E. triplinerve
Euphorbia hirta
E. hypericifolia
E. microphylla
E. neriifolia
E. pillulifera
E. prostrata
E. thomsoniana
E. thymifolia
Euphoria longana
Evolvulus alsinoides
E. nummularius

F
Feronia elephantum
Feronia limonia
Ferula foetida
Ficus bengalensis
F. carica
F. cunia
F. heterophylla
F. hispida
F. infectoria
F. lacor
F. racemosa
F. religiosa
F. rumphii
Flacourtia cataphracta
F. indica
F. jangomas
Fleurya interrupta
Foeniculum vulgare
Folidota oriculata
Fritillaria cirrhosa
F. imperialis
F. roylei
Fumaria indica
F. perviflora

G
Garcinia hanburyi
G. indica
G. mangostana
G. morella
G. pedunculata
G. tintoria
G. xanthochymus
Gardenia gummifera
G. lucid a
Gentiana kurroo
Gisekia pharnaceoides
Gloriosa superba
Glycosmis pentaphylla
Glycyrrhiza glabra
Gmelina arborea
Gomphrena globoza
Gossypium herbaceum
Grangea maderaspatana
Grataeva nurvala
G. religiosa
Grewia asiatica
G. tiliaefolia
Gymnema sylvestre
Gynandropsis gynandra
G. pentaphylla
Gynocardia odorata

H
Habenaria edgeworthii
H. latilabris
Helicteres chrysocalyx
H. isora
H. roxbhurghii

Heliotropium indicum
Hemidesmus indicus
Hemigraphis hirta
Hibiscus abelmoschus
H. esculentus
H. mutabilis
H. rosa-sinensis
H. rosa var. floro-teano
H. schizopetalus
Hiptage benghalensis
H. madablota
Holarrhena antidysenterica
Hordeum vulgare
Hydnocarpus kurzii
H. laurifolia
H. wightiana
Hygroryza aristata
Hyoscyamus niger

I
Ichnocarpus frutescens
Imperata arundinacea
I. cylindrica
Indigofera tinctorea
Inula racemosa
Ipomoea batatus
I. digitata
I. paniculata
I. quamoclit
I. reniformis
I. reptans

J
Jacubinia tinctoria
Jasminum auriculatum
J. grandiflorum
J. heyneana
J. multiflora
J. pubescens
J. sambac
Jatropha multifida
Juglans regia
Juniperus communis
J. macropoda
Jussiaea repens
Justicia gendarussa

K
Kalanchoe pinnata

L
Lac
Laccifer lacca
Lagenaria leucantha
L. siceraria
L. vulgaris
Lannea grandis
Laportea crenulata
Lathyrus sativus
Lawsonia inermis
Leea aequata
Leea hirta
Lens culinaris
Lepidium sativum
Leptadenia reticulata
L. spartium
Leucas cephalotes
L. lavandulaefolia
L. linifolia
Lilium polyphyllum
L. tigrinum
Limnanthemum crista tum
Linum usitatissimum
Lippia nodiflora
Liquidamber orientalis
L. styraciflua
Lobelia inflata
L. nicotianaefolia
Lochnera pusilla
L. rosea
Loranthus falcatus
L. longiflorus
Luffa acutangula
L. amara
L. echinata
Luvanga scandens

M
Madhuca indica
Mallotus philippinensis
Malaxis acuminata
M. muscifera
Mangifeia indica
Marsilea minuta
M. quadrifolia
Melia azedarach
Melilotus indica
Melothria heterophylla
Mentha spicata
Merremia tridentata
Mesua ferrea
Meyna laxiflora
Michelia champaca
Microstylis muscifera
Microstylis wallichii
Mimosa pudica
Mimusops elengi

Mimusops hexandra
Mirabilis jalapa
Momordica charantia
M. cochinchinensis
M. muricata
Mollugo hirta
M. lotoids
M. oppositifolia
M. pentaphylla
M. spergula
Morchella esculenta
Morinda bracteata
M. citrifolia
M. coreia
M. tinctoria
M. tomentosa
M. concanensis
M. oleifera
Morus alba
M. atropurpurea
M. indica
M. laevigata
Mucuna prurita
M. utilis
Murraya koenigii
M. paniculata
Musa cavendishii
M. chinensis
M. paradisiaca
M. sapientum
Myrica esculenta
M. nagi
Myristica fragrans
M. malabarica

N

Nardostachys jatamansi
Nauclea cordifolia
Nelumbo nucifera
Nephelium longana
Nerium indicum
N. odorum
Nicotiana plumbaginifolia
N. tabacum
Nigella sativa
Nyctanthes arbortristis
Nymphaea alba
N. nouchali
N. rubra
N. stellata

O

Ochrocarpus longifolius
Ocimum americanum
O. basilicum
O. gratissimum
O. kilimandscharicum
O. sanctum
Odina woodier
Oldenlandia corymbosa
O. diffusa
Operculina turpethum
Ophiorrhiza mungos
Oroxylum indicum
Oryza fatua
O. sativa
Ougeinia dalbergioides
O. oojeinensis
Oxalis acetosella
O. corniculata
O. corymbosa

P

Pacicum italicum
Paederia foetida
Paederia tomentosa
Pandanus odoratissimus
Pandanus tectorius
Panicum frumentacea
Papaver somniferum
Paris polyphylla
Parmelia perlata
Paspalum scrobiculatum
Pavonia odorata
Pedalium murex
Pentapetes phoenicea
Pergularia extensa
Periploca aphylla
Peucedanum graveolens
Phaseolus radiatus
P. radiatus var. aurea
P. radiatus var. grandis
P. sublobatus
Phlogacanthus thyrsiflorus
Phoenix aculis
P. dactylifera
P. paludosa
P. pusilla
P. sylvestris
Phragmites karka
P. maxima
P. roxburghii
Phyllanthus niruri
P. simplex
Physalis minima
Picrorhiza kurroa

Pinanga gracilis
Pinus longifolia
P. roxburghii
Piper arcuatum
P. aurantiacum
P. betle
P. chaba
P. cubeba
P. longum
P. nigrum
P. sylvaticum
P. wallichii
Pistacia integerrima
P. narbonensis
P. reticulata
P. vera
P. stratiotes
Pisum arvense
P. sativum
Platanthera latilabris
Pluchea lanceolata
Plumbago capensis
P. indica
P. zeylanica
Plumeria acutifolia
P. rubra
Podophyllum emodi
P. hexandrum
Poinciana pulcherrima
P. regia
Polianthes tuberosa
Polyalthia longifolia
P. suberosa
Polygonatum cirrhifolium
P. oppositifolium
P. verticillatum
Polygonum hydropiper
P. orientate
P. recumbens
Polypodium quercifolium
Polyporus igniarius
P. officinalis
Pongamia pinnata
Portulaca oleracea
P. quadrifida
Potamogeton indicus
Premna integrifolia
P. latifolia
P. serratifolia
P. spinosa
Prunus amara
P. amygdalus
P. cerasoides
P. cerasus
P. communis
P. domestica
P. persica
P. puddum
P. verginiana
Psaliota compestris
Psidium guyava
Psoralia corylifolia
Pterocarpus marsupium
P. santalinus
Pterospermum suberifolium
Pueraria tuberosa
Punica granatum
Putranjiva roxburghii
Pyrus communis
Pyrus malus

Q

Quamoclit pinnata
Quisqualis densiflora
Q. indica

R

Randia dumetorum
Ranunculas sceleratus
Raphanus sativus
Rauwolfia canescens
R. serpentina
R. tetraphylla
Rheum emodi
Rhododendron arboreum
Rhus succedanes
Ricinus communis
Rosa damascena
Roscoea purpurea
Rottlera indica
Rubia cordifolia
Rumex vesicarius

S

Saccharum bengalense
S. officinarum
Saccolabium papillosum
Salmalia malabaricum
Salvadora oleoides
S. persica
Salvia plebeia
Salvinia cucullata
Sansevieria roxburghiana
Santalum album
Sapindus trifoliatus

Saraca indica
Sarcostemma acidum
S. brevistigma
Saussurea lappa
Schleichera oleosa
S. trijuga
Schrebera pubescens
S. swietenioides
Scindapsus officinalis
Scirpus kysoor
Semecarpus anacardium
S. latifolius
Sesamam indicum
Sesbania grandiflora
S. sesban
Seseli indicum
Setaria italica
Shorea robusta
Sida cordifolia
S. rhombifolia
S. rhomboidea
S. stipulata
Smilax china
S. glabra
S. indica
Solanum indicum
S. khasianum
S. melongena
S. nigrum
S. torvum
S. xanthocarpum
Sorghum vulgare
Soymida febrifuga
Sphaeranthus africanus
S. indicus
Spinacia oleracea
S. tetrandra
Spondias dulcis
S. mangifera
Stephania glabra
S. hernandifolia
Stereospermum suaveolens
S. tetragonum
Streblus asper
Strychnos nux-vomica
S. potatorum
Swertia chirata
Symplocos laurina
S. racemosa
Syzygium aromaticum
S. cumini
S. fruticosa
S. operculatum

T

Tabernaemontana coronaria
Tacca aspera
T. integrifolia
Tagetes erecta
Tamarindus indica
Tamarix aphylla
T. articulata
T. dioica
T. ericoides
T. gallica
T. indica
T. troupii
Taxus baccata
Tectona grandis
Tephrosia purpurea
Terminalia arjuna
T. belerica
T. chebula
T. citrina
Tetragastsis ossea
Thalictrum foliolosum
Thespesia populnea
Thevetia neriifolia
T. peruviana
Tinospora cordifolia
T. malabarica
T. tomentosa
Trachyspermum ammi
Tragia involucrata
Trapa bispinosa
T. incisa
Trewia macrophylla
Trewia macrostachya
T. nudiflora
Trianthema monogyna
T. portulacastrum
Tribulus terrestris
Trichosanthes anguina
T. bracteata
T. dioica
T. palmata
Trigonella corniculata
T. foenum-graecum
Triticum aestivum
Tuber cibarium
Tylophora asthmatica
T. indica
T. vomitoria
Typha elephantina
T. latifolia
Typhonium trilobatum

U

Uraria hamosa
U. lagopoides
U. picta

V

Valeriana hardwickii
V. officinalis
Vallaris heynei
V. solanacea
Vanda roxburghii
V. tessellata
Vangueria spinosa
Vateria indica
V. macrocarpa
Vernonia cinerea
Vetiveria zizanioides
Viburnum foetidum
V. prunifolium
Vigna cylindrica
Vinca pusilla
V. rosea
Viscum album
V. articulatum
V. attenuatum
V. costatum
V. falcatum
V. fragile
V. heyneanum
V. indicum
V. moniliforme
V. monoicum
V. nepalense
V. orientale
V. verticillatum
Vitex agnus –castus
V. negundo
V. peduncularis
Vitis pedata
V. trifolia
V. vinifera
Volvaria displasia
V. terastria

W

Wedelia calendulacea
Withania somnifera
Woodfordia fruticosa
Wrightia antidysenterica
W. tinctoria
W. tomentosa

Z

Zanthoxylum acanthopodium
Z. alatum
Z. rhetsa
Zea mays
Zehneria umbellata
Zingiber officinale
Ziziphus jujuba
Z. minima
Ziziphus nummularia
Z. oenoplia
Z. sativa
Z. vulgaris

Attachment 2

Medicinal and aromatic plants in danger of genetic erosion in India

Abies spectabilis
Aconitum balfourii
A. chasmanthum
A. deinorrhizum
A. falconeri
A. ferox
A. heterophyllum
A. violaceum
Acorus calamus
Angelica glauca
Aquilaria malaccensis
Arnebia benthamii
Atropa acuminata
Berberis aristata
B. asiatica
B. chitria
B. lycium
B. petiolaris
Bunium persicum
Chlorophytum arundinaceum
Cinnamomum tamala
Colchicum luteum
Commiphora wightii
Coptis teeta
Coscinium fenestratum
Curculigo orchioides
Curcuma angustifolia
Curcuma caesia
Dactylorhiza hatagirea
Didymocarpus pedicillatus
Dioscorea deltoidea
Entada pursaetha
Entada pursaetha
Fritillaria roylei
Gaultheria fragrantissima
Gentiana kurroo
Gloriosa superba
Gymnema sylvestre
Hedychium coronarium
Hydychium spicatum
Heracleum lanatum
Hydnocarpus pentandra
Inula racemosa
Iphigenia stellata
Jurinea dolomiaea
Luvunga scandens
Nardostachys grandiflora
Onosma hispidum
Operculina turpethum
Orchis habenarioides
Paeonia emodi
Panax pseudo-ginseng
Physochlaina praealta
Podophyllum hexandrum
Picrorhiza kurroa
Polygonatum verticillatum
Pterocarpus santalinus
Rauvolfia serpentina
Rheum australe
Saraca asoca
Saussurea costus
Scilla hyacinthine
Swertia chirayita
Taxus baccata subsp. Wallichiana
Urginea indica
Violaodorata

Attachment 3

Medicinal plant species used in India for modern drugs

Acorus calamus
Aloe vera
Artemisia annua
Asparagus officinalis
Atropa belladonna
Ammi majus
Berberis spp
Cassia angustifolia
Catharanthus roseus
Cephaelis specaunha
Crysanthemum cinerareifolium
Cinchona officinalis
Coleus forskohlii
Colchicum luteum
Commiphora mukul
Coptis teeta
Coscinium fenestratum
Costus speciosus
Datura metel
D. stramonium
Digitalis lanata
D. purpurea
Dioscorea deltoidea
D. floribunda
Duboisia myoporoides
Ephedra gerardiana
Fagopyrum esculentum
Gloriosa superba
Glycyrrhiza glabra
Heracleum lanatum
Humulus lupulus
Hyoscyamus muticus
H. niger
Mucuna pruriens
Panax pseudo-ginseng
Papave somniferum
Physochlaina praealta
Picorrhiza kurroa
Plantago ovata
Psoralia corylifolia
Podophyllum emodi
Rauvolfia serpentina
Rheum emodii
Secale cereale (ergot)
Solanum khasianum
S. lanciniatum
S. viarum
S. xanthocarpum
Trigonella foenum-greacum
Taxus baccata
Swertia chirata
Valeriana wallichii
Withania somnifera

Attachment 4

List of medicinal plants banned for export

1. *Cycas beddomei* (Beddomes cycad)
2. *Vanda coerulea* (Blue Vanda)
3. *Saussurea costus* (Kuth)
4. *Paphiopedilium* species (Lady's Slipper Orchids)
5. *Nepenthes khasiana* (Pitcher plant)
6. *Ranathera imschootiana* (Red Vanda)
7. *Rauvolfia serpentina* (Sarpagandha)
8. *Ceropegia* species (*Ceropegia burbosa* Roxb.)
9. *Frerea indica* (Shindal Mankundi)
10. *Podophyllum hexandrum* (emodi) (Indian Podophyllum)
11. *Cyatheaceae* species (Tree Ferns)
12. *Cycadaceae* species (*Cycas ciricinalis* Linn.)
13. *Dioscorea deltoidea* (Elephant's foot)
14. *Euphorbia* species (Euphorbias)
15. *Orchidaceae* species (Orchids)
16. *Pterocarpus santalinus* (Red Sanders)
17. *Taxus wallichiana* (Common Yew or Birmi leaves) (*T. baccata*)
18. *Aquilaria malaccensis* (Agarwood)
19. *Aconitum* species.
20. *Coptis teeta*
21. *Coscinium fenestratum* (Calumba wood)
22. *Dactylorhiza hatagirea*
23. *Gentiana kurroo* (Kuru, Kutki)
24. *Gnetum* species (*Gnetum* montanum Markgraf)
25. *Kaempferia galanga*
26. *Nardostachys grandiflora* (Jatamansi)
27. *Panax pseudoginseng*
28. *Picrorhiza kurrooa*
29. *Swertia chirayta* (Charayata)

Inventory, documentation and status of medicinal plants research in Indonesia

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Introduction

The use of medicinal plants in Indonesia has always been a part of culture that has been passed down from generation to generation. By trial-and-error, the country's early inhabitants learned how to distinguish useful plants with beneficial effects from those that were either toxic or non-active. They picked, kept and used medicinal plants to satisfy their basic needs and even experimented on combinations of plants or processing methods to gain optimal results. Throughout the centuries, Indonesia's indigenous people developed traditional medicines from plants identified by their forefathers for curing illnesses and keeping their health. This empirical knowledge may have contributed substantially to the development of traditional medicines in the country.

Indonesia is ranked as the second largest in terms of biodiversity, with 30 000 flowering plant species (Bappenas 1993). About 7000 of these species are recognized as medicinal plants (Eisai 1986), with 950 known to have medicinal properties; 283 species are registered, being cultivated and used by traditional medicinal industries (Sampoerno 1999) and another 250 species directly harvested from forests as raw material by these industries (Zuhud *et al*. 2001).

The global trend towards the use of herbal and natural medicines has been increasing in recent years. More attention from the world community has been given to the tropical rainforest, which is believed to contain 50% of the world's biodiversity. Farnsworth *et al*. (1985) indicated that 74% of the 121 active compounds used for the development of important modern medicines in the United States, such as digitoxin, reserpin, tubocucorin and ephendrin, are derived from medicinal plants growing in and gathered from tropical forests.

Medicinal plants in Indonesia have high economic and health values in both indigenous and modern communities. The number of industries dependent on it have increased in recent years, with the market value of traditional medicine industries jumping from US$ 12.4 million in 1996 to US$ 130 million in 2002 (Sampoerno 2002). The number of traditional medicine manufacturers has also increased - from 578 in 1996 to 810 in 2000, with 87 manufacturers considered as large-scale industries (Pramono 2002).

Research activities geared towards the development of traditional medicines like "Jamu" as standardized extracts, phytopharmaca, etc. have been initiated and some of these products have been marketed. There is also currently great public interest for finding herbal medicinal plant species to cure major diseases such as cancer, hepatitis and heart disease. Other researches such as medicinal plant-based cure for diabetes and hyperlipidemie, as well as for food supplement and aphrodisiac have also been initiated.

Despite their recognized importance, the existence of medicinal plants in their natural habitats is threatened by the destruction of natural ecosystems. The condition continues to worsen with the opening of large forest areas for transmigration and farming (Bapedal 2001). A large number of medicinal plant species have been depleted from their natural habitats (Rifai *et al*. 1992; Zuhud *et al.* 2001). Most novel species' identities and potential benefits would remain unknown as these have been lost due to genetic erosion without being properly documented.

Medicinal plants and uses

The use of plant remedies in the treatment of ailments and diseases have been practiced by indigenous peoples for generations. A number of plants commonly used as folk medicine in Indonesia are shown in Table 1.

Table 1. Medicinal plants commonly used as traditional folk medicine in Indonesia

Scientific Name	Local Name	Uses
Abrus precatorius	Saga manis	
Andrographis paniculata	Sambiloto	Anti-cancer, anti-cholesterol, anti-diabetes
Blumea balsamifera	Sembung	Analgesic, antipyretic, expectorant
Carica papaya		Anti-inflammation
Centella asiatica	Pegagan	Vulnerary
Curcuma domestica		Anti-diarrhoea, antiseptic,anti-cancer
Curcuma xanthorrhiza	Temulawak	Antihepatitis, anti-cancer
Graphtophilum pictum	Daun wungu	Anti-hemorrhoid
Guazuma ulmifolia	Jati Belanda	Anti-cholesterol
Kaempferia galanga	Kencur	Coughs
Morinda citrifolia	Mengkudu	Leucorrhea, sapraemia, anti-diabetes, anti-cancer
Mysristica fragrans	Pala	Relaxant, flatulent, anti-diarrhoea
Orthosiphon aristatus	Kumis kucing	Diuretic
Piper betle	Sirih	Antiseptic
Piper retrofractum	Cabe jawa	Aphrodisiac
Psidium guajava	Jambu biji	Anti-diarrhoea
Sauropus androgynus	Katuk	Breast milk production stimulant
Sonchus arvensis	Sembung	Diuretic
Strobilanthes crispus	Keji beling	Diuretic
Syzygium aromaticum	Cengkeh	Antiseptic
Syzygium polyanthum	Salam	Rheumatism, anti-hyperurecimia
Talinum paniculatum	Som jawa	Tonic
Tinospora rumphii	Brotowali	Jaundice, stomach ache, antipyretic, skin infection
Vitex trifolia	Legundi	Tuberculosis, after-birth treatment, Relaxant
Zingiber officinale	Jahe	Anti-cancer, antiseptic, cough

Collection and conservation of medicinal plants

Medicinal plants are very valuable for economic and health reasons both for indigenous and modern communities in Indonesia. Therefore, its sustainability, especially in their natural habitat must be protected. Realizing the importance of medicinal plants, conservation has been ongoing for ages by the indigenous communities.

To protect and sustain the development of herbal medicinal plants and its industries, the government has made attempts to encourage cultivations and public awareness for conservation of medicinal plants. A national programme called TOGA (Tanaman Obat Keluarga) or "Medicinal Plants for Family", was implemented with the two-pronged vision of (1) providing cheap, alternative "medicines" to keep the family healthy by planting medicinal plants in home gardens; and (2) protect and conserve these medicinal plants in their natural habitats. This programme, besides reducing family spending on medicines, also serves as sources of medicinal plants supply for traditional industries and a means to increase people's income

(Departemen Kesehatan 1995). The choice of medicinal plants for propagation are those already grown in the surrounding area, easy to cultivate, do not need much care and attention, can be utilized for other purposes such as spices and can easily be processed. There are 106 species of recommended medicinal plants mostly used as preventive and curative for common ailments and diseases such as cough, skin disease, headache, diarrhoea, toothache, influenza, post maternity treatments, fever, etc.

Many institutions in Indonesia also make deliberate efforts to collect and maintain herbal and medicinal plants germplasm as part of their research and development programmes. The Indonesian Spices and Medicinal Crops Research Institute (ISMECRI) and several other government research institutions such as Balai Penelitian Tanaman Obat (BPTO), Badan Pengkajian dan Penerapan Teknologi (BPPT), Balai Pengkajian Teknologi Pertanian (BPTP), universities and private sectors are involved in the conservation of medicinal plants. At present, ISMECRI maintains 300 medicinal plants species in five conservation sites from lowland to highland composed of indigenous, introduced and elite materials from selected species (Bermawie *et al.* 2003).

From 1995 to 1997, ISMECRI collected a number of medicinal plants from several localities in Java and more than 20 accessions of *temoelawak*, 50 accessions of turmeric, 50 accessions of Indian galangal and 18 accessions of ginger. Inventory of ethno-medicines in National Parks recorded 40 medicinal plants used by the local people in Halimun, 126 species used by people in Salak and 79 species in the Gede-Pangrango National Park (Rosita *et al*. 2001). Collecting missions have been planned for 2003 for javanony, bitter leaves, tailed pepper and other similar crops.

Priority medicinal plants research (ongoing and proposed)

Research and development activities on Indonesian traditional medicines have been undertaken by researchers from the Ministry of Health, Ministry of Agriculture and from the universities and traditional medicine industries. All aspects of research have been conducted - from cultivation, ethno-pharmacology, utilization, isolation and identification of active constituents to efficacy evaluation, pharmacology, safety, standardization, formulation and clinical evaluation. Several policies and strategies have also been set up to develop Indonesian traditional medicines for commercialization and mainstreaming.

To facilitate research on medicinal plants, a multisectoral group of researchers on medicinal plants organized themselves into a working group in 1990, called "POKJANASTOI" (National Working Group on Indonesian Medicinal Plants), with the aim of systematizing the study of medicinal plants, identify priority needs and direct their efforts and attention. Since then, there have been 23 group meetings conducted where research results of more than 40 medicinal plant species recommended by the national working group were presented.

To provide scientific evidence and clinical proofs for Indonesian traditional medicines, the National Agency for Food and Drug Control (NAFDC) has set up the priorities for medicinal plants research. NAFDC determined nine medicinal plants as priority crops, with the objectives of: (1) obtaining traditional medicines to cure degenerative diseases such as hyperlipidemia, hyperuricemia, diabetes, hypertension, and rheumatism; (2) obtaining medicines to stimulate the human immune system; and (3) providing traditional medicines to be used in formal health care system (Table 2).

Table 2. Priority medicinal plants and traditional uses in Indonesia

Scientific name	Local name	Known use(s)
Andrographis paniculata	Sambiloto	Cardiovascular, arteriosclerosis, anti-cancer, anti-cholesterol
Curcuma domestica	Kunyit	Anti-cholesterol
Curcuma zanthorrhiza	Temulawak	Improvement of liver function, anti-cholesterol
Guazula ulmifolia	Jati Belanda	Anti-cholesterol, anti-cancer
Morinda citrifolia	Mengkudu	Anti-diabetes
Piper retrofractum	Cabe jawa	Androgenic, aphrodisiacs
Psidium guajava	Jambu biji	Anti-virus, dengue
Syzygium polyantha	Salam	Anti-diabetes
Zingiber officinale	Jahe	Anti-cancer

The researches conducted by the Agricultural Research Institutes focused on medicinal plants with high demand (>100 tonnes of *simplicia* monthly). The eight most-used species in traditional medicinal industries are: *Zingiber officinale*, *Alpinia galanga*, *Kaempferia galanga*, *Z. aromaticum*, *Curcuma domestica*, *C. xanthorrhiza*, *Piper retrofractum* and *P. betle*. Research activities have been focused on selecting plant variety with high yield and quality to provide good quality raw materials.

Summary of research on medicinal plants and important results

Research activities on nine priority medicinal plants have been started by several research institutes and universities. The overall objective is to integrate Indonesian traditional medicines into the formal health-care system by providing scientific backgrounds for the medicinal plants and proof with clinical trials. Several research and development aspects such as agronomy, chemistry and pre-clinical trials have been conducted though not yet completed. In 2003-2004, NAFDC planned for clinical trials of the priority medicinal plant species. The following is a summary of research activities and results:

Andrographis paniculata

Agronomy

- Identified, collected and evaluated high-yielding and good quality varieties
- Developed vegetative propagation techniques (cuttings, growth hormone, for harvesting age)
- Developed fertilizer application and pruning techniques to increase yield
- Conducted water stress and shading studies to increase active compound
- Undertook pest control

Chemistry

- Developed extraction methods
- Determined extracts parameters, including yield, chemical compound, essential oil content, dry weight, water content, ash, ash insoluble in acid, water soluble extractive, ethanol soluble extractive, pesticide residue, heavy metal, aflatoxin and microbes

Pre-clinical

- Conducted acute toxicity tests using leaf extract on mice-practically non–toxic; sub-chronic test did not show any abnormality on hematological parameters, biochemical blood, liver and kidney (macro and microscopically).
- Conducted mutagenic test - did not cause mutation on *Salmonella typhium* TA 100.

- Conducted anti-hepatotoxicity test – showed reduced SGPT and SGOT levels in male white mice
- Conducted efficacy test – showed reduced total cholesterol, triglycerides, LDL-cholesterol, SGPT, SGOT, blood glucose content and increased HDL-cholesterol in white mice treated with the extract

Curcuma domestica

Agronomy

- Identified and selected high-yielding cultivar with high curcumin content
- From 55 germplasm accessions tested, it was shown that yields vary from 1-2 kg per plant; essential oil content from 4.9% to 7.00%; curcumin content from 7% to 11%; fibre from 5.3% to 9.8%; extract soluble in water from 17.6% to 31.9%; and extract soluble in ethanol from 12.4% to 18.5 % (Syukur *et al.* 1999)
- Study conducted on different cultivation methods, particularly fertilizer application (effect of N) and mulching to increase yield

Chemistry

- Determined parameter extract
- Isolated and identified chemical components in turmeric
- Essential oil profile of turmerics obtained from several localities

Pre-clinical

- Conducted acute toxicity and sub-chronic toxicity tests
- Conducted mutagenic tests
- Conducted efficacy tests

Curcuma xanthorrhiza

Agronomy

- Identified and selected high-yielding cultivar with high essential oil and curcumin contents
- Collected 23 accessions of Temoelawak from several localities in Indonesia
- Found out that yield varies from 11.8 t/ha to 34.1 t/ha; 10 promising clones currently undergoing field and quality evaluation
- Study conducted on the effect of radiation and plant maturity on rhizome yield and curcumin content

Chemistry

- Determined extract parameters and characteristics of extract
- Conducted comparison studies of curcumin in essential oil from several turmeric accessions
- Isolated, identified and quantitatively evaluated xanthorrhizol
- Isolated, identified and determined the main compounds for standardization of *temoelawak simplicia*

Pre-clinical

- Conducted acute and sub-acute toxicity tests in mice
- Conducted studies to determine the effect of temoelawak on the intestines of experimental animals *in vitro*
- Conducted studies to determine the effect of temoelawak as anti-microbial agent
- Conducted anti-mutagenic tests using unscheduled DNA synthesis in mice hepatosit culture

- Conducted anti-hepatotoxicity test in male white mice using SGPT and SGOT
- Conducted anti-inflammation test in mice

Guazuma ulmifolia

Agronomy
- Carried out vegetative propagation by stem cuttings

Chemistry
- Developed extraction method
- Determined extract parameters and characteristics

Pre-clinical
- Conducted mutagenic test of leave extract
- Conducted acute toxicity tests
- Conducted studies to determine the infuse effect of leaves on blood lipid fraction in rabbit

Morinda citrifolia

Agronomy
- Collected javanony from several localities in Indonesia
- Identified agroecological parameters in cultivated areas
- Developed cultivation techniques

Chemistry
- Isolated and identified alkaloid compound from fruit juice
- Characterized and evaluated collected accessions for chemical compound and content

Pre-clinical trial
- Conducted studies to determine the effect of LD 50 from methanol extract of fruit on mice
- Conducted mutagenic test
- Conducted studies to determine the effect of javanony fruit juice on blood glucose content in mice and rabbit
- Conducted studies to determine the effect of fruit juice on male fertility
- Conducted studies to determine the hypoglycemic effect of fruit juice on white mice

Piper retrofractum

Agronomy
- Produced *P. retrofractum*
- Carried out vegetative propagation and cultivation

Chemistry
- Determined extract parameters
- Conducted microscopic and thin layer chromatography analysis of *P. retrofractum*

Syzygium polyanthum

Agronomy
- Carried out inventory, collection and quality evaluation of selected medicinal plants

Chemistry
- Determined extract parameters

Pre-clinical trial

- Conducted acute and sub-acute toxicity tests – proven to be practically non-toxic
- Conducted studies to determine the effect of infusion on blood sugar content on mice
- Conducted anti-diarrhoea activity test of methanol extract on mice
- Conducted studies to determine the effect on xanthin-oxidized activity – showed reduced hypoxanthine and xanthin

Psidium guajava

Agronomy

- Carried out inventory, collection and quality evaluation of selected medicinal plants

Pre-clinical trial

- Conducted acute toxicity tests

Zingiber officinale

Agronomy

- Eighteen accessions of ginger have been collected and evaluated for yield and essential oil content in several agroecological conditions. Yield varied from 15-35 t/ha; essential oil content from 1.7% to 4.8%; oleoresin content from 2.4% to 9.6%; and gingerol content from 0.57% to 2.66% (Hernani *et al.* 2001; Bermawie *et al.* 2001, 2002)
- Conducted studies on different cultivation techniques, including fertilizer applications, pest control, plant spacing for high productivity and good quality product

Chemistry

- Determined extract parameters
- Conducted studies to determine the effect of plant age and agroecological condition on essential oil and quality
- Established essential oil profile
- Conducted studies to determine the effect of drying on essential oil yield and chemical composition

Pre-clinical

- Conducted acute toxicity tests
- Conducted anti-inflammation test
- Conducted isolation of proteolitic enzymes and anthelmintic tests

Kaempferia galanga

Agronomy

- A total of 40 accessions have been collected from several localities in Indonesia. Yield and quality evaluation have been undertaken and showed that rhizome weight varied from 15.6-80.0 g/plant; essential oil content from 1.50% to 6.20%; extract soluble in ethanol from 1.4% to 9.5%; extract soluble in water from 15.3% to 21.7%; fibre content from 3.32% to 11.4%; and starch content from 35.4% to 52.9% (Syafaruddin and Bermawie 1998). Selected

accessions are undergoing multilocation tests to be released as recommended varieties.

Agencies/organizations working on medicinal plants in Indonesia

The following is a list of organizations involved in conservation efforts and researches on medicinal plants in Indonesia:

1. Indonesian Spices and Medicinal Crops Research Institute (ISMECRI), Jalan Tentara Pelajar 3, Bogor
2. Universities (Bogor Agric. Univ.)-Kampus Darmaga, Bogor, West Java
3. BPTO, Tawangmangu, Solo, Central Java
4. BPPT, Serpong, Tanggerang
5. Puslitbang Biologi-LIPI
6. Jl. Ir. H. Juanda 18, Bogor, West Java
7. Puslitbang Farmasi, Jalan Percetakan Negara 29, Jakarta
8. Badan POM (NAFDC) Jalan Percetakan Negara 23,Jakarta
9. Puslitbang Hasil Hutan, Jalan Gunung Batu 5 Bogor, West Java
10. Private sector entities:
    - PT Sido Muncul, Jalan Mlaten Trenggulung 108, Semarang, Central Java
    - PT Air Mancur, Jalan Raya Palur Km 7, Solo, Central Java
    - PT Martina Berto

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Inventory, documentation and status of medicinal plants research in Korea

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Introduction

Korea is famous for its long history of medicinal plants use and the extensive documentation of their effectiveness. Oriental medicines value in Korea is not only in its curative effect on diseases but also in its contribution in the restoration of the country. These facts were not only known from books but also from local or traditional knowledge. Considering the imbalance of the present diet system, the optimal use of medicinal plants, which contain multi-functional chemicals, makes body nutritionally balanced. But until now, the huge amounts of medicinal plant material, which cover many species, are harvested from forests, alpine and other multiple-use habitats. This leads to diminishing diversity. To sufficiently supply the needs of the increasing population, proper management based on the ecological habitat of the medicinal plant is necessary. For the sustainable use and to facilitate access to medicinal plants, efforts should be concentrated on its inventory and documentation. In this regard, the project on "Inventory and Documentation of Medicinal Plants in 14 Asia Pacific Countries", involving Korea is essential. The successful integration of information including published and unpublished literatures on conserved medicinal plants in Korea would contribute towards improving the balance of health not only for the nation's people but also for the other peoples of the world.

Status of medicinal plants research in Korea

Table 1. Cultivation and production of medicinal plants in Korea
(Source: Ministry of Agriculture and Forestry, Korea)

Year	1980	1985	1990	1995	1997	2000
Area Planted (ha)*	3966 (100)	4010 (101)	9179 (231)	13 741 (346)	13 600 (342)	9936 (250)
Production (tonnes)*	8380 (100)	12 616 (150)	22 822 (272)	42 769 (510)	39 492 (471)	30 141 (359)

*Figures in parentheses are percentages as compared with 1980 value

Areas dedicated to medicinal plants and its production in Korea has been increasing significantly. In 1980, only 3966 ha were planted with a total production of 8380 tonnes (Table 1). These figures peaked in 1995 when total area planted reached 13 741 ha while production exceeded 42 769 tonnes. Towards the year 2000, areas planted and production dropped to 9936 ha and 30 141 tonnes, respectively.

Table 2. Comparison of area planted and production of medicinal plants among provinces in Korea, 1995 - 2000

Provinces	Area Planted (ha)		Production (tonnes)	
	1995	2000	1995	2000
Kyungki	1225	832	3245	1427
Kangwon	3196	2483	7594	5105
Chungbuk	980	677	1762	1782
Chungnam	975	754	3268	2995
Kyungbuk	3890	2626	12 390	8109
Kyungnam	713	582	1500	2018
Chonbuk	1619	598	4896	1531
Chonnam	2170	758	6480	2056
Cheju	110	581	569	5022
Total	**13741**	**9936**	**42 769**	**30 141**

Table 2 shows that the areas cultivated with medicinal plants, as well as its production levels, from 1995 to 2000 generally decreased in most provinces. Kyungbuk Province had the biggest area planted to medicinal plants at 3890 ha in 1995. This, however, decreased to 2626 ha in 2000. Cheju Province, on the other hand, demonstrated how a slight increase in land use can produce more. With an increased land area of 471 ha (from 110 ha in 1995 to 581 ha in 2000) planted to medicinal plants, the province was able to produce 4453 tonnes more of medicinal plants. It was the third highest producer among the provinces in 2000.

Table 3. Major medicinal plants planted in 1995 and 2000 in Korea

Medicinal Plants			Area Planted (ha)	
Scientific name	Common name	Local name	1995	2000
Angelica gigas Nakai	Chinese angelica root	'Dangui'	2344	1106
Astragalus membranaceus Bunge	Membranous milk vetch root	'Hwanggi'	1620	945
Paeonia lactiflora Pall	Paeonia	*'Zakyak'*	998	390
Cnidium officinale Makino	Ligustici rhizoma	'Chongung'	885	179
Rehmannia glutinosa Liboschitz	Chinese foxglove root	'Jihwang'	143	83
Schizandra chinensis Ballon	Baill	'Omija'	393	238
Lycium chinese Mill	Barbary wolf, Berry fruit	'Kugija'	557	271

Table 3 above presents a list of major medicinal plants planted from 1995 to 2000. Chinese angelica root was the most widely planted, from 2344 ha in 1995 to 1106 ha in 2000. The area planted to membranous milk vetch root was 1620 ha in 1995 but fell to 945 ha in 2000. Paeonia, which was planted over 998 ha in 1995, dropped to 390 ha in 2000. The production area for Ligustici rhizoma significantly dropped to 80% in 2000. Areas planted with Chinese foxglove root, baill and barbary wolf (or berry fruit) also declined significantly.

Table 4. Domestic production, import, export and consumption of medicinal plant materials in Korea (in tonnes)

Parameter	1996	1997	1998	1999	2000
Domestic production	42 769	41 268	30 474	29 504	30 141
Imports (from China)	69 362	55 472	28 358	46 133	44 042
Exports	972	858	208	117	98
Demand (consumption)	111 159	95 882	58 651	75 520	74 085
Self-sufficiency (%)	38	43	51	39	40

Generally, domestic production and importation (from China) of medicinal plant materials showed a decreasing trend. Domestic production was lowest at 29504 tonnes in 1999, but increased to 30 141 tonnes in 2000. Imports dropped to its lowest in 1998 at 28358 tonnes, but gradually increased to 44 042 tonnes in 2000. Exports, however, continued to fall during the four-year period. Demand, in tandem with domestic production and imports, depicted a downturn but rising towards the year 2000. The rate of self-sufficiency peaked in 1998 at 51%.

Table 5. Uses of major medicinal plants imported from China in 1999 and 2000 (in tonnes)

Crop	1999		2000	
	Medical Supply	Food Article	Medical Supply	Food Article
Angelica gigas Nakai	0	30	0	113
Astragalus membranaceus Bunge	0	616	0	1550
Paeonia albitiflora var.	0	190	0	584
Atractylodes ovata var. *Koreanum*	565	420	447	1029
Rehmannia glutinosa Liboschitz	579	30	1201	832
Schizandra chinensis Ballon	79	338	122	188
Lycium chinese Mill	40	449	59	431

Major medicinal plants imported from China in 1999 and 2000 were concentrated more on food articles than medical supplies (Table 5). *Angelica gigas* Nakai, *Astragalus membranaceus* Bunge and *Paeonia albitiflora* var. were not registered as medical supplies. The most prioritized crop was *Astragalus membranaceus* Bunge, which increased two-fold to 1550 t in 2000. The most prominent crop for medical supply was *Rehmannia glutinosa* Liboschitz.

Table 6. Development and manufacturing of medicinal plant products in Korea

Crop/material	Food type and use
Chinese angelica root	An extract, granule, pill
Chinese foxglove root	Raw material of food, Traditional Korean tea (substitute for coffee)
Chicory	Functional beverage
Mulberry upper leaves	Extract tea
Pine needles	Functional beverage
Buckwheat	Functional beverage and food
Black soybean	Functional beverage, processing food
Capillary artemisia	Functional healthy beverage and pill
Cirsium japonicum	Manufactured powdered goods
Acanthopanax sp.	Medicinal plant wine
Sessiliflorus sp.	Medical material
Glycyrrhiza uralensis	Powder and raw material for manufacturing goods

Table 6 depicts the food type and use of selected medicinal crops. Extract of Chinese angelica root, for example, is prepared as granules or pills; Chinese foxglove root is used as tea, a substitute for coffee. Another tea extract is from upper mulberry leaves. Functional beverages, foods and pills are made from Chicory, pine needles, buckwheat, black soybean and Capillary artemisia. *Cirsium japonicum* and *Glycyrrhiza uralensis* make up goods manufactured in powder form. A medicinal plant wine is distilled from *Acanthopanax* sp. Other medical material source is from *Sessiliflorus* sp.

Table 7. Cultivation and production of ginseng (*Panax ginseng* C.A. Meyer) in Korea

Classification	1990	1995 (A)	2001 (B)	B/A(%)
No. of farmhouses	36 404	23 172	19 310	83.3
Area planted (ha)	12 184	9 375	13 018	138.9
Production (tonnes)	13 887	11 971	13 215	110.4
Average cultivated area (ha) (Area planted/no. of farmhouses)	0.335	0.405	0.674	166.4
Yield (t/ha)	1.140	1.277	1.015	79.4

Production of ginseng in Korea indicated increases in tandem with the increase in cultivated area (Table 7). However, the number of farmhouses for ginseng production declined from 36 404 in 1990 to 19 310 in 2001. The area planted to ginseng increased by 13% during the same period, but yield declined from 1.277 t/ha in 1995 to 1.015 t/ha in 2001.

Table 8. Exports of ginseng products from Korea (in million US$)

Export articles	1990	1995 (A)	2001 (B)	Difference (B-A)
Root	87.6	71.3	36.6	-34.7
Manufactured goods	68.6	61.8	32.8	-29.0
Others	9.0	6.8	5.4	-1.4
Total	**165.2**	**139.9**	**74.8**	**-65.1**

Actual exports of ginseng from Korea showed a declining trend, with an actual difference of negative US$ 65.1 million between 1995 and 2001 (Table 8). The steady decline of root, manufactured goods, and other export articles are evident, with deficits of US$ 34.7 million, US$ 29.0 million and US$ 1.4 million, respectively.

Table 9. New varieties of species *Carthamus tinctorius* developed since 1999

Name of species	Year developed	Name of variety	Yield (t/ha)	Main characteristics
Carthamus tinctorius	1999	Chongsu honghwa	1.8	Resistant to lodging
	2000	Euisan honghwa	2.2	Small grain but high yielding
	2000	Jinseon honghwa	2.4	Early maturing and disease resistant

New varieties of *Carthamus tinctorius* have been developed since 1999 (Table 9). Chongsu honghwa, first bred in 1999, resists lodging and yields 1.8 t/ha. Euisan hongwha, developed in 2000, is known for its small grain but high yield, producing

2.2 t/ha. Jinseon honghwa was also developed in 2000. It is early maturing, disease-resistant and yields an average of 2.4 t/ha.

Table 10. Development of new varieties of *Astragalus membranaceus* B. and *Rehmanniaglutinosa* (Gaertn.)

Medicinal crop	Year developed	Name of variety	Yield (t/ha)	Main characteristics
Astragalus membranaceus B.	1999	Poongseong hwanggi	2.4	high quality, resistant to lodging
Rehmannia glutinosa (Gaertn.) Steud.	1995	Jihwang 1	23.0	light green leaf, high yielding
	1999	Korea jihwang	9.1	good plant type, resistant to diseases

The varietal development of *Astragalus membranaceus* B. and *Rehmannia glutinosa* (Gaertn.) Steud. started in 1995 which resulted to three improved cultivars, namely: Poongseong hwanggi, a high-quality variety which is resistant to lodging and with average yield of 2.4 t/ha; Jihwang 1, with light green leaves, high-yielding (23 t/ha); and Korea jihwang, a good plant type with high disease resistance and a yield of 9.1 t/ha.

Table 11. Development of new varieties of *Lycium chinese* Mill (fruit of boxthorn) in Korea

Medicinal crop	Year developed	Name of variety	Yield (t/ha)	Main characteristics
Lycium chinese Mill	1997	Cheongyang kugija	2.9	Pest resistant, high saponin content and high yielding
	2000	Bulro kugija	2.4	Early maturing, large fruit, good branch type
	2000	Cheongdae kugija	2.2	Late maturing but disease resistant

In 1997, *Lycium chinese* Mill or the fruit of boxthorn was improved for better yield, insect-resistance and saponin content (Table 11). The improved varieties include Cheongyang kugija and Bulro kugi-a, with yields of 2.9 and 2.4 t/ha, respectively. Bulro kugija bears large fruits and matures early with good branch type. Another variety, Cheongdae kugija, developed in 2000 recorded an average yield of 2.2 t/ha. It is also disease-resistant but is late maturing.

Table 12. Development of new varieties of *Paeonia albitiflora* var.

Medicinal crop	Year developed	Name of variety	Yield (t/ha)	Main characteristics
Paeonia albitiflora Var.	1993	Euiseong zakyak	17.3	Resistant to disease, high yielding, multiple uses (medical and horticultural)
		Taebak zakyak	13.4	High quality, two-fold flower
	1997	Sagok zakyak	14.0	Early maturing
	2000	Geopoong zakyak	15.0	Many curative properties, disease-resistant

Paeonia albitiflora var Euiseong zakyak and Taebak zakyak were developed in 1993 (Table 12). The first variety yielded 17.3 t/ha, and the latter, 13.4 t/ha. Euiseong

zakyak is high-yielding, disease-resistant, and has multiple uses. Taebak-Zakyak is a high quality variety with two-fold flowers. Sagok zakyak variety was developed in 1997 and is early maturing. In 2000, Geopoong zakyak was released with yield performance of 15 t/ha. It is disease-resistant and has many curative values.

Ongoing activities and accomplishments

Publication of medicinal plant researches

In Korea, there were 345 research papers on medicinal plants published since 1964 dealing with various disciplines. Most of the published research papers were on cultivation physiology (116), analyses of ingredients (82) and tissue culture (64). Topics on the processing and use of medicinal plants are the least published with 40 papers, followed by breeding (43).

Collections of medicinal plants

Table 13. Collaborating research institutes in Korea and their conserved medicinal plants accessions

Institute	Accessions	Main Management Crop
National genebank or RDA Genebank	910	Pearl barley, Lady's finger, Sickle senna
National Crop Experiment Station	600	*Astragalus membranaceus* B., *Angelica gigas* NAKAI
Honam National Agricultural Experiment Station	9	*Saururus chinensis* Bail
Kyunggi Provincial Office of RDA	583	*Carthamus tinctorius*, *Panax ginseng* C.A. Meyer
Kangwon Provincial Office of RDA	28	*Acanthopanax sessiliflorus*
Chungbuk Provincial Office of RDA	129	*Saururus chinensis* Bail, *Carthamus tinctorius*
Chungnam Provincial Office of RDA	293	*Selosia cristata*, *Viola mandshurica*
Chonbuk Provincial Office of RDA	261	*Platycodon grandiflorum*Balloon flower *Angelica gigas* NAKAI
Chonnam Provincial Office of RDA	344	*Belamcanda chinensis*
Kyungbuk Provincial Office of RDA	109	*Archium lappa*
Kyungnam Provincial Office of RDA	109	*Arisaema amurense*, *Codonopsis lanceolata* Bonnet bellflower
Cheju Provincial Office of RDA	69	*Artemisia argyi* L. *Campsis grandiflora*
Others	105	-
TOTAL (12)	**3549**	

Table 13 presents a list of accessions of preserved medicinal plants managed by the Rural Development Administration (RDA) of Korea. Of the total 3549 accessions reported, the sources of 105 of the collections were not disclosed.

Table 14. Number of medicinal plants conserved in related research institutes and agencies in Korea

Family Name	No. of Species	No. of Accessions
Gramineae	2	376
Malvaceae	8	261
Compositae	67	250
Liliaceae	47	140
Umbelliferae	25	131
Leguminosae	27	129
Labiatae	33	124
Ranunculaceae	20	109
Rosaseae	25	92
Campanualaceae	8	49
Polygonaceae	13	47
Solanaceae	8	46
Scrophulariaceae	9	38
Araceae	7	31
Crassulaceae	12	24
Others (87 families)	97	1702
TOTAL (102 families)	**533**	**3549**

Based on the number of accessions in Table 14, the family gramineae is the biggest with 376 accessions, followed by Malvaceae, Compositae, Liliaceae, Mulbelliferae, Leguminosae, Labiatae, Ranunculaceae with 261, 250, 140, 131, 129, 124 and 109 accessions, respectively. Considering the number of species, Compositae is the biggest with 67 species, followed by Liliaceae, Labiatae, Leguminosae, Umbelliferae and Ranunculaceae with 47, 33, 27, and 25 species, respectively.

The characterization of the above collections will be done as part of the project's work plan and shared with other country participants to enhance cooperation and development.

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Inventory, documentation and status of medicinal plants research in Malaysia

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Introduction

Malaysia, being one of the 12 mega-diversity centres of the world, is rich in plant genetic diversity, with many of these plants used for medicinal purposes. Out of the 12 000 species of vascular plants, 10%, or approximately 1200 species, are reported to have medicinal properties. The three major races (Malays, Chinese and Indians) and the various tribes of 'Orang Asli' or indigenous people use these medicinal plants. Medicinal plants are the basis of health care for the 'Orang Asli' and rural populations.

Over the years, there is an increasing popularity of and demand for medicinal plants within and outside Malaysia. The market for herbs and plant-based medicine in Malaysia was worth about US$ 527 million in 2000 and this figure is expected to increase to US$ 1.37 billion in 2010 (Mohamad Setefarzi 2001). Ng and Mohd. Azmi (1997) predicted an enormous potential for the plant species traditionally used as health food and tonics to be developed into large-scale production of functional foods. Herbal drug industry in Malaysia is a growing industry with much potential in the regional and global markets.

Ng and Mohd Azmi (1997) reported an approximately 206% increase in import value of medicinal and aromatic plants from 1986 (US$ 37 million) to 1996 (US$ 113 million) with a corresponding 91% increase in export value over the same period (i.e. US $ 1.5 million in 1986 to US$ 16 million in 1996). The raw plant materials imported were mainly in the form of powder, pellets and plants coming largely from China, India, Indonesia, Hong Kong, Taiwan and the United States. Another parallel study by Kanta *et al.* (1998) had slightly lower figures for the period of 1992-1997 (Table 1). Both studies reveal that there is a steady increase in herbal product market value since 1986, with more notable growth observed in the 1990's. The national herbal market value is estimated at US$ 600-800 million annually. However, the local herbal industry only captures 5-10% of the national market (Anon. 2001).

Table 1. Import and export trends of medicinal plants in Malaysia (1992-1997) (Source: Kanta *et al.* 1998)

Year	Imports (in US$ '000 000)	Exports (in US$ '000 000)
1992	54.25	1.12
1993	59.07	2.07
1994	62.11	2.88
1995	71.82	3.33
1996	71.98	3.95
1997	83.00	3.06

Many medicinal resources currently used by the industry are imported, mainly from countries like India, Indonesia and China. Most of the local species used by the herbal industry are largely collected from the forests. Of these, only a small percentage is cultivated, with some still on a trial basis.

There is a need to reduce the dependence on imports for the supply of quality raw

materials. Local planters should engage in the large-scale planting of quality herbs for the local herbal manufacturers. In this, the role of the federal and state government is very important. Government research institutes (e.g. Malaysian Agricultural Research and Development Institute or MARDI, and the Forest Research Institute Malaysia or FRIM) would serve well by supplying planting guidelines and research on quality planting materials. Support from the state governments in allocating land for planting would be pertinent.

There are many repositories of medicinal plants conserved *ex situ* in the peninsula. Many are in herbal gardens of various sizes in research institutes, universities, private companies, colleges and even secondary schools.

Medicinal plants in the country and their uses

There are many species of medicinal plants used in folk remedies by various indigenous peoples in Malaysia. The following table is a truncated summary of some of the medicinal plants used by the Malays in the northern parts of Peninsular Malaysia. A more complete list will be included in the final report.

Table 2. List of medicinal plants used in traditional Malay medicine in Kuala Nerang, Kedah (Source: Zainon *et al.* 2001)

Scientific Name	Family Name	Vernacular Name(s)	Part(s) Used	Use(s)
Goniothalamus spp.	**Annonaceae**	Selayar, gajah beranak (Malay), chiak kru (Thai)	Root Raw leaf stalk	To relieve pain, reduce flatulence, stimulate sweating and to revitalise body
Alyxia calcicola	**Apocynaceae**	Mempelas hari (Malay)	Stem bark	As a fragrance, To prevent bugs
Wrightia pubescens		Pulai tanah(Malay)	Latex	To alleviate toothache
Agathis borneensis	**Araucariaceae**	Raja kayu (Malay)	Heartwood	To treat diarrhoea, abdominal pain, joint pains, and reduce menstrual flow (in women), To heal wounds
Calotropis gigantea	**Aslepiadaceae**	Remingu (Malay)	Latex from stem	To remove wood splinter
Erigeron linifolius	**Compositae (Asteraceae)**	Kembang pagi (Malay)	Leaves	To treat itchiness and peeling of skin
Spilanthes acmella		Subang nenek (Grandma's earring, Malay)	Flower	To reduce heated feeling resulted from aching tooth
Tagetes spp.		Bunga tahi ayam (Malay)	Fresh flowers	To clear giddiness
Melothria spp.	**Cucurbitaceae**	Mentimun tikus (Malay)	Unripe fruit	To stop bed-wetting in adults
Cibotium barometz	**Cyatheaceae**	Bulu pusi	Hairs at frond base	To heal wounds
Scleria sumatrensis	**Cyperaceae**	Sendayan	Ripe fruits	To treat diabetes

Scientific Name	Family Name	Vernacular Name(s)	Part(s) Used	Use(s)
Eriocaulon sexangulare	**Eriocaulaceae**	Rumput kepala lalat	Whole plant	To prevent unwanted pregnancy (for family planning)
Phyllanthus niruri	**Euphorbiaceae**	Rami buah	Whole plant	To treat diarrhoea
Phyllanthus rotundifolia		Siong beruang	Root	To revitalise body
Paraboea elegans	**Gesneriaceae**	Capa batu laut	Whole plant	To alleviate pain during menstruation
Lophatherum gracile	**Gramineae**	Rumput buluh	Root tuber	To increase semen production in males
Garcinia spp.	**Guttiferae**	Lulai (bat mai keling)	Root	To heal wounds
Illicium tenuifolium	**Illiciaceae**	Kacip Fatimah pokok	Root	To reduce discharge due to leucorrhoea
Ocimum sanctum	**Labiatae**	Ruku, keruku	Leaves	To treat coughs in children
Cinnamomum spp.	**Lauraceae**	Medang celangor, Medang kesing	Leaves and stem	To use as a tonic for the body To prevent cholera
Actinodaphne spp.		Medang pasir	Roots	To be taken by women after given birth
Desmodium ovalifolium	**Leguminosae**	Patah kemudi	Whole plant	To heal broken bones/bone fracture
Abrus precatorius		Saga betina, Saga kendri, Akar saga	Leaves	To treat hypertension, coughs and diabetes
Cassia hirsuta		Gelenggang kecil	Root and leaves	To shorten the menstruation period
Mucuna biplicata		Akar jueh	Stem	To treat stomach-ache
Caesalpinia sappan		Sepang	Heartwood	To treat stomach ulcer or stomach cancer
Dracaena graminifolia	**Liliaceae**	Hancing Fatimah	Root	To reduce discharge in leucorrhoea
Dracaena spp.		Riang, Jenjuang	Root	To revitalise, and to treat kidney pains
Peliosanthes viridis		Ubat merian batu	Root	To be taken by women after given birth
Strychnos intai	**Longaniaceae**	Gajah tarik	Root	To treat kidney pain
Cyclea laxiflora	**Menispermaceae**	Kong kermo	Root tuber	To treat headache
Fibraurea chloroleuca		Mengkunyit	Stem and root	To treat syphilitic ulceration and wounds
Ficus spp.	**Moraceae**	Akar mera	Stem	To treat stomach-ache and diarrhoea in children
Ardisia colorata	**Myrsinaceae**	Mata itik	Fruit	To treat boils
Melaleuca cajuputi	**Myrtaceae**	Gelam paya	Stem bark	To treat retreated womb
Leptospermum flavescens		Senna makki	Leaves	To treat hypertension, diabetes, kidney pains and constipation

Scientific Name	Family Name	Vernacular Name(s)	Part(s) Used	Use(s)
Oxalis barrelieri	**Oxalidaceae**	Belimbing tanah	Fruit	To treat hypertension
Piper spp.	**Piperaceae**	Lada burung	Stem and root	To reduce toothache
Piper muricatum		Kaduk gajah	Stem and root	To reduce stiffness or numbness in the limbs
Plantagor major	**Plantaginaceae**	Lobak angin	Whole plant	To reduce flatulence
Polygala paniculata	**Polygalaceae**	Rempah kampung	Air rebusan diminum.	To treat diarrhoea
Punica granatum	**Punicaceae**	Delima	Leaves	To treat skin diseases
Randia anisophylla	**Rubiaceae**	Ratna	Young fruits	To treat yellow fever
Psychotria stipulacea		Salang	Leaves	To treat septic boils
Lasianthus ridleyi	**Rubiaceae**	Bertak	Whole plant	To deworm
Luvunga scandens	**Rutaceae**	Tusoh ayam	Root	To treat low blood pressure
Zanthoxylum myriancantum		Hantu duri	Leaves	
Lygodium microphyllum	**Schizaeaceae**	Ribu-ribu padi	Leaves	To treat skin diseases
Selaginella spp.	**Selaginellaceae**	Pengantung	Whole plant	To revitalise body
Brucea amarissima	**Simaroubaceae**	Lada pahit, Tongkat gantang, Capa	Root	To revitalise the body, particularly in women
Eletteriopsis spp.	**Zingiberaceae**	Tepus sehelai setahun	Rhizome	To prevent pregnancy (family planning)
Globba pendula		Halia burung	Rhizome	To quicken the absorption of oil through skin

Present status of medicinal plants collecting and conservation in Peninsular Malaysia

There are various repositories for medicinal plants in the country. Two are highlighted here for their consistent efforts in conserving medicinal plants: FRIM Ethnobotanic Garden and Rimba Ilmu in University Malaya are two such repositories where medicinal plants are constantly added to the existing living collections. Other conservation efforts are in the form of small herbal gardens in colleges, secondary schools and private companies.

FRIM has a long-term plan to collect medicinal plants annually for conservation and research. Wherever possible, the same species from different localities will be collected, particularly for species with commercial potential.

In collaboration with other government agencies, yearly expeditions are conducted to collect plant materials, with medicinal plants being one of the larger groups for such collection. The agencies participating in these expeditions include the Forestry Department, National University of Malaysia (UKM), University Malaya (UM), FRIM and NGOs such as the Malaysian Nature Society (MNS).

Summary of research on medicinal plants conducted and important results

Medicinal plants research in Malaysia has a history of close to 50 years but the more intensive research has only been conducted in the last 20 years with focus on natural products. Institutions of higher learning, government research institutes and other government agencies and, in some cases, private companies manufacturing herbal products are involved in various aspects of medicinal plants research.

Early researches on medicinal plants mainly focused on bioprospecting studies and most were conducted randomly. Later, researchers from the University of Malaya began phytochemical screening, followed by researchers in other universities and research institutes working on taxonomic, ethnobotanical and bioassay-guided studies. Recent years have seen the elevated importance of medicinal plants research in Malaysia.

Priority medicinal plants research identified (ongoing and proposed)

Recognising the importance of research on medicinal plants and other bioresources, the Ministry of Science, Technology and the Environment (MOSTE) has identified the strategy and research priority areas through the National Cooperative Programme for Natural Product Research and Development (8th Malaysia Plan). Two programmes have been identified: (1) Discovery Programme (long-term); and (2) Development Programme (short to medium term).

Priority areas for the Discovery Programme:

- Enrichment of scientific data on Malaysian medicinal plants
- Efficacy studies in selected disease targets (cardiovascular, anti-cancer, anti-infective, immunomodulatory, CNS)
- Synthesis
- Pharmacokinetics
- Pharmacodynamics
- Clinical studies

Priority areas for the Development Programme:

- Standardization of herbal materials highly demanded by local industry
- Sustainable production of quality raw materials (including usage of biotechnology tools)
- Development of value-added products
- Efficient processing technologies for medicinal plants

Priority species for the Development Programme:

- *Morinda citrifolia* (mengkudu)
- *Andrographis paniculata* (hempedu bumi)
- *Orthosiphon aristatus/O. stameneus* (misai kucing)
- *Labisia pumila* (kacip Fatimah)
- *Cassia senna* (senna makki)
- *Ocimum basilicum/O. sanctum* (selasih)
- Zingiberaceae

Institutions/organizations working on medicinal plants in Peninsular Malaysia

Government research institutes:

- Institute of Medical Research (IMR)
- Forest Research Institute Malaysia (FRIM)
- Malaysian Agricultural Research and Development Institute (MARDI)

Government departments:

- Ministry of Health
- Ministry of Primary Industries
- Forestry Department
- Ministry of Science, Environment & Technology
- National Biotechnology Directorate
- Malaysian Industry- Government Group for High Technology (MIGHT)

Universities:

- University Science Malaysia (USM)
- National University of Malaysia (UKM)
- University Malaya (UM)
- University Putra Malaysia (UPM)

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Inventory, documentation and status of medicinal plants research in Mongolia

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Introduction

Mongolia occupies an ecological transition zone in Central Asia where the Siberian Taiga forest, Central Asian Steppe, the Altai Mountains and the Gobi Desert meet together. These different ecosystems provide specific habitat for a variety of plant species, some of which are globally endangered. Although Mongolia has a low population density, its renewable natural resources are limited and the climate is harsh with great extremes of temperature, low precipitation and severe storm. Ecosystems are fragile and extremely vulnerable to many forms of economic exploitation. Thus, unsustainable use of crop and wild plant genetic resources and overgrazing occur in some parts of the country. There are signs that the pressure on the environment has exceeded permissible limits causing the degradation of plant germplasm diversity.

Mongolians have ancient practices utilizing various medicinal plant species for their every day life to prevent and cure various human and animal diseases. Ancient famous travelers Marko Polo, Plano Karpini and a famous writer from Iran, Rashid Ad Din, collected a lot of evidences about the political and economic situation of Mongolia as well as how Mongolians cure different diseases and wounds from the war. Medicinal plants are also widely utilized for improving animal productivity and fertility. Medicinal plants contain biologically active components that allow full recovery from various ailments.

Ancient literatures indicated that Mongolians used more than 200 traditional medicines derived from plants, animal organs and minerals. At present, more than 3000 plant species known for Eastern traditional medicine is under the focus of modern medical practices.

According to the statistics, about 72% of Mongolian traditional medicines were developed from medicinal plants and plant parts, and other 28% are from animal and mineral sources. This figure shows an importance of medicinal plant species in Mongolian traditional medical practices. In Mongolian traditional medicines, diseases were divided into 16 categories and each category used certain number of different medicinal plants.

A lot of literatures were written about Mongolian traditional medicine and medicinal plants but very few of them remained in our days. Most of the ancient literatures were published in Tibetan and traditional Mongolian script. The procedures of preparation for the different traditional medicines were developed mostly by the famous monks at that time.

Between the 18th and 19th century, Russian researcher-botanists NS Turchaninov, A Bunge, EN Klements and famous traveler NM Prjevalskii started to study Mongolian flora, with some of their collected herbarium materials still existing up to the present.

The systematic study on exploration including medicinal plant resources started since 1940s when the government of Mongolia invited Russian scientists led by Dr IATsatsenkin, AAUnatov and BIGrubov. AAUnatov focused on rare and useful plant species giving emphasis on plant species of medicinal value. The first time he identified most of the plant species with medicinal value in Mongolia was in his

book "Research on Mongolian flora in 25 years".

Since then a lot of research activities on Mongolian flora were successfully carried out identifying existing plant diversity, natural resources, population structure of useful and medicinal plants, their distribution and chemical composition as well as medicinal value, etc. Among them, the most productive event was a Joint Russian-Mongolian Complex Biological Expedition conducted since 1970. Over 30 years, large-scale integrated study on ecosystem has been performed involving highly qualified researchers of Russia and Mongolia. This expedition developed the first synthetic map of Mongolian flora and ecosystem which became the basis of further set of measures to establish the protected areas of Mongolia.

As a result of research activity on Mongolian useful plant species, a significant amount of information has been gathered. However, there is still an urgent need to document the medicinal plant species location, existing population, places of conservation and their known traditional uses. This documentation would be necessary to identify priority medicinal plant species and setting up priority activities and policies on conservation, characterization and data sharing through national, regional and international collaboration.

This report presents some of the efforts and perspectives of exploration and conservation of medicinal plant species in Mongolia.

The status of Mongolian flora

It is estimated that about 3000 species of vascular plants exist in Mongolia. Since 1950s, the country's researchers were actively involved in the research on determining the structure and diversity of Mongolian flora. The research topic mainly covered the systematics, development dynamics of plant flora, biological effects of useful plants, as well as cultivation practices of useful plants. Based on the floristic study entitled "The Key to the Vascular Plants of Mongolia" developed in 1955 by VI Grubov, Mongolian vascular plant flora consisted of 1876 species belonging to 552 genera and 97 families. Later studies (as of 1996) conducted by other Mongolian researchers put the latest figures at 2823 species, 662 genera and 128 families of vascular plants.

In addition, the list included 150 vitamin-rich species, 200 with essential oils, 250 tanning matter, more than 200 with dye, 231 with flavanoid, 280 with alkaloid, 65 with cumarin and 68 species for sand movement control.

There are still largely unexplored areas existing in the country, such as Khentii, Khubsugul and Altai Mountain, immediate areas of Onon, Ulz River and the Gobi Desert areas of Zuungar and Borzon. Therefore, the number of vascular plant species could increase to more than 3000 species.

The largest known families within the vascular plant species include *Clynelymus Newski* (85 species), *Oxytropis* DC. (82 species), *Astragalus* L (80 species), *Artemisia* L(78 species), *Saussurea* DC. (44 species), *Potentilla* L (43 species), *Salix* L (41 species), *Pedicularis* L (33 species) and *Allium* L (32 species). Among the plant species with orthodox seeds, 348 are woody plants and 2095 are grasses of which 1765 are perennial and 330 are annual and biannual species (Figure 1).

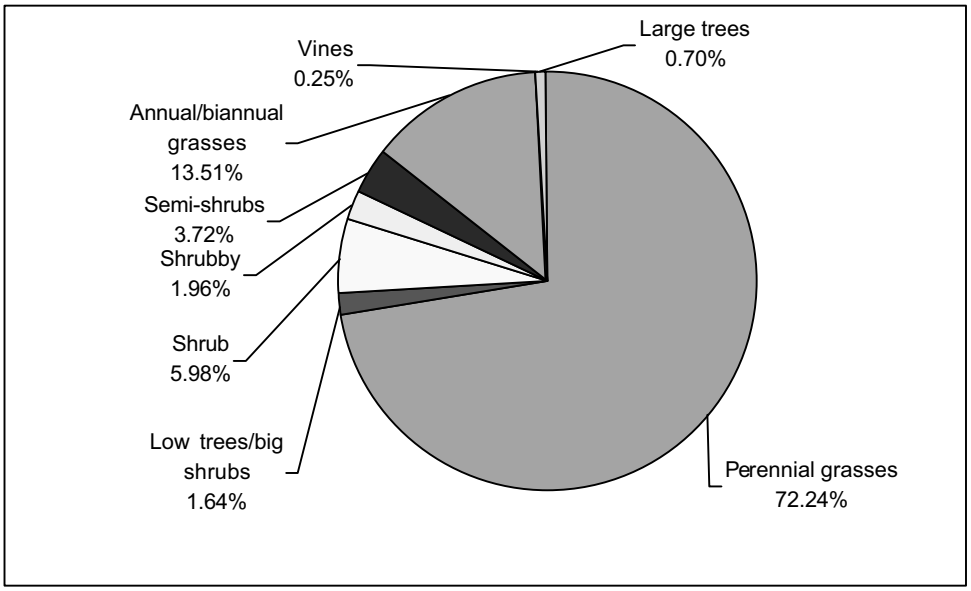

Figure 1. Distribution of different plant life forms in Mongolia

Status of medicinal plant genetic resources in Mongolia

More than 2200 species of economically important species exist in the country, including 845 species of medicinal plants and 238 species containing flavonoids, 280 alkaloid-bearing plants, over 60 coumarin-bearing plants, 232 saponin-bearing plants, 250 species of tanning plants, 200 essential oil plants, 150 high vitamin content plants, 200 dye-stuff plants, 200 food security plants, 200 industry-use plants, more than 480 ornamental plants and 70 soil-protecting plants and sand strengthening plant (Figure 2).

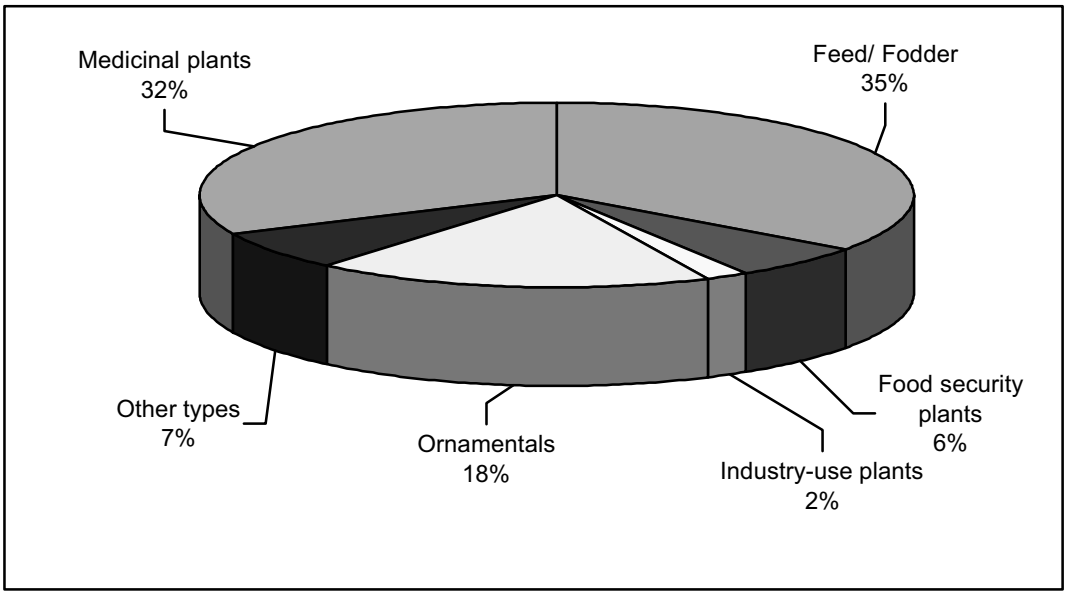

Figure 2. Distribution of economically important plant species in Mongolia

About 32% of the total vascular plant species found in Mongolia are registered as medicinal plants. More than 200 plant species, out of the 845 species identified, could be used for modern western medicine. At present, only about 100 medicinal plant

species are being used for medical treatment, with 92 of them in high demand and used regularly (Attachment 1.)

Classification of useful plant species

Among the medicinal plant species in the country, *Glycyrhiza uralensis* Fisch., *Paeonia anomala* L., *Paeonia lactiflora, Rosa acicularis* Lindl., *Sophora alopecuroides* L., *Thermopsis lancelota* L. and *Thymus gobicum* Tschern currently have high market value. These species have different medicinal effects and resource bases. Among them, *Glycyrhiza uralensis* Fisch., or Mongolian licorice, has been studied much more than any other medicinal plant as it has a comparatively wide distribution and production resources. Since 1974, Mongolian scientists determined 158 distribution sites of *Glycyrhiza uralensis* Fisch and identified eight sites with rich production resources. Mongolia has the potential to produce from 500 to 2000 tonnes of dry licorice roots annually. In fact, from 1970 to 1985, Mongolia has been exporting between 10-100 tonnes of the produce to China and Korea. From 1986 onwards, approximately 50 to 150 tonnes of root has been exported to Japan, Korea and China. The root of licorice contains substances like glycyrrhizin, flavonoid, saponin, vitamins, kamid, pectin, various minerals and tanning matter. These substances are known to prolong life expectancy and hasten the recovery from diseases of the liver, bile, stomach, pulmonary, heart, kidney and blood pressure. From licorice root extracts injection, glycyrrhizin can be obtained, which commands a very high price in the global market. On the other hand, the leaf, stalk and flower of licorice could be used as fodder for livestock. A kilogram of licorice leaves contains 0.52 feeding unit - a valuable source of protein. Also, it plays an important part in promoting cattle breeding, offspring twinning, and production of milk and wool products.

Among the medicinal plants, the following species of licorice are in great demand but are also in grave danger of being lost in the wild: *Astragalus membranaceus* (Fisch.) Bge., *Astragalus mongolicus* Bge., *Saposhnikovia divaricata* (Tursz.) Schischk. *Aconicum kusheroffii* Reich., *Acorus calamus* L., *Saussurea involucrata* (kar.et Kir.) Sch.Bip., *Dactylorihisa.*, *Orchis militaris* L., *Sophora flavescens* Soland., *Lilium pimilum* Delibe., *Cistanche deserticola.*, *Artemisia caespitosa* Ldb., *Zygophyllum Potaninii* Maxim., *Adonis mongolica* Sim., *Paeonia lactiplora* Pall., *Rhodiola quadrifida* (Pall.) Fisch.et Mey., *Cynomoriun soongaricum* Rupr., *Gentaina algida* Pall. These plants are widely used by local people for food, traditional medicine and livestock fodder and are usually harvested without any official permission and control.

There are a number of medicinal plant species in Mongolia that are becoming very rare and in imminent danger of genetic erosion due to environmental degradation, drastic changes in climatic conditions and intensified human activity, especially the uncontrolled and illegal mass harvesting of wild medicinal plants.

Recent studies indicated that about 45% of the total pasture area in the country was seriously affected by drought resulting in 5-10 times reduction in productivity. From 1970 to 2000, the number of pasture plant species existing in the semi desert slopes was halved while desertification expanded by 20 000 to 30 000 ha. Harvesting of medicinal plants by cash-needy collector is increasingly intensified since the value of these materials are recognized as cheaper, and more accessible for domestic and foreign markets. In 2000, 2000 tonnes of medicinal plant materials belonging to 100 species were harvested illegally and sold outside of the country. On the other hand, during the last 10-15 years, activities on conservation and rehabilitation of medicinal plant genetic resources weakened. Thus, resources of wild medicinal plant species are being threatened, resulting in serious erosion of genetic diversity and ecological instability.

In the second edition of the Mongolian Red Book released in 1997, the number of

registered threatened plant species was placed at 128, up from 86 species registered as endangered in 1987. Threatened are 75 medicinal plant species (with 20 species facing serious threat of loss), 11 natural food (6 seriously threatened), 16 industrial (4 seriously threatened), 55 ornamental (10 seriously threatened) and 15 species for sand movement control (5 seriously threatened).

To address this problem, the Mongolian government issued Protocol No. 105 on 29 May 2002, launching the national programme on the "Conservation and sustainable use of rare plant species of Mongolia", with the aim of rehabilitating the country's dwindling wild medicinal plants genetic resources and promoting the sustainable extraction and use of rare plant species.

Summary of medicinal plants research undertaken in Mongolia

Exploration and collection activities of medicinal plants in Mongolia

Exploration and introduction activities of medicinal plant genetic resources were always conducted within the framework of studies of rare and useful plant genetic resources in Mongolia, which began in the 1920s.

Several Mongolian–Russian joint expeditions played important roles in the study of rare and useful plant genetic resources, including plants of medicinal value, in Mongolia. Some of the most significant expeditions conducted include:

- The Russian Geographical Association Expedition (1923-1935);
- The Russian-Mongolian Agricultural Expedition (1940-1950);
- Expedition on assessing virgin land resources (1960-1961);
- Expedition on hydrology assessment (1959-1962);
- Russian Expedition on Forest Management (1958, 1970);
- Mongolian-German biological joint expedition (1963-1965); and
- The Joint Russian-Mongolian Complex Biological Expedition (1970-1999), considered to be the biggest undertaken ever.

The study of useful medicinal plants in Mongolian flora is generally divided into two phases. The first phase was undertaken from 1947 to 1952, which mainly focused on the basic floristic study of useful medicinal plant species throughout the country. The second phase, conducted from 1970 to 1985, included more sophisticated studies on systematics, identifying species structure and geographical distribution of different useful and medicinal plants as well as determining chemical composition and biological effects of major medicinal plants.

Results of detachment activities identified and quantified Mongolian flora as follows: flavonoids-bearing plants (238 species); alkaloid- bearing plants (280 species); coumarine-bearing plants (more than 60 species); saponin-bearing plants (232 species); tanning plants (250 species); essential oil-producing plants (200 species); high vitamin content plants (150 species); dye-stuff plants (200 species); medicinal plants (845 species), food plants (200 species); industry-use plants (200 species); ornamental plants (more than 480 species); and soil protecting/ sand strengthening plants (70 species).

Flavonoids have been found for the first time in 25 species of Mongolian flora, such as *Brachanthemum mongolicum, Ajania trifida, Potaninia mongolica, Cariopteris mongolica* and *Ammoppiptanthus mongolicus.* The composition of flavonoids has been studied in 80 species while the composition of coumarins has been analyzed in more than 10 species. These include *Angelica dahurica, A.decurrens* and *Haplophyllium dahuricum*. The quantitative content of arbiutin in the leaves of *Bergania crassifolia* and *Vaccinum vitis-idea* has also been studied.

High contents of essential oil have been found in some species of *Artemisia,*

Cnidium multicale (Turcz) Ledeb., *Ferula bungeana* Kitag., *Sphallerocarpus gracilis* (Bess.ex Trev) K.Pol., *Hissopus cuspidatus* Boiss., and *Schizonepeta annua* (Pall) Schischk. Tanning substances with good tanning quality have been found in the bark of *Larix sibirica*, of some species of *Salix,* and in the rhizome of *Bergenia crassifolia*. Some species with high dye-stuff quality were found in the families of *Fabaceae Lindl, Ranunculaceae* Juss and *Plumbaginaceae* Juss.

From 1970 to 1999, the distribution of over 200 useful plant species were determined and the production resources of over 30 useful and medicinal plants as well as cultivation technologies of 10 species including medicinal plants like *Adonis mongolica* Sim, *Glysyrrhiza uralensis* Fisgz, *Hippophae rhamnoides* L. and *Thlaspi arvense* L. were developed. During the same period, the distribution of medicinal plant genetic resources in the country, as well as productivity, biomorphology and issues of introduction and cultivation practices, were studied. Future research on medicinal and other useful natural plants would focus more on determining ways to introduce and cultivate medicinal and other useful plants as well as on the establishment of ecological and economical criteria for new introductions.

Conservation and introduction activities of medicinal plant genetic resources in Mongolia

Medicinal plant germplasm conservation and the study on introduction of new species, populations and cultivars of medicinal plants in Mongolian condition as well as research on cultivation practices of wild medicinal plant species were mainly carried out by the Institute of Botany of Mongolian Academy of Science and partly by the Plant Science and Agricultural Research Training Institute (PSARTI).

Since 1972, 29 cultivars and 539 species belonging to 116 families of different useful plants, both from local and foreign sources, have been studied in the Institute of Botany, from which a total of 443 species have been identified as promising. At the moment, 9250 plants consisting of various grasses, medicinal, food, fodder and other useful plants are planted in 126 plots at the State Botanical garden and are being used for introduction studies.

Under the National Plant Genetic Resources Project, PSARTI was able to organize a small collection of traditional medicinal plants consisting of more than 192 accessions belonging to 113 species and 52 genera.

At present, the only possible way of effective conservation of wild medicinal plant species is in the protected areas of Mongolia. Only few major medicinal plant species like *Glysyrrhiza uralensis* Fisgz, *Allium* species, *Rhosa asicularis* Lindl, *Rhodiola quadrifida* Pall, *Paeonia lactiflora* Pall, *Papaver nudcaule* L, *Lonicera altaica* Pall, etc are conserved in some designated institutions. A network of protected areas should be managed according to the sound principles of ecology and conservation biology. Apart from this, legal policies must be drafted and enforced to protect species and habitats outside the protected areas. Mongolia has taken substantial steps towards achieving these requirements. At present, there are a total of 38 protected areas all over the country, covering some 17.4 million hectares, or about 11.1% of Mongolia's total land area. It has also passed several laws on plant protection and conservation. Such legislation has led to the establishment of 12 strictly prohibited areas, 7 national conservation parks, 13 nature reserves and 6 natural and historical monuments (Table 1).

Table 1. Protected areas in Mongolia as mandated by legislation

Classification and Name	Area ('000 ha)	Year Established
I. Strictly prohibited areas		
Great Gobi	5311.7	1975
Khokh Serkh	65.9	1977
Bogd Khan Uul	41.6	1974
Khasagt Khairkhan	27.4	1965
Khan Khentii	1227.1	1992
Nomrog	311.2	1992
Dornod	570.4	1992
Mongol Daguur	103	1992
Otgon tenger	95.5	1992
Uvs Nuur	712.5	1993
Goviin Baga	1839.1	1996
Khoridol- sardig	188.6	1997
Subtotal	**10494.3**	
II. National conservation parks		
Khovsgol	838.1	1992
Khorgo Terkhiin Tsagaan nuur	77.3	1965
Gobi Gurvan Saikhan	2171.7	1993
Gorkhi – Terelj	293.2	1993
Altai Tavan Bogd	636.2	1996
Khangai Nuruu	888.5	1996
Khar - Us Nuur	850.3	1997
Subtotal	**5755.1**	
III. Nature Reserves		
Nagalkhaan Uul	3.1	1957
Batkhaan Uul	21.8	1957
Lkhachinvandad Uul	58.8	1965
Bulgan Gol	7.6	1965
Khustain Nuruu	49.9	1993
Ugtam Uul	46.2	1993
Sharga mankhan	390.0	1993
Zagiin Us	273.6	1996
Alag Khairkhan	36.4	1996
Burkhan Buudai	52.1	1996
Ergeliin Zoo	60.9	1996
Ikh Nart	43.7	1996
Khognokhaan Uul	47.0	1997
Subtotal	**1091.3**	
IV. Natural and historical monuments		
Bulgan Uul	1.8	1965
Uran togoo tulga Uul	5.8	1965
Eej Khairkhan Uul	22.5	1992
Khuisiin Naiman Nuur	11.5	1992
Ganga Nuur	32.9	1993
Suikhent Uul	4.8	1996
Subtotal	**79.3**	
TOTAL OF ALL PROTECTED AREAS	**17 420.0**	

Legislation concerning medicinal plants conservation in Mongolia

Measures have been taken under the "Law on Natural Plants"; the "Mongolian Law on Forests"; National Biodiversity Action Plan; National Action Plan for Specially Protected Areas; Governmental Guidelines on Ecology and National Security and other relevant documents to conserve, restore and use in a sustainable manner the plant species of Mongolia.

More than 20 projects are currently being implemented in Mongolia dealing with plant structure, life forms, their distribution, abundance, breeding, anatomy, physiology, embryology, paleontology, ecology and biology. The use of about 133 threatened plant species were legally prohibited, 128 species registered in the Red Book and about 40% of the total distribution area of threatened and rare plant species were included in the special protected areas.

Published literature and organizations working on medicinal plants in Mongolia

The findings of 30 years of studies on medicinal plants are contained in about 4000 scientific publications, including 40 volumes of the series on "Biological Resources and Natural Conditions of Mongolia". The published materials of previous expeditions served as basic references for 30 post-doctorate and over 60 PhD theses. On the basis of the investigations on rare and useful plants including medicinal plants, PhD theses on the following topics have been completed:

- The biologo-ecological peculiarities of sexual forests and their significance;
- The biologo-ecological peculiarities of genus **Thermopsis**;
- The biology, ecology and morphology of **Glycyrrhiza uralensis** Fisch and its introduction, acclimatization techniques; and
- The dynamics of accumulation of chemical substances of plants of dry steppes and desert of Mongolia.

At present, over 60 ancient literatures developed by Mongolian monks and doctors (maaramba) about the principles, secrets of Mongolian traditional medicine and medicinal plants used in traditional medicine are kept in the State Central Library. Most of these literatures mainly described the use of medicinal plants for making traditional medicines.

There are about 19 major books published since the 1960s on rare and useful plants, including medicinal ones (Attachment 2). There are also quite a number of research materials on medicinal plants published in different periodicals, research journals and conference proceedings. A number of related unpublished materials have also been produced through the years.

The very first acknowledged book on useful plants in Mongolian flora was written by AA Unatov in 1949-1950 entitled "Mongolian Useful Plants". Although this book was not published and widely disseminated, it was nevertheless stored in the State Library and is still considered as the foremost reference material for medicinal plants researchers.

There are also several research institutions, universities, government agencies, private companies involved in the research, protection, conservation and commercial utilization of major medicinal plants species in the country. However, at the moment, there is no designated research organization devoted solely on medicinal plants research.

The departments of chemistry and biology of major universities such as the Mongolian State University, Mongolian State University of Agriculture, University of Medical Sciences, University of Science and Technology and Pedagogical University, and Institute of Veterinary Science are mainly involved in the theoretical and fundamental studies of medicinal plants. Their research topics mainly focused on identifying biological active substances and medicinal value.

Research organizations like PSARTI and the Institute of Botany focus on collecting and conserving medicinal plant species. Researchers are oriented towards systematic, diversity study; distribution and resources in nature; and on elaborating ways for introduction and cultivation of medicinal and other useful plants.

The Ministry of Nature and Environment implements government's policy on natural protection through two agencies: the Department of Environmental Control and the Department of Nature, Forest and Water Resources.

Activities to be undertaken to inventory and document medicinal plants in Mongolia

Activities and approaches

1. The Mongolian State University of Agriculture will implement the project, through collaboration with the Plant Science and Agricultural Research Training Institute (PSARTI), the Institute of Botany and other research institutions, government and private agencies
2. Information to be generated would be categorized and three groups would be formed according to the following:
   - Exploration and resource identification of medicinal plants
   - Collecting and conservation of medicinal plant germplasm
   - Research on the medicinal value of medicinal plants of Mongolia
   - Other areas of research on medicinal plants
3. A questionnaire would be developed and distributed to external institutions (Table 2). Information sources to be targeted would include research institutions, universities, government and private agencies working on medicinal plants
4. Project groups would develop an integrated report according to the prescribed format and would contain a bibliographical list of related literature, information on documentation of conserved medicinal plants and summary of research activities undertaken and present status.

Table 2. Questionnaire content

Information to be generated	Target Organizations
1. List of published and unpublished literature on medicinal plants 2. Information on conserved medicinal plants in the country, indicating the following: a) Common name and scientific name b) Location of genebank or collection c) Number of accessions per species d) Number of plants conserved per species e) Identified medicinal value or uses of each medicinal plant genus/species f) Photograph and general morphological description of each genus/species 3. Summary of research activities on medicinal plants, results and research gaps 4. Priority listing of medicinal plants and future priority research areas on medicinal plants in Mongolia	1. Plant Science and Agricultural Research Training Institute, Darkhan 2. Institute of Botany, Ulaanbaatar 3. University of Medical Sciences 4. Veterinary Institute 5. Mongolian State University 6. University of Science and Technology 7. Ministry of Nature and Environment 8. Other research institutions, government and private agencies

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Attachment 1

Medicinal plant species regularly used in Mongolia

1. *Achillea asiatica* Serg.
2. *Aconitum kushezoffii*
3. *Acorus calamus* L.
4. *Adonis mongolica* Sim.
5. *Allium altaicum* Pall
6. *Allium victorialis* L. *A.microdiction* Prokh
7. *Aquilegia sibirica* Lam.
8. *Artemisia caespitosa* Ldb.
9. *Artemisia macrocephala* Jacq.
10. *Artemisia sieversiaha* Willd.
11. *Astragalus membranaceus* Fisch Bge.
12. *Astragalus mongolicus* Bge.
13. *Berberis sibirica* Pall.
14. *Bergenia crassifolia* L Fritsch
15. *Bupleurum scorzonerifolium* Willd .
16. *Cacalia hastata* L.
17. *Carum carvi* L.
18. *Cistanche deserticola* y Ma.
19. *Cynomorum soongaricum* Rupr.
20. *Dactylorhiza salina* Turcz.ex Lindle Soo
21. *Dianthus superbus* L.
22. *Dracocephalum foetidum* Bge.
23. *Dracocephalum moldavicum* L.
24. *Ephådra sinica stapt*
25. *Erysimum flavum* Georgi Bobrov.
26. *Filipendula ulmaria* (L) Maxim.
27. *Fragaria orientalis* Losinsk.
28. *Gentiana algida* Pall.
29. *Gentiana barbata* Freel.
30. *Ceranium pratense* L.
31. *Glycyrrhiza uralensis* Fisch.
32. *Halenia corniculata* L Comaz
33. *Hemerocalis minor* Mill.
34. *Hippophae rhamnoides* L.
35. *Inonotus obliquus* Pers Pilat.
36. *Juniperus sabina* L
37. *Juniperus pseudosabina* Fisch et Mey
38. *Ledum palustre* L.
39. *Leontopodium leotopodioides* Willd. Beauvd.
40. *Lilium pumilum* DC.
41. *Lonicera altaica* Pall.
42. *Malus baccata* L Borkh.
43. *Malva mohileviensis* Down.
44. *Nitraria Roborowskii* Kom.
45. *Nitraria sibirica* Pall.
46. *Odontites rubra* Baumg Opiz.
47. *Orchis militaris* L.
48. *Oxytropis myriophylla* /Pall/ DC.
49. *Padus avium* Mill.
50. *Paconia anomala* L.
51. *Panzeria lanata* (L) Bge.
52. *Parnassia palustris* L.
53. *Pentaphylloides fruticosa* (L) O. Schwarz.
54. *Physochlaina physaloides* (L) G.Don.
55. *Plantago depressa* Willd.
56. *Plantago major* L.
57. *Polygonatum odoratum* /Mill/ Druce.
58. *Polygonatum sibiricum* Delaroche
59. *Polygonum viviparum* L.
60. *Potentilla anserina* L.
61. *Pyrola incarnata* /DC /Freyn.
62. *Ribes altissimum* Turcz ex Pojak
63. *Ribes diacantha* Pall
64. *Ribes nigrum* L.
65. *Ribes rubrum* L.
66. *Rheum undulatum* L.
67. *Rhodiola quadrifida* Pall.
68. *Rosa acicularis* Lindl.
69. *Rosa dahurica* Pall.
70. *Salsola collina* Pall.
71. *Sambucus manschurica* Kitag
72. *Sanguisorcba officinalis* L.
73. *Saposchnikovia divaricata* /Turcz/ Schischk.
74. *Saussurea involucrata*/ Kar. et kir / Sch .Bip
75. *Saxifraga hirculus* L.

76. *Scutellaria baicalensis* Georgi.
77. *Sophora alopecuroides* L.
78. *Sophora flavescens* Soland.
79. *Sphaellerocarpus gracilis* /Bess.ex Trev/ K –Pol.
80. *Stellaria dichotoma* L.
81. *Thlaspi arvense* L.
82. *Thermopsis lanceolata* R. Br.
83. *Thymus gobicus* Tschern.
84. *Tribulus terrestris* L.
85. *Urtica cannabina* L.
86. *Vaccinium uliginosum* L.
87. *Vaccinium vites-idaea* L.
88. *Valeriana alternifolia* Ldb.
89. *Vincetoxicum sibiricum* (L) Decne.
90. *Xanthium strumarium* L.
91. *Zygophyllum potaninii* Maxim.
92. *Zygophyllum pterocarpum* Bge.

Attachment 2

Major publications on medicinal plant germplasm produced in Mongolia

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Inventory, documentation and status of medicinal plants research in Nepal

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Introduction

Nepal is a country rich in biodiversity. The country's estimated 7000 vascular plants include more than 700 plants of medicinal value, with several of these having economic, cultural, aesthetic and religious significance. The age-old practice of using these plant resources in traditional medicines is still prevalent in the rural areas of the country. Medicinal and aromatic plants also serve as a source of livelihood to the majority of the rural people in the countryside. The collection, transportation and general trade in medicinal plants are important sources of revenue and foreign exchange to the government, as well as provide off-farm employment for people in remote rural areas. But the continuous over exploitation of these resources, without consideration for their optimum regeneration and productivity, has led to the deterioration of the condition of these important natural resources, especially in the wild. For this reason, conservation and rational utilization of medicinal plants are considered as key issues in the national forestry sector, with significant amounts of financial resources earmarked for natural resource management. However, unless the socioeconomic condition of poor people who are dependent on these resources is improved, the genetic erosion of these precious materials would continue due to over extraction and destruction of habitats. Historically, the exploitation of plant genetic resources has never ensured benefit sharing among the people dependent on them. Hence, it is essential to introduce a sustainable use concept as per the objectives of the Convention on Biological Diversity (CBD), which has three objectives: (a) the conservation of biological diversity; (b) sustainable use of its components; and (c) fair and equitable sharing of the benefit arising out of the utilization of the genetic resources.

National commitments on medicinal plants

The important role of medicinal and aromatic plants in improving the plight of the rural poor is recognized by His Majesty's Government, which is reflected in the various plans and strategies developed through the years. Economic development plans started in the mid-1950s, focusing on developing policies for conservation and utilization of forests and its components. From the mid-1960s, policies emphasized the need for survey, exploration, production and/or commercial farming and processing of herbs.

The Forestry Sector Master Plan (1989) endorsed the development and management of medicinal plants as one of its six primary programmes. The Eighth Five-Year Plan (1992) focused on two areas with regards to medicinal plants and Non-Timber Forest Products (NTFPs), specifically income and employment generation for rural marginalized people; and ecosystem and biodiversity conservation.

The 9th Five-Year Plan (1998-2002) recognized the role of medicinal plants in alleviating poverty of the rural people. The Tenth Five-Year Plan (2003-2008) greatly emphasizes the development of medicinal plants as a platform for poverty reduction. Rare and high-priced medicinal herbs are top priorities for domestication, processing and marketing. The plan also emphasizes the amendment of existing rules, laws, and by-laws that are creating uncertainties and obstacles for the development of this

sector. The National Conservation Strategy (NCS) of 1988 also emphasized the importance of conservation and management of medicinal plants, not only for alleviating poverty of the rural people but also to help safeguard the economic health of the country. The 1993 Nepal Environment Policy and Action Plan (NEPAP) recommended reorienting forestry research to include underutilized or lesser-known forest species for specific user groups, industries and private individuals. The Forest Act of 1993 and the Forest Rules of 1995 were enacted to ensure the development, conservation and proper utilization of forest resources and contain provisions for the protection of 18 species of plants (Attachment 1). The Nepal Biodiversity Strategy of 2002, published recently by His Majesty's Government and the Ministry of Forests and Soil Conservation, has also recognized NTFPs, which includes medicinal plants, as "national treasures". The main components of the NTFP programme include:

1. Immediate measures to solve problem regarding collecting, marketing and related concern;
2. Cultivation of medicinal and aromatic plants; and
3. Development of industries based on medicinal and aromatic plants and other NTFPs.

The major forums held in connection with developing the country's medicinal plants and NTFPs generally recommended that concerned government agencies and stakeholders collaborate to achieve greater impact. To address this, His Majesty's Government formed a 13-member Herb and NTFP Coordination Committee, chaired by the Minister of Forests and Soil Conservation, for inter-sectoral coordination. The committee is comprised of representatives from the National Planning Commission (NPC), related government agencies, the Royal Nepal Academy of Science and Technology (RONAST) and Asia Network for Small-Scale Bioresources (ANSAB). The committee is mandated to:

1. Formulate national policies and relevant laws for sustainable development and proper utilization of herbs and NTFPs;
2. Finalize strategic activities and maintain inter-agency coordination; and
3. Coordinate conservation, research, technology development, market management, training and publicity.

The second meeting of the committee was held on 14 March 2003, during which 30 highly important medicinal plants were identified for priority conservation, domestication and processing.

Research and development of medicinal plants

Since its inception in 1960, the Department of Plant Resources (DPR) under the Ministry of Forests and Soil Conservation has been undertaking activities to promote the conservation and efficient utilization of medicinal plants. DPR has been engaged in surveying and identifying the medicinal plants resources of the country, developing agrotechnologies for medicinal plants, providing basic information on medicinal plants to related industries, developing protocol on tissue culture propagation, conducting phyto-chemical analyses, improving quality control, developing standards, issuing certifications and developing processing technologies for medicinal plants. The department has been able to develop agrotechnology for 11 medicinal and aromatic plants both indigenous and exotic species (Attachment 2). Protocols to propagate 12 important medicinal and aromatic plants (Attachment 3) through tissue culture have been developed. This may prove useful in the mass propagation of seedlings of economically valuable medicinal plants. DPR has also identified the essential oil content of 219 species of aromatic and medicinal plants

belonging to 60 plant families by hydro-distillation.

At present, the DPR is running a separate government-funded "Herbs Promotion Project" for germplasm collecting, conservation, cultivation, technology development, training and information dissemination focusing primarily on self-employment generation (entrepreneurship) to reduce poverty, especially among the country's rural population.

Conservation and sustainable utilization of medicinal plants

Nepal understands the role and importance of all life forms in effective environmental management and the socioeconomic development of the country. Sustainable use of natural resources is instrumental in improving the living standard of the people. Recognizing this, Nepal agreed to be a signatory to various legally binding international instruments such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Climate Change, Desertification and Biological Diversity. The conservation of biological diversity in Nepal is not only a national priority but also a global commitment. However, there is a need for developing a mechanism for sustainable use of biological resources so that the country could be in a position to contribute to global biodiversity protection and be able to attain the goal of sustainable development.

Biodiversity conservation policy has been deeply linked with the forest and agricultural policies. Policy focus on forest management has been redirected towards community participation, where people are considered as guardians, decision makers and ultimate beneficiaries of conservation measures. About 61% of the government-owned forestlands have been identified for potential turnover to local communities, with 20%, or about 0.85 million ha already handed over to some 11 000 communities. An equally large number of forest areas are already being managed by communities, albeit informally, hoping that the government will someday formally recognize their efforts and hand over to them the management of these forest areas.

At the community level, local people are the true resource managers with a vested mandate of maintaining the resources on which they depend. Awareness creation, coupled with training, capacity building and technical inputs, are essential in managing medicinal plant resources for sustainable economic development and biodiversity conservation.

National parks and equivalent reserves (collectively called protected areas) of Nepal cover about 18.3% of the country's total land area and are considered as major conservation sites of wildlife habitats and ecosystems. These 2.7 million ha of conservation areas are also the *in-situ* sites for medicinal plants, which are restricted to harvesting, utilization and other forms of commercial extraction.

DPR, as mentioned, has long been engaged in the study and management of medicinal plants. It has already developed expertise in various fields such as identification, conservation, propagation, cultivation, management, processing and marketing. Recently, a training model to promote medicinal plants is being implemented in the Daman area with the support from the Danish International Development Agency (DANIDA). It is hoped that the training will provide not only the technical know-how for the cultivation of potential medicinal plants but also provide sufficient skills for processing and marketing. The cultivation of medicinal plants in the community-managed forests will help ensure that medicinal plant species would grow and naturally evolve, providing sufficient plant materials for export and industrial purposes. At least for now, this seems to be the only feasible way to ensure the continuous supply of quality plant materials without further endangering their survival.

Sharing benefits from the use of medicinal plants

Before the CBD came into existence in 1992, there was no legal basis for traditional communities and countries to claim rights for sharing benefits from products developed using their resources and traditional knowledge. The CBD has recognized the sovereign right of the state over their biological resources (Article 15(1)) and also advocated to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities and encourage the equitable sharing of benefits arising from the use of their resources (Article 8(j)). The convention also encourages the parties for sharing benefit by formulating legislative, administrative, or policy measures arising from the use of genetic resources and traditional knowledge. In order to meet Nepal's obligation under the provision of the CBD and to protect the country's rights as per the above provision, a draft bill on Access to Genetic Resources and Benefit Sharing has been forwarded to parliament for approval. The draft bill proposes a modality to protect indigenous knowledge and practices of the local community with respect to the utilization and conservation of the biological and genetic resources. It also proposes the establishment of an autonomous body, to be called the National Biodiversity Authority of Nepal (NBAN), to act as facilitator between access seekers and genetic resources and traditional knowledge providers. The draft bill is formulated with the following guiding principles:

1. Nepal has the sovereign right over her *in-situ* and *ex-situ* biological resources;
2. Ownership rights over genetic resources is based on the location of such resources, whether they are on government-owned land, in local communities or in private landholdings;
3. Formation of community register to protect the rights of the local communities, indigenous knowledge and practices associated with the biological and genetic resources from being patented, subjected to the Intellectual Property Rights or other forms of monopoly rights; and
4. Prior informed consent of the holder of the genetic resources is mandatory before NBAN can enter into any form of contract or agreement with a third party applicant.

NBAN would act in a transparent manner and would involve all concerned government line agencies and other stakeholders by seeking their comments in any proposal requesting export of genetic resources for commercial purposes. Negotiating committees, comprising of genetic resources experts, high-level government officials, owners and representatives of local communities, would draft the agreements to be entered into by the NBAN.

Biodiversity registration and bioprospecting

In order to protect the country's traditional knowledge on medicinal plants from being illegally patented, Nepal is currently engaged in the registration of knowledge, innovations and practices of indigenous and local communities to promote their wider applications in conservation. A pilot project has been launched in Kaski and the adjoining areas of Western Nepal. The results are very encouraging. The registration will also help in developing new methodologies for the sustainable use of biodiversity for providing alternative means of livelihood to rural people. There is now a growing interest from pharmaceutical and biotechnical industries of many countries to conduct a systematic research on wild medicinal plants for new products such as medicines, agrochemicals (pesticides and herbicides), flavors, fragrances and industrial enzymes. Biodiversity prospecting is an emerging field for testing biological materials for economically valuable biochemical purposes, which could bring potential benefits to Nepal. The DPR, in this respect, is planning to conduct

bioprospecting of plant resources based on ethnobotanical information of the biodiversity register. In addition to biodiversity registration and bioprospecting, the following would be done to achieve the goal of conservation and sustainable use:

1. Explore possible options and measures to mitigate overexploitation of medicinal plants from the wild, thereby increasing their production potential in their natural habitats;
2. Develop and improve present collection and harvesting technologies;
3. Undertake inventory of wild medicinal plants to assess their yields from the natural habitats;
4. Develop domestication and cultivation methodologies on commercially important as well as threatened, vulnerable and endangered medicinal plants species;
5. Promote a participatory approach to the management of medicinal plants;
6. Develop mechanisms to ensure equitable distribution of benefits from collectors to users; and
7. Provide technical training to collectors to improve their skills and efficiency in collecting, cultivating, harvesting, processing and marketing of medicinal plants.

Conclusion

The proposed collaboration of DPR with the International Plant Genetic Resources Institute (IPGRI) is timely and valuable in helping Nepal in its national mandate of effectively and systematically conserving, utilizing and equitably sharing the benefits of medicinal plants found in the country. The following areas can be considered for the research, development and sustainable utilization of medicinal plants of Nepal:

1. Inventory , documentation and assessment of medicinal plants resources;
2. Technologies on cultivation of commercially important medicinal and aromatic plants;
3. Human resources development for concerned government institutions, specifically the DPR;
4. Improvement of laboratory facilities of DPR and other concerned academic and research institutions to further develop quality control, standardization, public analysis technology and bioprospecting of medicinal and aromatic plants;
5. Joint project on research and development of medicinal plants; and
6. Technology transfer.

Project activities for immediate implementation

1. Documentation of published and unpublished literature on medicinal plants of Nepal;
2. Inventory and documentation of conserved medicinal plants in Nepal with the following information:
    a. Scientific and local names
    b. Collection and conservation sites
    c. Number of plants conserved per species
    d. Medicinal value or uses of each medicinal plants genus/species
    e. General morphological description of medicinal plants genus/species, including photographs, if available;
3. Assessment and analysis of the status of medicinal plants research on medicinal plants in Nepal, the results and research gaps; and
4. Identification of priority medicinal plants and related priority areas of research.

Attachment 1

Protected medicinal plants of Nepal

(Source: Nepal Gazette 2058/9/16, 2001)

Scientific Name	Local Name
Banned for collection and export	
Dactylorhiza hatagirea	Panchaunle
Bark of *Juglans regia*	Okhar ko bokra
Picrorhiza scrophulariiflora	Kutki
Banned for export without processing as specified (Not applicable for cultivated products)	
Nardostachys grandiflora	Jatamansi
Rauvolfia serpentina	Sarpagandha
Cinnamomum glaucescens	Sugandhakokila
Valeriana jatamansi	Sugandhawal
Lichen spp.	Jhyau
Abies spectabilis	Talispatra
Taxus spp.	Lauth salla
Cordyceps sinensis	Yarsagomba
Banned for felling, transportation and export	
Michelia champaca	Champ
Acacia catechu	Khayar
Shorea robusta	Sal
Bombax ceiba	Simal
Dalbergia latifolia	Satisal
Pteocarpus marsupium	Bijayasal
Juglans regia	Okhar

Attachment 2

List of aromatic and medicinal plants of Nepal with developed agrotechnology

Scientific Name	Common/Vernacular Name(s)	Remarks
Chrysanthemum cinerarifolium	Pyrethrum	Exotic
Crocus sativus	Saffron/Kesar	Exotic
Cymbopogon flexuosus	Lemon grass	Exotic
Cymbopogon martinii	Palmarosa	Exotic
Cymbopogon winterianus	Citronella	Exotic
Digitalis purpurea	Digitalis	Exotic
Mentha arvensis	Mentha/Padina	Exotic
Mentha piperata	Mentha/Padina	Exotic
Rauvolfia serpentina	Serpentine/Sarpagandha	Indigenous
Valeriana jatamansi	Indianvalerian/Sugandhawal	Indigenous
Vinca rosea	Periwinkle/Sadabahar	Exotic

Attachment 3

List of medicinal and aromatic plants in Nepal with tissue culture protocols

Scientific Name	Common/ Vernacular Name(s)	Remarks
Ammomum subulatum	Big cardamoum/Alainchi	Exotic
Atropa belladona	Belladona	Exotic
Cephales epicacuana	Epicac	Exotic
Chrysanthmum cinerarifolia	Pyrethrum	Exotic
Elaeocarpus sphaericus	Bead tree/ Rudrakshya	Indigenous
Ocimum basilicum	French Basil/ Tulsi	Exotic
Rauvolfia serpentina	Serpentine/ Sarpagandha	Indigenous
Rheum australe	Rhubarb/ Padamchal	Indigenous
Solanum laciniatum	Solanm/ Kankari	Exotic
Swertia chirayita	Chiretta/ Chiraito	Indigenous
Valeriana jatamansi	Indian valerian/ Sugandhawal	Indigenous
Zingiber officinale	Ginger/ Aduwa	Indigenous

Inventory, documentation and status of medicinal plants research in the Philippines

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Introduction

The Philippines is endowed with rich and varied flora, which are known to have medicinal properties since ancient times. The native herb doctor or *herbolario* or *arbularyo* of olden times were skilled in the use of local plants to cure varied illnesses. Most *arbularyos* learned the secret of herbal doctoring from their fathers; their knowledge on folk medicine handed down from one generation to another. It is also speculated that Chinese traders, who came before the Spaniards, introduced their herbal medicines. When the Spanish priests and missionaries first arrived in the Philippines during the early 16th century, they brought with them their experience on the use of herbs as medicine but they also relied on *arbularyos* in the use of local plants with therapeutic values. These priests authored treatises and manuscripts, which are considered to be the earliest published records on medicinal plants in the Philippines.

Arbularyos still practice herbal healing in the countryside. There are *hilot*s or midwives who also practice traditional healing but they mostly assist in childbirth. While they cannot really compare with the skills of a trained doctor of medicine, the important role that they play in delivering primary health care in rural areas is acknowledged.

The practice of traditional medicine and use of medicinal plants flourished because of prohibitive cost of medicines and health care and the problem of their inaccessibility. Medicinal plants are easily available because they grow everywhere and can be easily propagated. The right use of such plants lessens dependence on costly and imported western drugs.

The utilization of medicinal plants evolved from the concoction of herbs mixed by the a*rbularyos* to medicinal plants sold and used nowadays as home remedies, over the counter drugs, and raw materials for the pharmaceutical industry in the Philippines. Most of these plant drugs are sold in powder form as herbal teas, capsules, sachets and other nutritional supplements. The market demand for raw materials of popular medicinal plants such as lagundi (*Vitex negundo* L.), akapulko (*Cassia alata* L.), tsaang gubat (*Ehretia microphylla* Lam.), ampalaya (*Momordica charantia* L.) and sambong (*Blumea balsamifera* L. DC.) for the production of drugs and other health care products far exceeds that of production. Professor E Quintana of the University of the Philippines Los Baños (UPLB) estimated that a net profit of Php 268 000/year (US$ 5000) could be generated from a one hectare production of *lagundi*. So, venturing on this activity can be a worthwhile enterprise and could be a potential source of income.

Health care and cosmetic products from plants such as avocado, papaya, and cucumber are becoming popular among consumers and their production can be profitable businesses. Some plants such as *ilang-ilang* and patchouli contain essential oils, which are essential components of fragrances and perfumes.

Medicinal plants also contain chemical compounds, which have been developed into important drugs. An estimated 119 pure chemical substances from less than 90 plant species are used as medicines worldwide. In the Philippines, 200 medicinal plants have identified phytochemical content but there could be more plant species

that are sources of pharmaceutical or drug products. They are potential nontraditional export products because of the increasing demands of the international pharmaceutical industry.

The use of a new range of products is becoming a trend internationally and locally. These products or "pharmafoods" provide both pharmaceutical and nutritional benefits because they contain saponins, flavonoids, anthocyanin and a number of micro- and macronutrients. They may enhance the body's biological defense mechanism, can be eaten as part of the daily diet and are naturally occurring.

Some medicinal plants can also provide flavors and spices (black pepper and ginger) while several species are good sources of bio-pesticides.

Medicinal plants of the Philippines and their known uses

The Philippines is estimated to have more than 1500 plant species that have known medicinal value. In a survey conducted by UPLB in 766 barangays or villages in 12 regions of the country, 1687 plants (based on common names) were found being used by local traditional healers or *arbularyos*. The results of this research are available in a CD entitled "Folk Uses of Potential Medicinal Plants: A Survey". Researchers found that about 130 plants were in common use in the three or four provinces surveyed. Most plants have more than one purported medicinal use. Leaves are the most commonly used part and most healers use them as decoction. It is highly possible that there are more plant species that can be classified medicinal given the Philippines' rich and diverse flora.

Only 120 medicinal plants have been scientifically validated for safety and efficacy. The National Integrated Research Programme on Medicinal Plants (NIRPROMP) of the Philippine Council for Health Research and Development (PCHRD) of the Department of Science and Technology (DOST) studied 10 priority medicinal plants. As a result of this programmeme, the Department of Health (DOH) recommends the use of these plants to the public. A series of recommendations on how to grow and process these medicinal plants have been prepared and disseminated to the public. This could be the reason why they are now becoming popular among people in urban areas when their application used to be limited to the countryside. These plants and their uses are:

Plant		Use(s)
Lagundi (*Vitex negundo* L.)	-	asthma and coughs
Yerba buena (*Mentha x cordifolia* Opiz ex Fresen)	-	body pain
Sambong (*Blumea balsamifera* (L.) DC.)	-	diuretic, anti-urolithiasis
Tsaang gubat (*Ehretia microphylla* Lam.)	-	stomach ache
Niyog-niyogan (*Quisqualis indica* L.)	-	anti-ascaris
Akapulko (*Cassia alata* L.)	-	against skin diseases
Bayabas (*Psidium guajava* L.),	-	cleaning of wounds, swelling of gums, tooth decay
Bawang (*Allium sativum* L.)	-	lower cholesterol
Ulasimang bato (*Peperomia pellucida (*L.) HBK.	-	lower uric acid
Ampalaya (*Momordica charantia* L.).	-	diabetes mellitus

Only three out of these 10 medicinal plants became commercially available in dosage forms. These are *lagundi*, *sambong*, and *ampalaya*. A Filipino-owned company manufactures and distributes these medicines. Attachment 1 presents a partial list of other medicinal plants found in the Philippines and their known uses.

Medicinal plants collection and conservation

Several institutes/departments under UPLB collect and maintain medicinal plants in a genebank or garden. The following are some of their activities:

- In a project conducted by UPLB and funded by the DOST (then called the National Science and Technology Administration or NSTA) during the early 1980s, researchers conducted a national survey to document the healing practices of the *arbularyos* and *hilots,* and collected the plants they were using. Plants collected were established and maintained in a medicinal plant genebank of the UPLB Department of Horticulture. This genebank evolved into a medicinal garden in the early 1990s where 120 species of plants were to be planted. There are plants still being maintained there. Aside from this, the Department of Horticulture also has two production areas in UPLB where raw materials of NIRPROMP's medicinal plants for clinical testing are produced.
- The National Plant Genetic Resources Laboratory (NPGRL) of the Institute of Plant Breeding at UPLB maintains 170 plant accessions of 68 species of medicinal plants in its genebank.
- The Institute of Biological Sciences at UPLB is developing a small collection in the Museum of Natural History. At present, only 54 species are being maintained.
- The Ecosystems Research and Development Bureau (ERDB) of the Department of Natural Resources (DENR), which is based within UPLB's campus, maintains an active collection of 183 species of medicinal plants in their 1.2 ha field genebank located on Mt Makiling in Laguna.

In other regions of the Philippines, the state colleges and universities have their own collection of medicinal plants. In the province of Cavite in Southern Luzon, Cavite State University (CavSU) maintains a small garden of 32 accessions of herbs and spices for instruction, research, and extension.

In northern Luzon, several universities/colleges have established medicinal plant genebanks or gardens. These are the Mariano Marcos State University (MMSU), Don Mariano Marcos Memorial State University (DMMMSU), Ifugao State College of Agriculture and Forestry (ISCAF) and the Isabela State University (ISU). Benguet State University (BSU) is planning to put up a park or garden that will feature medicinal plants among other crops. Requests for more information on medicinal plants, genebanks and research in these universities and those located in the Visayas and Mindanao have been forwarded and replies are still forthcoming.

Status of medicinal plants research in the Philippines

There were scattered research projects on different medicinal plants that were conducted by several state colleges and universities in different regions of the Philippines in the last 20 years. But there is one integrated, interdisciplinary programme on medicinal plants, NIRPROMP or the Programme on Drug Development from Priority Medicinal Plants for the Treatment of Priority Diseases. It covers an agricultural component, pharmacologic/toxicologic studies, mutagenecity and clastogenecity of drug preparations, establishment of quality control bioassay standard procedures, dosage forms form plant constituents, and clinical screening and validation studies of medicinal plants used in traditional folk medicines. NIRPROMP was created in 1977 to develop medicinal preparations from indigenous medicinal plants to cushion the effect of escalating prices of commercial drugs and increase the availability of drugs especially in the rural areas. Its implementing agencies are University of the Philippines (UP) Colleges of Medicine, Pharmacy,

Agriculture and Science. In the past, other agencies involved were Ateneo de Manila, University of Santo Tomas, Jose Reyes Memorial Medical Center and the Central Luzon State University (CLSU). The programme is under the coordination of PCHRD and funded by DOST.

The Philippine Council for Agriculture and Natural Resources Research and Development (PCARRD) is the planning and monitoring agency of the DOST in agricultural research and development programmes. The Crops Research Division of PCARRD is responsible for research and development on eight commodity crops, including ornamental horticulture and medicinal plants.

The projects on medicinal plants, including the agricultural component of NIRPROMP, that were monitored by PCARRD focused on plant production, propagation and post-harvest handling and storage of plant parts for medicinal purposes. The following are some of the important projects and summary of their coverage and results:

- ***Collection of Locality Source and Survey of Folk Uses of Potential Medicinal Plants (UPLB).*** Fifty-five provinces involving 807 barangays in 416 municipalities and 1264 healers were surveyed. More than 1000 plants were found as being used by local traditional healers, mostly as decoction. Leaves are the most commonly used parts.
- ***Indigenous Herbal Remedies and their Application in Ifugao (ISCAF).*** Indigenous herbal plants (133) were collected in four areas in the Ifugao Province in the highlands of northern Philippines. The medicinal plants were inventoried and their uses documented.
- ***Morphology and Economic Value of Some Weed Plants in Bukidnon (Central Mindanao University, CMU).*** Fifty-one species belonging to 23 families of herbal weeds were collected, characterized, and found economically important because of their medicinal values. A guidebook on these plants shall be prepared for instructional purposes.
- ***Ethnobotanical Knowledge of Farmers in Baybay, Leyte (Leyte State University (LSU) formerly Visayas State College of Agriculture or VISCA).*** Four villages in Baybay, Leyte Province were surveyed to document the traditional knowledge of farmers on pesticidal and medicinal plants. Results showed that farmers knew more than 58 medicinal plants. These plants were used to relieve common ailments such as cough, scabies/wounds, fever, and diarrhea. Farmers were also familiar with the dosage, plant parts used, and the exact procedures for the preparation of these plants. They had limited knowledge on pesticidal plants.
- ***The Promising "Pharmavegetables" of Marinduque (Marinduque State College).*** This ethnobotanical and phytochemical study on the common "pharmavegetables" covered 20 plant species, which are distributed in 16 families. The fresh leaf concoctions of these plants are used by *arbularyos* against a number of diseases. They are also used as vegetables, especially in the hinterlands. Phytochemical screening of the plant samples revealed that they have triterpenes, alkaloids, triterpenoidal glycosides, steroid glycosides, cyanogenic glycosides, saponins and tannins. They also contain essential micro- and macronutrients.
- ***Antiseptic and Healing Properties of Indigenous Plants (DMMMSU).*** The antiseptic and healing properties of povidone-iodine solution were compared with the leaf juice, sap, and ointment preparations of 12 indigenous plants, namely: *Moringa oleifera, Phyllanthus niruri, Heliotropium indicum, Tabernaemontana pandacaqui, Mimosa pudica, Anamirta cocculus, Impatiens balsamina, Musa sapientum, Helianthus annuus, Vernonia cinerea, and Aloe*

barbadensis. All plants tested reduced inflammation or swelling, and degree of redness on wounds.

- ***Production and Mass Propagation of Medicinal Plants for Primary Health Care (UPLB).*** This project produced raw materials of akapulko, ampalaya, bayabas, damong maria, ipil-ipil, lagundi, niyog-niyogan, sambong, solasi, tanglad and ulasimang bato that were supplied to NIRPROMP. It established a genebank consisting of 120 medicinal plant species; 83 species were collected from other places and propagated. Further propagation of plants was done for the regional trial, for replanting of annual and dead plants and for dissemination to the public. Regional trials were established in Regions 1 and 2; lagundi, sambong, and tsaang gubat had better growth performance in Region 2 but there were fewer incidences of insect pests and diseases in Region 1.
- ***Cultural Management and Postharvest Handling of Lagundi (UPLB).*** A rapid and efficient method of propagating lagundi was established using basal stem cuttings. Growing conditions affecting favorable growth and development were determined. Guidelines in harvesting were established.
- ***Propagation of Medicinal Plants (UPLB).*** Rapid and efficient methods of propagating priority medicinal plants were developed. Percent survival and rooting of suitable plant parts as affected by growth regulators, media, number of leaves, growth media, stem length and nutrition of mother plants and the germination of seeds of plants such as akapulko as affected by germination media were studied. The optimum rates of fertilizer for the cuttings were also determined.
- ***Hydroponic Culture of Pansit-pansitan (UPLB).*** Pansit-pansitan (*Peperomia pellucida*) grown in a hydroponic culture using Hoagland's solution had lower Pb and Cd content than those grown in soil.
- ***Tissue Culture of* Catharanthus roseus *for the Production of Clinically Tested Important Alkaloids (UPLB).*** A unique culture line of *C. roseus* callus designated as BCR-1 was established. Analysis of the crude alkaloid extracted form BCR-1 callus showed the presence of several indole alkaloids.
- ***Evaluation of Rice Straw as Mulching Material for Hierba Buena Production (CLSU).*** Mulching with rice straw prolonged the life span of hierba buena, thus increasing the number of harvest and consequently, the herbage yield.
- ***Organic Fertilization of Lagundi and Sambong Using Readily Available Farm Manures (CLSU).*** Decomposed chicken and carabao dung (15 t/ha and 20 t/ha) were as good as urea (120 kg/ha) in increasing herbage yields of both medicinal plants under study.
- ***Study on Different Levels of Pruning on Herbage Yield of Three Medicinal Plants (CLSU).*** Fully-grown plants of sambong, lagundi, and tsaang-gubat were pruned at 15, 30, 45 cm from the base to determine the level of pruning that will give the highest herbage yield. Results showed that increasing the level of pruning from 15-45 cm from the plant base did not significantly affect the herbage yield.
- ***Survey of Insect Pests Commonly Associated with Some Medicinal Plant Species (CLSU).*** Insect pests of sambong, lagundi, tsaang gubaat, hierba buena, and niyog-niyogan in the province of Nueva Ecija in Central Luzon were monitored. Major pests of sambong were shootworm, mealybug, long-horned grasshopper, leaffolders, leaf beetles, and aphids. The major insect pests of tsaang gubat were leafminer, aphids and thrips while those of niyog-niyogan were thrips, scale insects, and mites. The most numerous insect species that attacked hierba buena were mites, leaf beetle, and thrips.

- ***Survey and Management on Insect Pests of Some Medicinal Plants (UPLB).*** Surveys and collection of insects and other arthropods infesting medicinal plants were conducted at UPLB, CLSU, and FORI. Life history studies and control studies using temperature and *Bacillus thuringiensis* were also conducted. A total of 46 species and 3 gall mites were observed feeding on sambong, lagundi, niyog-niyogan, akapulko, tsaang gubat and pandakaki.
- ***Survey and Identification of Diseases Attacking Medicinal Plants (Bureau of Plant Industry, BPI).*** The most common diseases observed to attack medicinal plants were bacterial rot caused by *Erwinia carotovora*, stem rot caused by *Sclerotium rolfsii* and leaf spot caused by *Cercospora sp*.
- ***Diseases of Selected Medicinal Plants in the Philippines (UPLB).*** In the survey of important diseases of medicinal plants at the genebank in UPLB, the degree of infection of Cercospora and Corynespora leaf spot of lagundi were 5-90%; Cercospora leaf spot and scab-like leaf spot of niyog-niyogan were 5-90% and 2-80% respectively. The incidence of circular leaf spot and orange leaf spot of sambong were 2-10% while the Cercospora leaf spot infection of tsaang-gubat was 2-3% only.
- ***Selective Harvesting and Storage of Medicinal Plant Parts (UPLB).*** This study determined the effects of maturity of leaves and drying methods on volatile oil yields of lagundi and sambong. Results showed that 3-month old leaves of sambong yielded higher volatile oils than older ones. Both 3- and 6-month old leaves of lagundi gave same yield levels of volatile oil. Sun drying of leaves, followed by air-drying produced high volatile oil yields.
- ***Documentation and Authentication of Philippine Medicinal Plants: Powdered Drugs (UPLB).*** Monographs and illustrations of selected medicinal plant drugs have been prepared. Samples of 70 plants were studied. Organoleptic evaluation showed some changes occur during drying. The colour of most drugs changed to brown, blackish-green and gray. There was also reduction of aroma in the case of aromatic drugs. Microscopic evaluation of the powders showed fragments of the lamina, with sections of the veins and mesophyll layers and very numerous parenchyma cells. Prismatic to cluster crystals of calcium oxalate, when present, are distributed in isolated groups of parenchyma cells.
- ***Isolation, Bioassay and Field Evaluation of Some Philippine Plants for Insecticidal Activity in Shrubs (UPLB).*** Results showed that ethanolic extracts of of lagundi, timbangan, tsaang-gubat, makabuhay and niyog-niyogan caused 20% mortality at concentration of 0.1 or 0.2 g/ml on *R. dominica, S. zeamais, T. castaneum,* and cutworm. The feeding tests showed that the first three plants were growth inhibitors while the last two plants were antifeedants. A minimum concentration of 0.01 g/ml of oregano, lagundi, and sambong volatile oil extracts applied topically had toxic effect on *D. cingulatus, M. domestica, R. dominica* and *S. zeamais*.
- ***Herbs and Spices Development Project for Urban Agriculture Research Highlights (CavSU).*** This research documented the production and post-production practices, production areas and local practices in growing herbs and spices in Cavite. Growth and yield of selected herbs were evaluated using commercial and self-prepared potting mixes. Processing techniques were tested and two herbal products were processed: herbal tea of four plant species and herb-flavored honey using eight plant species.
- ***Promising Plant Extracts Against Weeds (UPLB-National Crop Protection Center).*** Extracts of plants with medicinal values were subjected to bioassay test and observed for any root inhibition effect. Initial screening showed that

Cinnamomum mercadoi, Coccinia grandis, and *Tinospora rumphii* contained active compounds that inhibited root growth and consequently caused weeds to die.

- ***Integrated Studies in Botanical Pesticide for Small-scale Farmers (UPLB).*** The project was undertaken to identify and develop botanical pesticides for use by small-scale farmers within the context of integrated pest management programmemes. A survey and documentation of farmers' use of indigenous pesticidal plants were done as well as collecting and identification of these plants. The safety of selected botanical pesticides, namely, "makabuhay", "luyang dilaw", "tubli/derris", was evaluated in terms of their toxicity to laboratory rats and aquatic organisms such as fish, snails and tadpoles.

There are many research projects on medicinal plants that were or are being monitored by PCHRD. As these are mostly on pharmacologic/toxicologic studies and other related research, they will not be tackled in this paper. Interested researchers can see the list of these projects and their abstracts in the Health Research and Development Information Network (HERDIN) in the PCHRD Web page (http://pchrd.dost.gov.ph).

Priority research areas on medicinal plants

The first of the seminar series on the State of the Art of Medicinal Plant Research and Business Opportunities was held on 31 March 2003 at UPLB. Other monthly seminars on medicinal plants have been scheduled until July 2004. During the workshop session, the participants identified the R & D priorities for the next three years. These include:

I. Validation
   - Identification and morphological characterization
   - Chemical characterization
   - Conservation

II. Production
   - Mass propagation
   - Effect of agroclimatic conditions
   - Crop protection
   - Controlled growing
   - Crop nutrition
   - Seed generation/ physiology
   - Floral biology

III. Processing
   - Drying methods
   - Storage
   - Fabrication of machines
   - Type of packaging materials

IV. Marketing
   - Other uses of medicinal plants (veterinary uses)
   - Development of standards both for export and local markets
   - Product market assessment

V. Policy Issues

During the IPGRI-PCARRD Consultative Meeting on Medicinal Plants held last November 2002 at PCARRD Headquarters in Los Baños, Laguna, a tentative list of priority areas for collaboration was established (Table 1).

Table 1. Initial priority areas for collaboration

Areas of Collaboration	Activities	Time Frame	Participants
Inventory and documentation of medicinal plants (MPs)		2002-2003	PCARRD IPGRI
Characterization of MPs	• Morphometric		PCARRD, IPGRI
	• Molecular markers		
	• Farmers' protocol		
Database harmonization/ development/ sharing			PCHRD, UPLB, DOH
Demand and supply survey-local, international			DTI, Private sector
Market channels development/ market demand creation/ market promotion			DTI, Private sector
Research on herbal veterinary medicine			UPLB CVM, Private sector
Develop production systems	• For research		UPLB
	• For industry		DENR, DA
	• Training of producers		UPLB, PCARRD, ITDI
	• Establishment of propagation center	2004	UPLB, OTHER SCU, Private groups, farmers associations
Enterprise module development			ITDI
Microfinancing / credit scheme			DA, BANKS
Identify MP for specific uses	• Less serious local diseases		DOH-PITAHC ITDI, NIRPROMP
	• Hypertension		
	• HIV/AIDS		
	• Diabetes		
	• Cancer		
	• Arthritis / Rheumatism		
	• Tonic		
Chemical/Biochemical analysis			Ateneo de Manila. La Salle, UP Diliman/ Manila
Clinical studies			DOH, NIRPROMP
Support to BFAD approvals			Private sector, DOH PCHRD
Policy/ Advocacy and related activities			Private sector, DOH PCHRD, PCARRD, Media group, PIA
Regular forum on MP		Quarterly	All, PCHRD, PCARRD
Develop strong industry partnership/ support			Private industry, PCHRD, PCARRD
Master plan/ strategy development			All
Fund raising	• For research		IPGRI, PCARRD,

Areas of Collaboration	Activities	Time Frame	Participants
	• For industry development (production to marketing)		Private sector DA, DENR, DTI, Banks association DBP
Network on MPs research			All, PCHRD, PCARRD, IPGRI
Regional meeting on MPs			PCHRD, PCARRD, IPGRI, DTI

Agencies/organizations working on medicinal plants in the Philippines

Both government and non-government agencies are active in medicinal plant research, development, and business. These are some of the agencies and organizations:

Academic institutions and government agencies:

Ateneo de Manila
- Philippine Institute for Pure and Applied Chemistry

Department of Science and Technology
- Philippine Council for Health Research and Development
- PCARRD
- Philippine Council for Industry and Energy Research and Development (PCIERD)
- Industrial Technology Development Institute

Department of Health
- Philippine Institute of Traditional and Alternative Health Care (PITAHC)

Department of Environment and National Resources
- Ecosystems Research and Development Bureau

University of the Philippines at Los Baños
- College of Agriculture
- National Plant Genetic Resources Laboratory
- Institute of Biological Sciences

UP Manila - National Institute of Health
UP College of Medicine
Other State Colleges and Universities in the Philippines

Non-government organizations:
- ALTERMED (subsidiary of Pascual Laboratories)
- Chamber of Herbal Industries of the Philippines
- CRD Herbal Products, Inc.
- Pascual Laboratories
- Reneur Research and Development Institute
- VERALUZ International Corporation

Bibliography of published materials on medicinal plants

Attachment 2 presents a partial bibliographical list of published materials on medicinal plants. They are categorized as books, information bulletin, manual or handbook and articles on research results that are published in journals. The list of published articles has been searched from the Plant Resources of South-East Asia

Programme (PROSEA) databases.

It is also worthwhile to mention that the RED Foundation developed a PROSEA Herbal page in coordination with the PCARRD and PROSEA. Important information on medicinal plants is featured in this home page (http://www.pcarrd.dost.gov.ph/prosea/proseaherbal/index.htm). Information on species list, techno-catalogue, indication index and kitchen technologies are available. PROSEA is also producing leaflets on medicinal plant production.

Progress of ongoing IPGRI project

The project on "Documentation of Conserved Medicinal Plants of Philippines" formally started last February 2003. Some of the reports have been incorporated in this country paper, particularly in the topic "Medicinal Plants Collection and Conservation". The search on published and unpublished work is already ongoing. Inquiries along this line have been sent to the 14 Regional Consortia of PCARRD. The member agencies of the different consortia are now working on the databases of their agricultural R and D programmes to classify the institutions with research work on medicinal plants. Detailed information will be retrieved during the second quarter of 2003. As an offshoot also of the IPGRI-PCARRD consultative meeting, the three sectoral councils of the Department of Science and Technology (DOST), namely PCHRD, PCIERD and PCARRD met and discussed the recent developments in medicinal plants R&D framework. One of the components to be initiated is the compilation of research on conserved medicinal plants.

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Attachment 1

Partial list of Philippine medicinal plants and their known uses

(Source: De Padua et al. 1999; PCHRD 1999)

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Abelmoschus esculentus	okra (Tagalog)	• Remedy against spasms and scabies
Abroma augusta (L.) L.F.	ambong (Tagalog) bodobudo (Iloko) anabo (Bisaya)	• Roots are good for dysmenorrhea, emmenagogue
Abrus precatorius L.	saga, kansasaga, bangati (general)	• Seeds treat conjunctivitis, purgative, emetic, antidiarrhetic, aphrodisiac and tonic
Acacia farnesiana (L.) Willd.	aroma (Tagalog) kamban (Sulu)	• Leaves are good for bladder • Bark is emetic • Wood is a remedy for toothache • Fruit is antidiarrhetic
Achryranthes aspera L.	hanggod (Tagalog)	• Plant is emetic, laxative, dysenteric, and a good remedy for toothache
Acorus calamus L.	lubigan (Tagalog, Bisaya)	• Masticatory against toothache • Stimulant (carminative and antirheumatic)
Adenanthera pavonina L.	sagahutan (Malayan)	• Decoction is good for gout, diarrhoea, dysentery, hemorrhage • Seeds – supporation • Roots are emetic
Adiantum caudatum L.	culantrillo (Tagalog)	• Whole plant is aperitive, diuretic, emmenagogue, expectorant
Adiantum philippinensis L.	culantrillo (Tagalog)	• Decoction is antidysenteric, diuretic and to relieve stomache
Aerva lanata (L.)	tabang ahas apugapugan pamaynap	• Decoction is considered to be an efficacious diuretic • Used against catarrh of the bladder and gonorrhoea
Ageratum conyzoides L.	blak-manok (Tagalog) singilan (Iloko) banug-bahug (Panay Bisaya)	• Externally, it heal wounds and treat skin diseases • Internally, treat diarrhoea, as a febrifuge and as an anti-allergenic agent
Aglaia iloilo (Blco.) Merr.	iloilo (Tagalog)	• Leaf decoction is a colic remedy (in case of vomiting, apply cold towel to stomach)
Aglaia odorata Lour	sinamomong sonsong (Tagalog)	• Leaves and roots are febrifuge, pectoral, for convulsion • Leaf infusion is a good remedy for excessive menstruation
Albizia lebbeck (L.) Benth.	kariskis (Iloko)	• Bark is antidiarrhetic, antidysenteric and ulcer wash
Aleurites moluccana (L.) Willd.	lumbang (Tagalog)	• Leaves are antirheumatic • Seeds, purgative
Allamanda cathartica L.	kampanilya (Tagalog)	• Leaf infusion is a good remedy for colic, purgative

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Allium ascalonicum L.	sibuyas-tag (Tagalog) lasuna (Iloko)	• Bulb is for chronic bronchitis, cough and diuretic
Allium cepa L.	sibuyas tagalog, bauang pula (Tagalog) lasona (Iloko)	• Considered anthelmintic and stomachic • Treats diarrhoea, bronchitis, headache, earache, amenorrhoea, and tubercolosis • Shallot stimulates appetite
Allium sativum L.	bawang (Tagalog, Ilokano)) ajos (Bisaya) ahus (Ibanag)	• Lower blood sugar and cholesterol levels, treats asthma • Externally, it cure headache, insect bites, rheumatism and toothache • Decoction internally as febrifuge • Treats scabies
Allium tuberosum Rottler ex Sprengel	kutsay (Tagalog) ganda (Bisaya) amput di imayyaw (Ifugao)	• Leaves and bulbs are used as antiseptic and vulnerary • Treats cancer
Alocasia macrorrhiza (L.) Schott	badiang (Tagalog)	• Leaves, antidote for lip sting
Alocasia portei (Schott) Engl. And Becc	badiang (Bikol)	• Root decoction hasten labor pain in childbirth
Aloe vera (L.) Burm.f.	sabila (Tagalog) dilang buwaya (Bicol) dilang-halo (Bisaya)	• Cure dysentery and kidney problems or against dyspepsia
Alphonsea arborea (Blco.) Merr.	kalay (Tagalog)	• Boiled fruit is febrifuge and decoction is emmenagogue and antidysenteric
Alstonia macrophylla Wall.	batino (Tagalog)	• Root decoction is a good remedy for high blood pressure; anticholeric and tonic
Alstonia scholaris (L.) R. Br.	dita (Tagalog)	• Plant is antimalaria, antidote for snake bite
Apium graveolens	kinchai	• Treats arthritis, bronchitis and spasms
Amanranthus spinosus L.	urai (Tagalog) harum (Bisaya) kalunai (Iloko)	• Decoction of the root is used to treat gonorrhoea and applied as an emmenagogue and antipyretic • Leaves are good emollient as applied externally in cases of eczema, burns, wounds and boils
Andropogon aciculatus	amorseco	• Treats diarrhoea
Andropogon citrates DC.	tanglad	• Cures headache and hypertension
Anona squamosa	atis	• Treats pulmonary disorders
Antiaris toxicaria Lesch.	dalit (Tagalog) ipo (Tagalog, Bisaya)	• Soft wood is macerated and the fluid is used as a poultice for swellings
Arcangelisia flava (L.) Merr.	abutra (Ilokano, Bisaya) suma (Tagalog, Pampango)	• Yellow-fruited moonseed is a popular antiseptic • Decoction of the wood is used to clean wounds, ulcers and other skin irritations

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Areca catechu L.	buñga	• Tender seeds – purgative • Ripe fruits – vermifuge • Treats hypertension and tubercolosis
Aristolochia philippinensis Warb.	barubo (Negrito) puso-pusoan (Tagalog) tambal-balanding (Zambales)	• Decoction of roots is used as stomachic and emmenagogue
Aristolochia sericea Blanco	bangisi, pangisi (Iloko)	• Roots are chewed to treat gastralgia
Artocarpus heterophyllus Lam.	langka	• Burned leaves are cicatrizant for ulcer and wounds • Green fruit used as astringent • Ripe fruit is demulient • Relieves pain caused by swelling
Artemisia vulgaris L.	damong-maria (Tagalog) erbaka (Iloko) gilbas (Cebu-Bisaya)	• Decoction or infusion of the leaves is used as vulnerary, expectorant, stomachic and emmenagogue • Good for spasms
Asparagus officinalis	asparagus	• Treats arthritis
Averrhoa bilimbi	kamias	• Good for scabies
Barringtonia acutangula	kalambuaya	• Remedy against respiratory diseases
Belamcanda chinensis (L.) DC.	abaniko (Tagalog)	• The rhizome is used against inflammations of throat and upper respiratory tract such as laryngitis, pharyngitis, tonsillitis, cough and asthma
Benincasa hispida	kondol	• Remedy against tuberculosis
Bidens pilosa L.	dadayem (Ibanag) burburtak (Ilokano) pisau-pisau (Bisaya)	• Leaves as vegetables prevents goiter
Bixa orellana	achuete	• Remedy against asthma
Blumea balsamifera (L.) DC	sambong (Tagalog) lakadbulan (Bikol) subsub (Ilokano)	• Medicine for diuretic, scabies and kidney-stone
Blumea lacera (Burm.f.) DC.	damong-mabaho, tubang-kabayo (Tagalog) lamlampaka (Bontoc)	• Decoction of flowers treat bronchitis • Leaf juice is anthelmintic for haemorrhages • Used as febrifuge, astringent, deobstruent and stimulant
Brassica integrifolia	mustasa	• Treats bronchitis
Brassica oleracea	repolyo (Tagalog)	• Treats arthritis
Brucea javanica (L.) Merr.	balaniog (general) magkayapos (Samar, Leyte, Bisaya) manongao-bobi (Cebu Bisaya)	• Pyrenes and roots are medicinally used against amoebic dysentery, diarrhoea, malaria and as a febrifuge
Bryophyllum pinnatum (Lamk) Oken	katakataka (Tagalog) karitana (Bisaya) abisrana (Iloko)	• Fresh leaves used as poultice in the treatment of boils, wounds, burns and scalds • Remedy for tubercolosis
Caesalpinia crista	kalumbibit	• Remedy against hemorrhage

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Caesalpinia pulcherrima	bulaklak ng paraiso	• Treats asthma
Caesalpinia sappan	sapang	• Treats hemorrhage
Calophyllum inophyllum	bitaog	• Treats arthritis
Calotropis gigantea (L.)	kapal-kapal	• Leaf juice – vermifuge • Root infusion – antihemorrhagic
Capsicum frutescens	siling-labuyo (Tagalog)	• Treats arthritis
Cardiospermum halicacabum L.	parol-parolan (Tagalog) kana (Cebu Bisaya) paria-aso (Iloko)	• Leaves are antirheumatic
Carica papaya	papaya (Tagalog)	• Treats cancer and tubercolosis
Carmona retusa (Vahl) Masam	tsaang gubat (Tagalog) putputai (Bikol) alangit (Bisaya)	• Substitute for tea, stomachic, antidiarrhoeal and a remedy for dysentery and cough
Cassia alata	akapulko (Tagalog) sunting	• Treats bronchitis
Cassia fistula L.	kana-fistula, bitsula (Tagalog, Cebu Bisaya)	• Used as laxative
Casuarinas equisetifolia Forst.	agoho (Tagalog)	• Leaves – anticolic, stomachic • Bark decoction – ecbolic, astringent, emmenagogue
Catharanthus roseus (L.) G. Don	chichirica (Sp) kantotai, amnias (Tagalog)	• Decoction of all parts is used to treat malaria, diarrhoea, diabetes, cancer, skin diseases and hypertension
Ceiba pentandra	kapok, buboi	• Remedy for tubercolosis
Centella asiatica (L.) Urb.	takip-kohol, tapingan-daga (Tagalog) hahang-halo (Bisaya)	• Extract is effectively used in the treatment of keloids, leg ulcers, phlebitis, slow-healing wounds, scleroderma, lupus, leprosy, surgical lesions, striae distensae, cellulites, aphthae • Good for hypertension
Chenopodium ambrosioides L.	alpasotis (general) adlabon (Igorot) bubula (Bontok)	• Used as carminative in poultices applied to the abdomen of children suffering from dyspepsia • An emmenagogue
Cissampelos pareira L.	sansau (Tagalog) sampare (Bisaya) kalaad (Iloko)	• Root decoction is used as diuretic, colic • Pounded leaves cured scabies, treat abscesses, wounds and ulcers
Citrullus vulgaris	pakwan	• Treats hemorrhage and hypertension
Citrus microcarpa	kalamansi	• Treats hypertension, scabies and pulmonary disorder
Cocos nucifera L.	niyog	• Coconut water is a good astringent and vermifuge
Coffea arabica L.	kape	• Good remedy for wounds
Coleus amboinicus	oregano	• Remedy for pulmonary disorders and respiratory diseases
Coleus blumei Benth.	mayana	• Poultice for headache and wounds • Leaf decoction is used for ophthalmia and dyspepsia

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Colocasia esculenta	gabi	• Applied to wounds
Corchorus capsularis L.	saluyot	• Applied to wounds
Crescentia alata	krus-krusan	• Treats hemorrhage
Cucumis melo	melon	• Treats cancer
Curculigo orchioides Gaertner	taloangi (Bagobo) tataluangi (Bukidnon) sulsulitik (Bontok)	• Rhizomes used as diuretic and aphrodisiac, cure skin diseases (externally), peptic ulcers, piles, gonorrhoea, leucorrhoea, asthma, jaundice, diarrhoea and headache
Curcuma longa L.	dilaw (Tagalog) kalabaga (Bisaya) kunik (Ibanag)	• Stomachic, stimulant, carminative, haematic or styptic in all kinds of haemorrhages, and a remedy for certain types of jaundice and other liver trouble • Relieve itch, small wounds, insect bites and certain skin eruptions and smallpox
Curcuma zedoaria (Christm.) Roscoe	barak (Tagalog) alimpuyas (Cebu Bisaya) tamahilan (Bikol)	• Rhizomes used as stimulant, stomachic, carminative, diuretic, anti-diarrhoeal, anti-emetic, anti-pyretic and depurative • Cure ulcers, wounds and other kinds of skin disorders • Chewed to prevent bad breath • Decoction against stomach ache, indigestion and colds
Cymbopogon citratus	tanglad, salay	• Remedy for respiratory diseases
Cyperus brevifolius (Rottb.) Hassk.	boto-botonisan (Tagalog) kadkadot (Igorot) pugo-pugo (Central Bisaya)	• Used as poultice for sores and decoction is used as diuretic and against malaria
Cyperus diffusus Vahl	tuhog-dalag (Tagalog) singao (Mindanao) barsanga-bakir (Iloko)	• Roots are used to treat diseased lips
Cyperus kyllingia Endl.	anuang (Tagalog) borobotones (Bisaya) borsa-ñga-dadakkel (Iloko)	• Decoction of rhizomes used as diuretic and mixed with oil fights certain forms of dermatosis
Cyperus rotundus L.	mutha (Tagalog) ahos-ahos (Bisaya) boto-botones (Bikol)	• Used as stimulant, diuretic, anthelmintic (in large doses), galactagogue, sudorific, mouthwash, astringent against diarrhoea and dysentery • Treats cancer and malaria
Datura metel L.	talong-punay (Tagalog) kamkamaulau (Iloko) katchibong (Bisaya)	• Dried leaves relieve asthma
Daucus carota	carrot	• Treats diarrhoea
Derris elliptica (Wallich) Benth.	tubli, tugling-pula (Tagalog) upei (Bontok)	• Roots are used as emmengogue

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Desmodium gangeticum (L.) DC.	dikit-dikit, mangkit (Tagalog) pega-pega (Cebu Bisaya) andudukut (Sulu)	• Anticatarrh, vermifuge
Desmodium triflorum (L.) DC.	kaliskis-dalag (Tagalog) himbispuyo (Visaya) gumadep (Ifugao)	• Decoction used as mouthwash and expectorant. • Treats diarrhoea and dysentery. • Poultice of leaves used for wounds, ulcers and skin problems
Dioscorea esculenta	tugi	• Plant decoction is diuretic, antirheumatic • Tubers are antiberiberi
Dolichos lablab L.	bataw	• Good for spasms
Elephantopus mollis Kunth	malatabako (Tagalog) tabtabako (Iloko) kaburon (Igorot)	• Leaves are vulnerary to wounds • Decoction used as diuretic and febrifuge
Elephantopus scaber L.	dila-dila, tabatabakohan (Tagalog) kabkabron (Iloko)	• Decoction used as diuretic, febrifuge, and emollient • Treats cough
Elephantopus spicatus Juss. Ex Aublet	dilang-aso (Tagalog) maratabako (Iloko) kalkalapikap (Bontok)	• Leaves are used topically to treat eczema, and as a vulnerary
Euphorbia neriifolia L.	bait (Pampangan) soro-soro (Tagalog)	• Latex from heated leaves relieves earache • Purgative, diuretic, vermifuge and treats asthma
Euphorbia tirucalli L.	bali-bali (Panay Bisaya)	• Poultice for broken bones
Fatoua villosa (Thumb. Ex Murray) Nakai	sikir (general) malbas-damo (Tagalog)	• Decoction of roots against fever • Effective for swollen gums when gargled • Roots for irregular menstruation and as diuretic
Ficus ampelas Burm.f.	upling-gubat (Tagalog)	• Treats diarrhoea
Ficus microcarpa L.f.	baleteng-liitan (Filipino)	• Treats wounds, headache, toothache, colic and liver trouble
Ficus septica Burm.f.	huili (Filipino) kauili (Tagalog) sio (Bikol)	• Leaves are applied for rheumaism • Roots are diuretic • Latex cure certain varieties of herpes and wounds caused by poisonous fish • Treats headache
Hedychium coronarium Koen.	kamia	• Treats malaria • Stem decoction is a good gargle for tonsillitis • Rhizome is antirheumatic excitant
Heliotropium indicum L.	trompa ng elepante, buntot-leon (Tagalog, Bikol) kambra-kambra (Bisaya)	• Roots are emmenagogue • Leaves are used to wash wounds and sores
Helmintostachys zeylanica	tukod-langit	• Treats tuberculosis
Hibiscus rosasinensis	gumamela (Tagalog)	• Treats bronchitis and pulmonary disorder

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Impatiens balsamira L.	kamantigi	• Poultice for felon • Flowers for lumbago, neuralgia • Seeds for difficult labor in childbirth
Imperata conferta (J.S. Presl) Ohwi	kogon-lake (Tagalog) gogon (Bikol) kogon (Bisaya, Sulu)	• Decoction against diarrhoea caused by indigestion and against gonorrhoea
Imperata cylindrical (L.) Raeuschel	kogon (Tagalog) gogon (Bikol) bulum (Ifugao)	• Rhizome decoction treats dysentery and tuberculosis
Ixora chinensis Lamk	santan (Tagalog, Bikol) santan-pula, santan-tsina (Tagalog)	• Remedy against incipient tuberculosis, haemorrhage and headache
Ixora coccinea L.	santan-pula, santan (Tagalog) tangpupo (Bisaya)	• Decoction of roots used as sedative in the treatment of nausea, hiccups and loss of appetite • Flowers treat dysentery, leucorrhea, dysmenorrhea, haemoptysis and catarrhal bronchitis
Jasminum elongatum (Bergius) Willd.	manol (Central Bisaya) sampagitang-gubat (Tagalog)	• Decoction of roots used for scurry, and as a gargle for inflamed gums
Jasminum multiflorum (Burm.f.) Andr.	sampagitang-sunsong (Tagalog)	• Poultice of leaves treats ulcer • Flowers applied as lactifuge • Roots used as an emmenagogue or emetic
Jasminum sambac (L.) aiton	manul (Bisaya) sampagita (Tagalog) kampupot (Pampanga, Tagalog)	• Leaves and flowers as poultice to breast of women as a lactifuge • Decongestant to eyelids • Treats asthma and spasms
Jatropha curcas L.	tagumbau-na-parau (Iloko) tuba (Igorot, Bikolm Tagalog) tubang-bakod (Tagalog)	• Leaves used as cataplasm to swollen breasts, and as a lactagogue., diuretic • Roots are poultice for fractures • Seeds are purgative • Treats diarrhea
Jatropha gossypiifolia L.	lansi-lansinaan (Tagalog) tagumbau-a-nalabaga (Iloko) tuba-tuba (Panay Bisaya, Cebu Bisaya)	• Cataplasm of fresh leaves is applied to swollen breasts, a febrifuge in intermittent fever, as a purgative, stomachic and blood purifier
Jatropha multifidia L.	mana (Filipino) tubang-amerikano (Bikol)	• Seeds are used fresh as a purgative and emetic • Latex is used externally in the treatment of wounds, ulcers, skin infections and scabies
Justica gendarussa Burm.f.	kapanitulot (Tagalog) bunlao (Bisaya) tagpayan (Iloko)	• Extract of leaves or young shoots used as an emetic in coughs and asthma • Fresh leaves are applied as topical to cure oedema of beri-beri and rheumatism

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Kaempferia galanga L.	gisol (general) disok (Iloko) dusol (Tagalog)	• Whole plant is used as remedy for common cold, bronchitis and tuberculosis • Rhizomes treat headache, dyspepsia and malarial chills
Kaempferia rotunda L.	gisol na bilog (general)	• Rhizomes are used internally to treat gastric complaints and externally, mixed with oil as a cicatrizant
Kalanchoe ceratophylla Haw.	siempreviva (Sp, Tagalog)	• Topical treatment of ulcers and relieve headache
Lactuca sativa	legas, letsugas	• Remedy against spasms
Lagenaria siceraria	upo	• Treats pulmonary disorder
Lansium domesticum (Correa)	lansones (Tagalog))	• Bark – antidysenteric • Seeds – vermifuge • Dried rind – anticolic Treats malaria
Lantara camara L.	koronitas, kantutay (Tagalog) baho-baho (Bisaya)	• Leaves are applied to cuts, ulcers, swellings and treat rheumatism • Decoction of leaves and flowers treat constipation, as a febrifuge, diaphoretic and stimulant • Relieve catarrh and bronchitis • Decoction of roots treat toothache, headache, inflammation, gonorrhoea and leucorrhoea • Treats asthma
Leucaena glauca	ipil-ipil	• Treats diarrhoea
Lippia nodiflora (L.) Rich.	tsatsahan (Tagalog)	• Leaf infusion is carminative • Plant – poultice for erysipelas and ulcer
Luffa cylindrica (L.)	patolang bilog	• Leaves are good for arthritis • Vines and roots for toothache and anthelmintic • Treats hypertension
Lycopersicum esculentum	kamatis (Tagalog)	• Treats asthma and bronchitis
Lycopodium clavatum	licopodio	• Treats erysipelas
Mangifera indica	manga (Tagalog)	• Treats asthma, scabies and diarrhoea
Manilkara sapota L.	chico (Tagalog, Iloko)	• Bark is febrifuge • Fruit is antidysenteric • Seeds are aperient
Melia azedarach L.	paraiso	• Relieves hernia • Alternative tonic • Treats erysipelas
Melochia corchorifolia L.	bankalanan (Iloko) kalingan (Panay Bisaya)	• Leaves are used for poulticing sores and swellings of abdomen. • Decoction of leaves stops vomiting and roots treat dysentery
Mentha arvensis L.	polios (Tagalog) herba-buena (sp)	• Leaf infusion used as carminative, analgesic
Mentha crispa	hierba buena	• Good remedy for respiratory diseases

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Michelia champaca L.	sampaka	• Leaves – poultice for swelling • Juice – vermifuge
Mimosa pudica L.	makahiya (Tagalog) torog-torog (Bikol) babain (Ilokano)	• Decoction of entire plant is anti-asthmatic • Leaves are good pain reliever for kidneys and hips • Decoction of root is diuretic and treats dysmenorrhoea and diarrhoea • Treats malaria
Momordica charantia L.	ampalaya (Tagalog) paria (Ilocano) palia (Bisaya)	• Fruits and young shoots are used as mild insulin dependent diabetes mellitus • Treats arthritis, asthma. diarrhea, malaria and a good remedy for children's cough
Monochoria hastata	gabi-gabihan (Tagalog)	• Treats cancer
Morinda citrifolia	bangkoro	• Sap is antiarthritic • Ripe fruit is antidiabetic • A good remedy for pulmonary disorders
Moringa oleifera	malunggay (Tagalog)	• Remedy against arthritis and asthma
Morus alba L.	amoras (Filipino) amingit (Igorot) mora (Ibanag)	• Leaves are galactogogue, diannoretic, antidote for snake bite
Myrica rubra	cham-poi	• Treats bronchitis
Nelumbium nelumbo (L.)	baino, lotus	• Leaves – poultice • Roots are remedy for piles • Flowers are used as astringent and expectorant • Good remedy against hemorrhage
Nicotiana tabacum	tabako (Tagalog)	• Treats asthma and spasms
Nopalea cochinellifera (L.)	dilang-baka	• Plant joints – poultice for articular rheumatism, earache, toothache, erysipelas • Treats wounds
Oldenlandia biflora L.	pisek (Ivatan) dalumpang (Subanun) palarapdap (Samar-Leyte Bisaya)	• Applied to wounds • Decoction cures diarrhoea
Oldenlandia brachypoda DC.	ulasiman-kalat (Tagalog) daniri (Bisaya)	• Decoction of whole plant treats gonorrhoea
Oldenlandia corymbosa L.	malaulasiman, ulasiman-aso (Tagalog)	• Leaves used for poulticing to treat sores • Decoction of entire plant as febrifuge and stomachic
Orthosiphon aristatus (Blume) Miq.	balbas-pusa, kabling-gubat (Tagalog)	• Leaves are diuretic and infusions against various kidney illnesses • Medicine for nephritis, arthritis, gallstones and diabetes
Oryza zativa	palay, rice	• Treats diarrhoea and erysipela

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Oxalis corniculata L.	taingan-daga (Tagalog) marasiksik (Iloko) daraisig (Bikol)	• Leaves are used for: • cleansing wounds and treat itch, burns, sores, insect and scorpion stings and to remove warts • pain reliever due to swelling • treat miliaria, cough, fever, scabies and dysentery • Whole plant as a diuretic and treats opacity of the cornea
Pachyrrhizus erosus (L.) Urb.	singkamas	• Half a seed is laxative • Remedy against hemorrhage
Peperomia pellucida (L.) Kunth	ulasiman-bato (Tagalog) olasiman-ihalas (Cebu-Bisaya) tangon-tangon (Bikol)	• Whole plant used as a warm poultice to treat abscesses, boils and pimples • Decoction is used against gout, kidney troubles and rheumatic pain
Persea americana Mill.	abukado (Tagalog)	• Treats diarrhoea, hypertension and malaria • Emmenagogue
Phaseolus lunatus	patani	• Treats diarrhoea and malaria
Phyllanthus acidus (L.) skeels	iba (Tagalog) bangkiling (Bisaya) karmay (Ilokano)	• Leaf decoction are applied to urticaria • Decoction of bark treats bronchial catarrh
Phyllanthus amarus Schum.	sampa-sampalukan (Tagalog) san pedro (Bisaya) kurukalunggai (Bikol)	• Plant is emmenagogue, febrifuge and antidiarrhetic • Remedy against scabies
Phyllanthus reticulates Poiret	malatinta (Tagalog) matang-buiud (Bikol) sungot-olang (Bisaya)	• Leaf or bark is diuretic, alterative, depurative, refrigerant and odontalgic • Remedy against pinworms • Roots treat asthma
Phyllanthus simplex Retz.	kaya-an, kayut-bulang (Bagobo)	• Leaf juice as eyewash for inflamed eyes
Phyllanthus urinaria L.	ibaiba-an (Tagalog) laiolaioan (Bikol) takumtakum (Bisaya)	• Stimulate a child's appetite
Piper nigrum L.	paminta	• Root decoction is used as tonic and mouth wash in case of toothache • Treats malaria and scabies
Piper betle	Ikmo, buyu	• Remedy against pulmonary disorders
Pithecellabium dulce (Roxb.) Benth.	kamatsile	• Leaf decoction cures indigestion • Bark is antidysenteric • Treats malaria
Plantago lanceolata L.	lanting-haba (Tagalog)	• Leaves are applied to wounds, skin inflammations and sores
Plantago major L.	lanting, lantin, lanting-haba (Tagalog)	• Leaves are emollient

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Plectranthus amboinicus (Lour.) Spreng.	oregano (Sp.) segunda (Tagalog)	• Macerated leaves are good to burns and stings of centipedes and scorpions • Treats headache, dyspepsia and asthma • Infusion of leaves as a carminative
Plectranthus scutellarioides (L.) R.Br.	badiara, malaina, mayana (general)	• Fresh leaves cataplasm to bruises and contusions, and treats headache
Plumbago indica L.	laurel (Tagalog, Bikol) pampasapit (Tagalog)	• Bark is used as vesicant and an antidyspeptic • Roots treat headache
Plumbago zeylanica L.	sangdikit (Tagalog) bangbang, talankan (Ilokano)	• Infusion of roots is used against itch • Pounded roots are applied externally as vesicant and ebolic • Root decoction treat scabies
Plumiera acuminata Ait.	kalachuchi	• Latex – remedy for toothache • Bark decoction is antiherpetic and emmenagogue • Treats malaria and scabies
Portulaca oleracea L.	olasiman	• Plant decoction is good for cough and treats erysipelas and hemorrhage
Pteris ensiformis	pakong parang	• Relieves pain caused by swelling
Pterocarpus indicus	siempreviva	• Remedy for respiratory diseases
Premna cumingiana Schauer	magilik (Tagalog) manaba (Bikol, Bukidnon) banaba (Ibanag)	• Leaves are diuretic to treat dropsy
Prema odorata Blanco	alagao (general) agdau (Pangasinan) anobran (Iloko)	• Leaves are diuretic, treat cough, carminative and useful to beri-beri, febrifuge, used against abdominal pains and dysentery • Roots against cardiac troubles
Psidium guajava	bayabas (Tagalog)	• Treats diarrhoea,wounds and scabies
Punica granatum	granada	• Treats respiratory diseases
Quisqualis indica L.	niyog-niyogan (general, Tagalog) balitadhan (Bisaya) tartaraok (Ilokano)	• Used as bechic or pectoral • Fruits and seeds alleviate nephritis • Seeds are anthelmintic
Raphanus sativus	labanos	• Treats cancer and diarrhea
Rauvolfia amsoniifolia DC.	sibakong (Tagalog) banogan (Panay Bisaya) maladita (Bikol, Bukidnon)	• Decoction of the bark is used as stomachic • Young leaves treat stomach disorders in babies
Rhinacanthus nasutus (L.) Kurz	ibon-ibonan, tagak-tagak (Tagalog)	• Roots and leaves are remedy for ringworm, eczema, scurf and herpes
Saccharum officinarum	tubo	• Roots are diuretic • Good remedy for respiratory diseases
Saccharum spontaneum	talahib	• Treats diarrhoea and tuberculosis
Samanea saman (Jacq.) Merr.	akasia (Tagalog)	• Leaf decoction is antidiarrhetic • Bark decoction is antidysenteric

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Samadera indica	manunggal	• Treats erysipelas
Samanea saman	narra	• Remedy for respiratory diseases
Sandoricum koetjape	santol	• Remedy for spasms
Schefflera caudate (S. Vidal) Merr. & Rolfe	himainat (Filipino) lima-lima (Tagalog, Bisaya)	• Decoction is given as a tonic to women after childbirth
Schefflera cumigii (Seem.) Harms	kalkugamat (Filipino) kolokagama (Negrito	• Cures stomach trouble
Schefflera elliptica (Blume) Harms	lima-lima (Filipino) arasagat (Iloko) galamai-amo (Tagalog)	• Bark is employed as a bechic, the resin as vulnerary • Decoction of leaves is an effective antiscorbutic • Wood relieves toothache
Schefflera elliptifoliola Merr.	galami (Filipino)	• Decoction of leaves is used as tonic by women after childbirth
Schefflera insularum (Seem.) Harms	galamai-amo (Filipino) kalankang (Panay Bisaya) pararan (Bagobo)	• Juice of pounded fresh leaves is used as purgative and treats cancer
Schefflera trifoliata Merr. & Rolfe	sinat (Filipino) gauai-gauai, himainat (Tagalog)	• Crushed leaves applied externally against tympanites of children and tonic for women after childbirth and treats irregular menstruation
Scutellaria indica L.	banod (Bagobo)	• Carminative, tonic and resolves blood clot
Scutellaria javanica Jungh.	lupingan, sidit (Igorot)	• Decoction cures stomach pain
Sesbania grandiflora	katuray (Iloko)	• Leaf juice is a good remedy for catarrh and headache • Bark is antidiarrhetic
Senna alata (L.) Roxb.	andadasi (Iloko) katanda (Tagalog) palochina (Bisaya)	• Used against ringworm and scabies • Laxative and purgative
Senna sophera (L.) Roxb.	andadasi (Iloko) tambalisa (Tagalog)	• Seeds treat fever
Senna tora (L.) Roxb.	katanda, balatong-aso (Tagalog)	• Pounded leaves are smeared on the head of restless children • Decoction of leaves used as purgative, vermifuge and treats cough
Smilax bracteata K. Presl	banag (general) kamagsa-obat (Tagalog) banagan (Bisaya)	• Decoction is emmenagogue, depurative
Smilax china L.	sarsaparillang-china (Tagalog) buanal (Igorol) palipit (Bontok)	• Rhizomes are used against herpes, syphilis, chronic rheumatism, skin disease and asthma
Smilax leucophylla Blume	sarsaparillang-puti (Tagalog) banag (Tagbanua) kaguno (Negrito)	• Rhizomes are considered blood purifier and used in cases of syphilis, rheumatism and skin diseases
Solanum erianthum D. Don	malatong (Tagalog) liuangkag (Bukidnon) ungali (Bisaya)	• Root decoction removes impurities through urine; also antidiarrhetic

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Solanum melongena L.	talong	• Remedy for wounds
Solanum nigrum L.	Konti, lubi-lubi (Filipino, Tagalog) anti (Bontok, Tagalog) kuti (Bikol)	• Plants are used as an emollient and antalgic in itching, burns and neuralgic pains, expectorant and laxative • Fruits are antidiarrhetic • Treats erysipela
Solanum sanitwongsei Craib	talong-siam (Filipino)	• Fruits are effective against diabetes • Expectorant and diuretic
Solanum tuberosum	patatas (Tagalog)	• Treats arthritis and spasms
Sophora tomentosa L.	tambalisa (Filipino) mangguiau (Bikol, Tagalog) pangalangan (Tagalog, Bisaya)	• Seed oil is a good expectorant • Soothes painful bones • Seed, root and bark decoction used against cholera • Pounded seeds cure colic and dysentery
Spondias purpurea	siniguelas	• Bark decoction is antidysenteric for stomatitis in babies and treats diarrhoea • Remedy for pulmonary disorders
Stephania japonica (Thunb.) Miers	malabuta (Igoro) maratugi (Iloko) kuren (Ibanag)	• Tuberous root treat dysentery, stomachache, fever, urinary disorders, hepatitis, inflammation and itch • Crushed leaves in water are applied to breast infections
Streblus asper Lour.	kalios	• Chewed bark – antidote for bite • Decoction is antidiarrhetic • Relieves pain caused by swelling
Strychnos ignatii Bergius	katbalonga (Tagalog) igasud (Bisaya) pepita-sa-katbalogan (Tagalog, Bisaya, Pampango)	• Seeds and bark are stomachic, febrifuge, anticholeric and tonic
Strychnos minor Dennst.	bukuan (Ibanag, Negrito) pamulaklakin (Tagalog) bugahin (Bisaya)	• Wood, bark and root decoction are emmenagogue and treat throat complaints
Tabernamontana pandacaqui	pandakaki	• Treats cancer • Poultice for wounds
Tagetes erecta	ahito, amarillo	• Treats bronchitis
Tamarindus indica L. HBK	sampalok	• Treats diarrhoea and pulmonary disorder • “Malasibu” is good for indigestion
Terminalia catappa	talisay	• Treats scabies
Theobroma cacao	cacao	• Root decoction is echolic and emmenagogue • Treats hypertension
Tinospora crispa (L.) Hook.f. & Thomson	makabuhay, meliburigan (Mindanao) paliaban (Bisaya) panyawan vine (Visayas)	• Stem decoction used internally as tonic and externally, pasaticide

Scientific Name	Vernacular/ Common Name(s)	Use(s)
Tinospora glabra (Burm.f.) Merr	makabuhay (Luzon, Mindoro) papaitan (Palawan) sangawnaw (Mindanao)	• Burnt leaves are used to treat pinworms, ground bark is applied to sore breasts of nursing mothers
Trichosanthes cucumerina L.	melon-daga, pakupis, tabubok (Tagalog)	• Fruits of wild plants are used as purgative and vermifuge
Trichosanthes quinquangulata A. Gray	patolang-gubat (Tagalog) kalanum-uak (Bisaya) katimbau (Iloko)	• Cooked, powdered seeds are applied to itch and mixed with wine to treat stomach ache
Trichosanthes villosa Blume	Kandolamo (Bukidnon)	• Juice from plant treats diarrhoea when the stool is white • Crushed leaves smeared on the body to reduce fever, also alleviate the pain of swollen legs of pregnant women
Verbena officinalis L.	verbena	• Tonic, galactagogue, emmenagogue, purgative, febrifuge, diaphoretic, astringent, anthelmintic, antihaemorrhagic, antispasmodic and antiscorbutic
Vernonia cinerea (L.) Less.	kolong-kugon (Bisaya) agas-moro (Ilokano) bulak-manok, tagulinao (Tagalog)	• Root decoction is used against diarrhoea and stomachache • Infusion of the plant treats cough
Viola odorata	Violeta, sweet violet	• Treats cancer
Vitex glabrata R.Br.	bongoog (general) ampapalut (Balabac) talang-pulo (Camarines)	• Bark is used as anthelmintic and as remedy for gastro-intestinal disorders • Root and bark are applied as a component of masticatories
Vitex negundo L.	lagundi (Filipino) dangla (Iloko)	• Boiled seeds prevents spread of toxins from poisonous bites of animals • Syrup, tablets and capsule prepared from leaves and flowering tops are given for coughs, colds, fever and asthma
Vitex quinata (Lour.) F.N. Williams	kalipapa (general)	• Bark is used as tonic and as a stomachic, infusion of the trunk stimulate appetite
Vitex trifolia L.	lLagunding-dagat (Filipino) dangla (Iloko) tigao (Sulu)	• Poultice of leaves is used to treat rheumatism, contusions, swollen testicles, and as a discutient in sprains • Infusion of boiled root is regarded as diaphoretic and diuretic and treats fever of child after birth • Treats cancer
Wedelia biflora	hagonoi	• Treats scabies
Zingiber officinale	luya	• Treats diarrhoea

Attachment 2

Bibliographic list of published materials on medicinal plants

Books

Title : *Plant Resources of South East Asia 12(1) Medicinal and Poisonous Plants*
Editors : LS de Padua, N Bunyapraphatsara and RMHJ Lemmens

Title : *Plant Resources of South East Asia 12(2) Medicinal and Poisonous Plants*
Editors : JLCH van Valkenburg and N Bunyapraphatsara

Title : *Plant Resources of South East Asia 12(3) Medicinal and Poisonous Plants*
Editor : RMHJ Lemmens and N Bunyapraphatsara

Title : *Medicinal Plants of the UPLB Museum of Natural History*
Author : LS de Padua

Title : *Plants that You Know but Really Don't*
Author : IN Inaylo

Title : *Selection and Scientific Validation of Medicinal Plants for Primary Health Care*
Publisher: Philippine Council for Health Research and Development

Title : *Handbook on Medicinal Plants, Volume 1*
Authors : LS de Padua, GC Lugod and JV Pancho

Title : *Handbook on Medicinal Plants, Volume 2*
Authors : LS de Padua, GC Lugod and JV Pancho

Title : *Handbook on Medicinal Plants, Volume 3*
Authors : LS de Padua, GC Lugod and JV Pancho

Title : *Handbook on Medicinal Plants, Volume 4*
Authors : LS de Padua, GC Lugod and JV Pancho

Title : *Medicinal and Poisonous Plants*
Authors : LB Cardenas, MA O Cajano and NO Aguilar

Title : *National Trainers' Manual on the Use of Philippine Medicinal Plants*
Author : NPCortes- Maramba

Title : *Manwal sa Paggamit ng mga Halamang Gamot*
Author : NP Cortes-Maramba

Title : *Healing Wonders of Herbs*
Author : H de Guzman-Ladion

Information Bulletins

Title : *Primer on Growing Medicinal Plants*

Author : EG Quintana

Title : *The Local Production of Medicinal Plants*
Publisher: Philippine Council for Health Research and Development

Title : *Philippine Herbals Production and Utilization: A Guide for HMT's and RIC Leaders of the Ministry of Agriculture and Food*
Author : SC Serrano

Title : *The Herbal Medicine Technoguide, Vol. 1*
Publisher: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development

Title : *How to Grow Medicinal Plants*
Author : ML Generalao

Title : *Recommended Bioassay Procedures for Medicinal Plants*
Author : Philippine Council for Health Research and Development

Title : *Medicinal Plants: The Wonder Drugs*
Author : NS de la Cruz

Title : *Aromatic and Medicinal Herbs of the Philippines*
Author : MS Cantoria

Title : *Medicinals from the Collection of Forest Research Institute*
Author : Forest Product Research and Development Institute

Title : *Herbal Medicine – A Viable Alternative for the Filipino People*
Author : J Cruz

Title : *Technical Information on Medicinal Plants*
Author : Philippine Council for Health Research and Development

Title : *Yerba Buena for Arthritis, Aches, and Pains*
Author : Philippine Council for Health Research and Development

Title : *Botanical Expeditions in the Philippines*
Authors : DA Madulid and HG Gutierrez

Title : *Twenty Common Medicinal Plants and How to Use Them*
Author : M Asis

Title : *Flora of Manila*
Author : ED Merrill

Title : *Capiz Medicinal Plants*
Author : B Molina

Title : *Herbs and Spices (Business Kit)*
Author : Technology and Livelihood Resource Center

Title : *Manwal sa Paghahanda ng mga Halamang Gamot*
Author : L de Padua

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Inventory, documentation and status of medicinal plants research in Sri Lanka

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Introduction

Sri Lanka has the highest plant diversity per unit area than any other country in Asia, containing over 3700 species of flowering plants and over 350 species of ferns. Over 28% of the flowering plants and 18% of the ferns are endemic to the island. Among the native flora of Sri Lanka, there are well over 500 species that have been and are still being used in traditional medicine, with 10% of these endemic to the country. Apart from that, there are over 900 non-indigenous medicinal plants used in folk medicine. Of all the medicinal plants used in Sri Lanka, 79 species are considered as threatened. These 79 species are either endemic to the island or have a limited distribution over the Indian sub-continent. The populations of medicinal plants are adversely affected by over harvesting and lack of care to their habitat when collecting plants from the wild. Over harvesting of plants is mainly due to the high demand for Ayurvedic medicines. Currently, 60% of the demand for medicinal plants is supplied through imports.

Authentic information on medicinal plants is not readily available. Usually, the sources of knowledge are contradictory (e.g. several plants are identified under different names and uses by practitioners of traditional medicine) or are scattered and fragmentary. Shortage of skills on ethnobotany has also hindered effective conservation strategies. However, Sri Lanka is fortunate to have a rich reserve of indigenous knowledge on medicinal plants due to a large number of practitioners of traditional medicine. This important source of knowledge is currently under threat as little effort has been made to understand and document their knowledge. Unless a concerted effort is made to record the knowledge of plants used by practitioners of indigenous medicine, it is very likely that vital information on plant uses, their characteristics and habitats will be lost.

Medicinal plants In Sri Lanka and their uses

Over 1400 plants are used in indigenous medicine in Sri Lanka. Although western medicine is the predominant system of health care in the island, many people still use indigenous medicines for some illnesses such as common cold, body aches, minor fractures, etc. Many of these plants are common trees and shrubs (Attachment 1).

Collecting and conservation efforts undertaken

Over 80% of the medicinal plants used locally in Sri Lanka are harvested from the wild. It is only recently that people are turning to the commercial cultivation of medicinal plants. Since most of the domestic supply of plants come from the wild, this has led to over harvesting of populations from their natural habitats, with some plants (e.g. *Munronia pinnata*) becoming endangered due to indiscriminate collecting. In addition, increased demand for agricultural land and unsustainable cultivation practices such as shifting cultivation and slash and burn cultivation destroy the natural habitats of medicinal plants.

Through the World Bank-funded Sri Lanka Conservation and Sustainable Use of Medicinal Plants Project, five Medicinal Plant Conservation Areas (MPCAs) were

established at Ritigala, Naula, Rajawaka, Kanneliya and Bibile. The villagers in and around these conservation areas have been trained in cultivation and enrichment of medicinal plants in the wild and extension services to promote the sustainable harvesting of plants. This has resulted to increased nursery capacity and cultivation of plants in home gardens and farms in those areas. The medicinal plant garden at Ganewatte also serves as an *ex-situ* conservation centre for medicinal trees, shrubs and herbs.

Research on medicinal plants conducted in Sri Lanka

Many of the Sri Lankan medicinal plants have been investigated by scientists in the universities and research institutes for their chemical properties and biological activities (Hewage *et al.* 1997, 1998). These investigations are primarily aimed at the discovery of substances with commercial potential for exploitation as drugs or pesticides. In addition to phytochemistry, research on medicinal properties such as anti-microbial and hypoglycaemic activity, immunomodulatory, anti-inflammatory and hepatoprotective action and diuretic effects of medicinal plants are also being done at several universities (e.g. Colombo, Peradeniya, and Ruhuna).

Unfortunately, the agreements on benefit sharing are the exception rather than the rule and rarely do developing countries receive any sharing of the benefit from commercial exploitation (Kumar 2000). A good example is a Sri Lankan medicinal plant, *Salacia reticulate,* long reputed and locally exploited for its anti-diabetic properties. The plant and a relative, *Salacia prinoides*, which is also found in Sri Lanka, have been investigated in Japan and the United States for the properties mentioned. Its hypoglycaemic constituents have been the subject of several publications (Yoshikawa *et al.* 1998a, 1998b, 1998c; Shimodo *et al.* 1998) and patents by Japanese (Yamahara 1999) and American (Inman and Reed 1997) scientists, with no reference whatsoever to Sri Lanka. It is unlikely that any commercial exploitation of this discovery will result in the sharing of benefits with Sri Lanka or the holders of the traditional knowledge involved (Kumar 2000).

Priority areas for medicinal plants research in Sri Lanka

The following are priority areas of medicinal plant research identified in Sri Lanka:

1. Improvement of medicinal plants using breeding and selection of high-yielding superior varieties;
2. Research on agronomy of medicinal plants to lower the cost of production;
3. Pest and disease control;
4. Organic production of medicinal plants;
5. Research on the *ex-situ* and *in-situ* conservation of medicinal plants;
6. Phytochemistry of indigenous medicinal plants and their relatives; and
7. Analysis of medical properties of indigenous medicinal plants.

Agencies/Organizations working on medicinal plants in Sri Lanka

Sri Lanka has a well-organized, state-sponsored system to support the development of native medicine. There is even a state ministry dealing with indigenous medicine. The mandate of this ministry is the implementation of policies, plans and programmes with respect to indigenous medicine. The main institutions concerned with medicinal plants research under the Ministry of Indigenous Medicine include:

1. Department of Ayurveda;
2. Bandaranaike Memorial Ayurvedic Research Institute;
3. Ayurveda Drugs Corporation;
4. National Institute of Traditional Medicine; and
5. Ayurveda Medical Council.

The Ministry of Indigenous Medicine supports 34 Ayurvedic hospitals including a teaching hospital in Colombo and a research hospital at Navinna. There is an estimated 10 000 certified Ayurvedic practitioners in Sri Lanka. The ministry has also established five medicinal plant gardens: Navinna (6.5 ha); Kotte (1.5 ha); Bathgoda (30 ha); Girandurukotte (68 ha); and Pattipola (11.5 ha).

The Sri Lanka Conservation and Sustainable Use of Medicinal Plant Project have also established several medicinal plant nurseries and conservation sites.

Several universities like those located in Peradeniya, Colombo and Ruhuna are currently working on the chemistry, medical properties and cultivation of medicinal plants.

The national botanic gardens of the Department of Agriculture have a 21-ha medicinal plant garden and small medicinal plant collections in three main botanic gardens in Peradeniya, Gampaha and Hakgala.

Published literature on medicinal plants in Sri Lanka

The Department of Ayurveda, Sri Lanka (DASL) has documented the Sri Lankan indigenous medicinal system in three volumes of Ayurveda Pharmacopoeia (DASL 1976; DASL 1980; DASL 1985). The Ayurveda Pharmacopoeia identifies the raw materials used by local physicians in indigenous medical systems, listing of drugs prescribed for different diseases and the methods of preparation of the different drugs. Although the Pharmacopoeia claims to deal with Ayurvdic, Siddha and Unani systems, it concentrates mainly on Ayurveda.

Plants used in the local Ayurveda system have also been botanically described in a well-illustrated, five-volume work by Jayaweera (1981-1982). Other notable publications on medicinal plants in Sri Lanka include those by Attygala 1917; Chandrasena 1933; and Parsons 1937. Several Sinhala language publications also exist (i.e., Gnanawimala 1959; Karunanayake 1992; DASL 2002; and Perera 2002).

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Attachment 1

Common trees and shrubs used in traditional medicine in Sri Lanka
(Source: Ashton et al. 1997)

Known Use(s)	Plant Species
Antiseptic	*Canarium zeylanicum*
	Calophyllum inophyllum
	Azadirachta indica
	Pongamia pinnata
	Citrus aurantifolia
Aphrodisiac	*Ceiba pentandra*
	Dichrostachys cinerea
	Ficus hispida
Asthma	*Acanthus ilicifolius*
	Justicia adhatoda
	Mangifera zeylanica
	Phyllanthus reticulatus
	Erythrina variegata
	Mussaenda frondosa
	Sapindus trifoliatus
	Justicia adhatoda
Beri-beri	*Carica papaya*
Bladder and kidney stones	*Ceiba pentandra*
	Crateva adansonii
	Artocarpus heterophyllus
	Prunus cerasoides
	Annona muricata
Boils, external ulcers and sores	*Lannea coromandelica*
	Alstonia scholaris
	Plumeria obtusa
	Calotropis gigantea
	Bambusa bambos
	Canarium zeylanicum
	Dipterocarpus zeylanicus
	Erythroxylum zeylanica
	Phyllanthus emblica
	Phyllanthus reticulatus
	Litsea longifolia
	Erythrina variegata
	Strychnos nux-vomica
	Hibiscus rosa-sinensis
	Thespesia populnea
	Memecylon capitellatum
	Artocarpus heterophyllus
	Streblus asper
	Horsfieldia irya
	Syzygium caryophyllatum
	Borassus flabellifer
	Morinda citrifolia
	Tarenna asiatica
	Acronychia pedunculata
	Gyrinops walla

Known Use(s)	Plant Species
	Cinnamomum verum
	Tamarindus indica
	Clerodendrum inerme
	Flueggea leucopyrus
	Horsfieldia irya
	Adina cordifolia
Bronchial diseases and pneumonia	*Justicia adhatoda*
	Mangifera indica
	Plumeria obtusa
	Bambusa bambos
	Cordia dichotoma
	Cinnamomum verum
	Cassia fistula
	Zizyphus jujuba
	Atalantia ceylanica
	Citrus aurantiifolia
Bruises, sprains and swellings	*Lannea coromandelica*
	Cassine glauca
	Litsea glutinosa
	Bauhinia tomentosa
	Ficus benghalensis
	Acronychia pedunculata
	Atalantia monophylla
Cardiotonic	*Justicia adhatoda*
	Nerium oleander
	Aegle marmelos
Catarrh and sinusitis	*Barleria prionitis*
	Azadiracta indica
	Clerodendrum serratum
	Vitex negundo
	Sesbania grandiflora
	Atalantia ceylanica
	Vitex leucoxylon
Cholera	*Strychnos nux-vomica*
	Borassus flabellifer
Colds and coughs	*Barringtonia acutangula*
	Barringtonia racemosa
	Careya arborea
	Albizia odoratissima
	Citrus limon
	Citrus aurantiifolia
	Madhuca longifolia
	Vitex negundo
	Citrus limon
	Sapindus emarginatus
Cuts and wounds	*Justicia adhatoda*
	Bauhinia tomentosa
	Diospyros malabarica
	Euphorbia antiquorum
	Citrus aurantiifolia
	Zizyphus oenoplia
Diabetes	*Anacardium occidentale*
	Canarium zeylanicum

Known Use(s)	Plant Species
	Kokoona zeylanica
	Butea monosperma
	Pongamia pinnata
	Pterocarpus marsupium
	Cassia auriculata
	Lagerstroemia speciosa
	Osbeckia octandra
	Artocarpus heterophyllus
	Ficus benghalensis
	F. racemosa
	Syzygium cumini
Diarrhoea and dysentery	*Justicia adhatoda*
	Anacardium occidentale
	Mangifera indica
	Spondias dulcis
	Alstonia scholaris
	Carissa carandas
	Oroxylum indicum
	Ceiba pentandra
	Garcinia mangostana
	Terminalia bellirica
	T. catappa
	T. chebula
	Phyllanthus reticulatus
	Cinnamomum verum
	Litsea glutinosa
	Barringtonia acutangula
	B. racemosa
	Butea monosperma
	Bauhinia recemosa
	Bauhinia tomentosa
	Hibiscus tiliaceus
	Aglaia roxburghiana
	Streblus asper
	Horsfieldia iryaghedi
	Psidium guajava
	Syzygium cumini
	Punica granatum
	Ixora coccinea
	Aegle marmelos
	Limonia acidissima
	Santalum album
	Allophylus cobbe
	Mimusops elengi
	Helicteres isora
	Grewia rothii
Dropsy	*Anacardium occidentale*
	Terminalia bellirica
	Terminalia chebula
	Premna latifolia
Ear ache	*Spondias dulcis*
	Alstonia scholaris
	Terminalia arjuna

Known Use(s)	Plant Species
	Euphorbia antiquorum
	Erythrina variegata
Emetics	*Cassine glauca*
	Hibiscus tiliaceus
	Walsura trifoliolata
	Ficus hispida
Eye diseases	*Callophyllum inophyllum*
	Terminalia bellirica
	Terminalia chebula
	Dichrostachys cinerea
	Sesbania grandiflora
	Ixora coccinea
Fever	*Alstonia scholaris*
	Terminalia bellirica
	Dillenia indica
	Cassia auriculata
	Cassia fistula
	Streblus asper
	Mitragyna parvifolia
	Euodia lunu-ankenda
	Glycosmis pentaphylla
	Santalum album
	Sapindus emarginatus
	Clerodendrum inerme
	Clerodendrum infortunatum
	Clerodendrum serratum
	Gmelina arborea
Fractures and dislocations	*Calophyllum walkerae*
	Dillenia retusa
	Euphorbia tirucalli
	Saraca asoca
	Phoenix zeylanica
	Acronychia pedunculata
	Allophylus cobbe
	Allophylus zeylanicus
	Madhuca longifolia
	Terminalia arjuna
Gastric ulcer	*Caryota urens*
Hair growth	*Cocos nucifera*
	Caryota urens
	Schleichera oleosa
	Tectona grandis
Headache	*Cassine glauca*
	Konoona zeylanica
	Rhododendron arboreum
	Ricinus communis
	Calophyllum inophyllum
	Vitex leucoxylon
Insect bites	*Annona squamosa*
	Cassia fistula
	Anacardium occidentale
	Azadiracta indica
	Zizyphus oenoplia

Known Use(s)	Plant Species
	Limonia acidissima
	Vitex negundo
Intestinal and stomach aches	*Carica papaya*
	Syzygium aromaticum
	Clausena indica
	Limonia acidissima
	Murraya koenigii
	Helicteres isora
	Premna tomentosa
Jaundice and hepatitis	*Barleria prionitis*
	Calotropis gigantea
	Flacourtia indica
	Tamarindus indica
	Osbeckia octandra
	Azadiracta indica
	Mussaenda frondosa
	Callicarpa tomentosa
Laxative	*Cordia dichotoma*
	Cycas circinalis
	Phyllanthus emblica
	Ricinis communis
	Cassia auriculata
	Tamarindus indica
	Ficus religiosa
	Aegle marmelos
	Murraya koenigii
	Sterculia balanghas
Malaria	*Barringtonia acutangula*
	Cassia fistula
	Clerodendrum infortunatum
	C. serratum
Menstrual pains	*Memecylon umbellatum*
Piles	*Semecarpus coriacea*
	S. gardneri
	Capparis zeylanica
	Saraca asoca
	Thespesia populnea
	Ficus racemosa
	Aegle marmelos
	Terminalia chebula
	Cycas circinalis
	Flacourtia indica
	Osbeckia octandra
Acne and pimples	*Kokoona zeylanica*
	Garcinia morella
	Tamarindus indica
Purgatives	*Annona squamosa*
	Oroxylum indicum
	Calophyllum inophyllum
	Terminalia chebula
	Dimorphocalyx glabellus
	Euphorbia antiquorum
	Cassia auriculata

Known Use(s)	Plant Species
	C. fistula
	Ficus religiosa
	Moringa oleifera
	Syzygium caryophyllatum
	Acronychia pedunculata
Rheumatism	*Acanthus ilicifolius*
	Carica papaya
	Vitex negundo
	Barleria prionitis
	Spondias dulcis
	Dipterocarpus zeylanicus
	Mallotus philippensis
	Sesbania grandiflora
	Michelia champaca
	Calophyllum inophyllum
	Bridelia retusa
	Pongamia pinnata
	Ficus benghalensis
	Madhuca longifolia
Scalds and burns	*Madhuca longifolia*
Sedative	*Capparis zeylanica*
	Artocarpus hetertophyllus
	Ixora coccinea
Sexual (venereal) diseases (Gonorrhea and syphilis)	*Phyllanthus emblica*
	Borassus flabellifer
	Ficus racemosa
	Phoenix zeylanica
	Capparis horrida
	Capparis zeylanica
	Carissa carandas
	Plumeria obtusa
	Carmona retusa
	Macaranga peltata
Skin diseases	*Nerium oleander*
	Glycosmix pentaphylla
	Tectona grandis
	Butea monosperma
	Jasminum angustifolium
	Psidium guajava
	Semecarpus coriaecea
	Semecarpus gardneri
	Semecarpus subpeltata
	Calotropis gigantea
	Crateva religiosa
	Terminalia catappa
	Mallotus philippensis
	Hydnocarpus venenata
	Barringtonia racemosa
	Pongamia pinnata
	Cassia fistula
	Santalum album
	Tectona grandis
Snake bite	*Walidda antidysenterica*

Known Use(s)	Plant Species
	Horsfieldia irya
	Acanthus ilicifolius
	Bauhinia tomentosa
	Morinda citrifolia
	Gyrinops walla
	Cassine glauca
	Kokoona zeylanica
	Anogeissus latifolius
	Butea monosperma
	Moringa oleifera
	Caryota urens
	Prunus cerasoides
	Citrus aurantifolia
	Citrus medica
	Limonia acidissima
Sore throat	*Wallida antidysenterica*
	Dipterocarpus zeylanicus
	Diospyros malabarica
	Butea monosperma
	Myristica dactyloides
	Tectona grandis
Stimulant	*Acanthus ilicifolius*
	Michelia champaca
	Walsura trifoliolata
	Syzygium zeylanicum
	Areca catechu
	Limonia acidissima
Toothache and gum diseases	*Barleria prionitis*
	Ficus religiosa
	Lannea coromandelica
	Alstonia scholaris
	Plumeria obtusa
	Euphorbia antiquorum
	Euphorbia tirucalli
	Cinnamomum verum
	Erythrina variegata
	Syzygium aromaticum
	Psidium guajava
	Nauclea orientalis
	Gyrinops walla
	Terminalia chebula
	Ficus religiosa
	Syzygiumcumini
	Mimusops elengi
	Barleria prionitis
	Canarium zeylanicum
	Carica papaya
Tonsillitis	*Citrus aurantiifolia*
	Sapindus emarginatus
Urinary diseases	*Semecarpus coriacea*
	Semecarpus gardneri
	Semecarpus subpeltata
	Cordia dichotoma

Known Use(s)	Plant Species
	Crateva adansonii
	Cassia auriculata
	Ficus racemosa
	Cocos nucifera
	Mimusops elengi
Warts and corns	*Carica papaya*
	Euphorbia antiquorum
	Euphorbia tirucalli
Worms	*Bambusa bambos*
	Mallotus philippensis
	Erythroxylum zeylanica
	Areca catechu
	Mallotus philippensis
	Punica granatum

Inventory, documentation and status of medicinal plants research in Vietnam

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Introduction

Vietnam is a tropical country rich in plant genetic resources, with more than 3300 plant species classified as medicinal plants. Throughout its history, Vietnamese traditional healers have used medicinal plants to prevent and cure certain types of diseases through indigenous medical procedures.

In 1987, the Government of Vietnam started to implement a national programme entitled "Conservation of Medicinal Plant Genetic Resources". After 15 years, the programme has been largely considered a success, although it had many difficulties with funding, international collaboration and information sharing.

Medicinal plants collecting and conservation efforts undertaken and present status

Vietnamese traditional medicine holds an important position within the health care system of the country, especially among the rural population. Many of the medicinal plants used have both dietary and medicinal uses. Very little is known about the health benefits of regularly consuming small quantities of medicinal plants, moreso their curative properties. Medicinal plants are used as direct traditional therapeutic agents or as raw material for pharmaceutical products. Furthermore, chemical structures derived from plants can be used as models for synthetic compounds.

Studies show that there are about 10 500 vascular plant species in Vietnam, some even put the figure at around 12 000 species, out of which more than 4000 are considered as medicinal plants. Medicinal plants play an important role in the natural biodiversity of the country as more than 80% are found in the wild and only 20% are being cultivated. Conservation of medicinal plants in the country, therefore, is a national priority.

During the 1970's, North Vietnam produced thousands of tons of herbal medicines from at least 350 plant species for both export and local markets. Since 1975, over extraction of wild medicinal plants led to the near disappearance of some valuable and rare species such as *Coscinium fenestratum, Fibraurea spp., Staphania brachyandra, Cibotium barometz, Homalonea occulta, Panax vietnamensis, Coptis chinensis, Stephania tetrandra, Morinda officinalis* and others. In 1988, the Ministry of Science and Technology approved a national programme entitled, "Conservation of Medicinal Plants Genetic Resourses", with the Institute of Materia Medica (IMM) as the lead implementing agency. The main objective of this national programme is to stem the tide of overexploitation and eventual destruction and disappearance of rare medicinal plants species from their natural habitats.

To date, a network for conserving medicinal plants endemic to Vietnam has been formed, which consists of 14 units from Sapa (>1500m ; 22°N), Tam Dao (>800m ; 20°N), Van Dien (50m ; 20°N), Thanh Hoa (80m ; 19°N), Bach Ma (1000m ; 17°N) and Moc Hoa (5 -10m ; 15°N). The network categorized medicinal plants into five groups: (1) endangered varieties; (2) commonly used varieties; (3) newly introduced varieties; (4) traditional varieties; and (5) under "experiment." Many approaches have been used to conserve these medicinal plants, including:

1. *Ex situ* conservation through 15 ecological gardens in the country;

2. *In situ* conservation in the delta, forest, mountains and other ecosystems;
3. On-farm conservation in farmers' fields;
4. Seed conservation in cold storage; and
5. *In vitro* conservation of rare and endangered species.

Achievements to date:

1. More than 705 medicinal plant species, consisting of rare and endangered species, have been conserved;
2. Collection gardens have been established in every province;
3. A total of 263 species have been conserved *ex-situ* in the gardens;
4. A total of 175 species of medicinal plants seeds are kept in the cold storage (cryopreservation);
5. About 120 species have been conserved *in-situ* in four national gardens;
6. On-farm conservation of *Panax bipinnatifidus, Panax stepuleanatus, Panax vietnamensis* and *Hibiscus sayistifolius* in farmers' field have been established;
7. Seven rare species have been conserved *in vitro*;
8. A total of 263 medicinal plant species were evaluated;
9. A total of 353 medicinal plant species were documented;
10. Conservation gardens were established in farmers' fields, home-gardens, and hospitals in Vinh Phuc, Hai Duong and Thanh Hoa provinces;
11. Special varieties of medicinal plants were provided to other national projects for these studies. These selected varieties are C*rinum latifolium, Desmolium stinacifolium, Crinum spp, Angelica pubescens,* and *Silibum marianum;* and
12. Seeds of species such as *Angelica acutiloba, Mentha spp, Cymbopogon spp, Achyranthes bidentata, Angelica dahurica* and *Plantago asiatic* have been provided to consumers.

Plans for the implementation of the project on inventory and documentation of medicinal plants in Vietnam

1. Establishment of bibliographic database of published and unpublished information on medicinal plants in Vietnam;
2. Summary status of research on major medicinal plants in Vietnam. The subsequent report shall include research results, research gaps, related national policies and the different uses of medicinal plants;
3. Development of a list of conserved medicinal plant species in Vietnam, with information on where these are conserved and how they are managed, and their known uses;
4. Priority listing of medicinal plant species based on economic value and priority research needs at the national level; and
5. Establishment of a database containing the names and contact addresses of agencies working on the conservation and use of medicinal plants in the country.

CHAPTER 4

THE ASIA-PACIFIC MEDICINAL PLANTS RESEARCH MEETING REPORT

7-9 April 2003
Putra World Trade Centre
Kuala Lumpur, Malaysia

Report on the Asia Pacific Medicinal Plants Research Meeting[1]

Background

A workplan for partnership between the Rural Development Administration (RDA) of the Republic of Korea and the International Plant Genetic Resources Institute (IPGRI) was signed on 5 December 2001 to implement a project entitled "Inventory and documentation of medicinal plants in 14 Asia Pacific countries". The project involves 14 proposed countries: China, India, Indonesia, Malaysia, the Philippines, Vietnam, Republic of Korea, Bangladesh, Mongolia, Nepal, Sri Lanka, Thailand, Fiji and Papua New Guinea.

When IPGRI began to implement the project, several countries identified a number of issues and concerns, which included intellectual property rights, sharing of information, exchange of germplasm, and national policies. These were considered by the implementing agencies contacted as the most sensitive issues with which the participating countries would be concerned. Several countries, therefore, recommended that the participating countries meet with IPGRI and RDA to discuss the issues associated with project implementation. In recognition of this recommendation, RDA agreed to consider holding a meeting for this purpose and a Letter of Agreement was signed for the funding of such a meeting by RDA to be hosted by IPGRI.

The Asia Pacific Medicinal Plants Research Meeting (APMPRM) was held at the Putra World Trade Center (PWTC), Kuala Lumpur, Malaysia, on 7-9 April 2003. The meeting was attended by 25 participants from nine of the participating countries: Indonesia, India, Malaysia, Mongolia, Nepal, the Philippines, Republic of Korea, Sri Lanka and Vietnam. In the case of China, the project leader had an English graduate school examination; Bangladesh was unrepresented due to visa problems; Fiji and Papua New Guinea were unrepresented due to constraints in travel processing and approvals; and Thailand has not yet identified its project leader. In addition to country participants, representatives from the Malaysian Herbal Corporation (MHC), the International Plant Genetic Resources Institute's Regional Office for Asia, the Pacific and Oceania (IPGRI-APO) also attended the meeting.

In conjunction with the meeting, visits were made to the Forest Research Institute of Malaysia (FRIM), Enstek Sci-Tech City and the regional office of IPGRI for Asia, the Pacific and Oceania. The details of the APMPRM meeting programme are shown in Annex 1 and the list of participants is shown in Annex 2.

The meeting was held back-to-back with the Asia Pacific Natural Products Conference and Exposition (NATPRO 2003), which was organized by the Government of Malaysia and held on 10-12 April 2003 at the same venue. Most of the participants to the APMPRM also attended activities held under NATPRO 2003, enriching their appreciation of the value of medicinal plants and the advantages of research collaboration among countries. They were also exposed to a range of natural products including medicinals, nutriceuticals and cosmetics that were part of the NATPRO exposition from various national and foreign exhibitors as well as a range of scientific papers presented during the NATPRO Conference.

The objectives of the medicinal plants meeting were

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[1] Report submitted by the International Plant Genetic Resources Institute (IPGRI) to the Rural Development Administration (RDA) of the Republic of South Korea from the proceedings of the 1st Project Leaders' and Stakeholders' meeting of the IPGRI-RDA project on the "Inventory and Documentation of Medicinal Plants in the Asia Pacific region" held at the Putra World Trade Centre (PWTC), Kuala Lumpur, Malaysia from 7 to 9 April 2003.

1. To provide opportunities for medicinal plants researchers to share information on the status of medicinal plants research in their respective countries;
2. To update the work plans of participating countries in the IPGRI–RDA medicinal plants project; and
3. To identify priority areas for research and mechanisms for collaboration in project implementation and fund generation.

The meeting was opened with welcome remarks (Annexes 3, 4 and 5) by Dr Oh Dae-Geun, Director, IICC, RDA, Dr Percy Sajise, Regional Director of IPGRI-APO, and Dr Syed Kamaruddin, Chief Executive Officer of MHC. Dr Pons Batugal, project coordinator, presented a brief background and summary of the IPGRI-RDA medicinal plants project at the beginning of the meeting. The project coordinator also delivered a paper by Dr Keith Chapman of FAO on the status of medicinal plants in the Asia Pacific region. The participants then presented papers on the status of medicinal plants research in their respective countries and the progress of work being carried out under the project. Important areas of concern in project implementation were also discussed and recommendations were proposed.

Important results of the meeting

1. Nine participating countries shared information on the status of medicinal plants research in their respective countries through presentation of papers and discussions.
2. Workplans of each participating country were updated and schedules for report submission were agreed on (Table 1).
3. Priority research areas for future collaborative research were identified by representatives of the nine participating countries. Tables 1 and 2 will be sent to Bangladesh, China, Fiji, Papua New Guinea and Thailand to be accomplished and sent back to IPGRI. It was also agreed that the project coordinator will visit Fiji, PNG and Thailand to discuss the project with project leaders in June 2003.
4. The status of project implementation was assessed.
5. The nine participating countries drafted recommendations for the meeting for consideration by IPGRI and RDA.
6. In the visit to the IPGRI-APO office, the project participants and IPGRI staff discussed concerns and issues of participating countries related to the project and project implementation. This discussion clarified many of the issues and allayed many of the doubts of project participants who, thereafter, committed to collaborate fully in the project.
7. The nine participating countries agreed to establish a Medicinal Plants Research Network as a high-priority collaborative activity.
8. The participants agreed that IPGRI should develop other related project proposals to implement agreed priority collaborative research.

Meeting recommendations

Research and collaboration

Each country should endeavour to undertake or promote the following:

1. Conduct an economic analysis on at least one species of medicinal plant per country. This study will demonstrate the importance of medicinal plants and will seek to generate research support from national governments;
2. Promote and develop a systematic approach for *in situ* conservation of

medicinal plants. This will standardize the approach, enhance *in situ* conservation effectiveness and generate comparable data that can be shared;
3. Promote e*x situ* conservation of rare and endangered popular species by protecting the germplasm and making them available for commercial and educational purposes;
4. Promote the cultivation of commercially important medicinal plants. Preference for rare/endangered species and species that are unique to the country should be selected if these are marketable;
5. Classify medicinal plants according to uses as human medicine, veterinary medicine, nutraceuticals, cosmeceuticals, tonics and aromatherapy;
6. Identify and promote medicinal plants for maintaining and improving health;
7. Augment collection of medicinal plant species from high-elevation areas;
8. Exert a special effort to get forestry research agencies to include medicinal plants in their forest ecosystem survey and documentation;
9. Improve the quality of products derived from medicinal plants;
10. Promote the establishment of herbal gardens in institutions, which could commit resources for maintenance, as well as in individual farmers' homes;
11. Participating countries such as Vietnam, India, Indonesia and Malaysia, which have successfully piloted these initiatives, are requested to document their respective "success stories" in 1-3 page write-ups and share this information. These will be disseminated to the other participating countries to serve as models for their own initiatives;
12. Formulate methods and criteria for choosing priority medicinal plants according to use. These protocols and information will be shared with participating countries;
13. Establish and formalize a National Committee and a network for medicinal plants research in each participating country. This will enhance collaboration and generate support from national and external funding agencies;
14. Conduct discussions, through e-mail, on how this project would benefit poor people. Examples from participating countries could be disseminated to share practical experiences;
15. Conduct consultation meetings with concerned researchers, non-government organizations, government agencies, development organizations, health agencies and private sector entities to identify priority research and development projects in medicinal plants. IPGRI will help as needed;
16. Develop, test and pilot models for an effective benefits sharing scheme on medicinal plants based on the principles of the CBD and WTO, where consistent and applicable; and
17. It was also suggested that Malaysia include Sabah and Sarawak in this project since these two states are rich in medicinal plants genetic diversity.

Publication and information sharing

1. Share publications and other public awareness materials on medicinal plants with other countries.
2. Develop a medicinal plants descriptors list (to be included in Phase 2 of the project).
3. Design and develop a medicinal plants database and identify those who can access this database (to be included in Phase 2 of this project).
4. Develop an herbal homepage to disseminate research results, current and future events and activities on medicinal plants. A task force was formed to make a recommendation on this item consisting of representatives from South Korea, India and the Philippines.

5. Establish one regional reference library on medicinal plants in one of the partner institutes of the region, which will be tasked to collect and disseminate related publications and information on medicinal plants.
6. Environmental parameters (meteorological data) of field genebanks should be generated and made available to the project by partner institution.
7. Establish a world-class exhibition, training and information center for medicinal plants in each participating country.
8. Include complete contact information of directors/heads of medicinal plant genebanks and collections in each country report to be submitted.
9. Include the address and complete contact information of concerned agencies working on medicinal plants in each country report to be submitted.

Project continuation and expansion

1. Request the Rural Development Administration (RDA) of the Republic of Korea to fund Years 3 and 4 of the current project and other new priority activities as appropriate.
2. Request IPGRI to coordinate the development of other projects consistent with the identified priority areas of research and the recommendations of the meeting and to identify funding sources to support these new initiatives.

Table 1. Project timetable for report submission

Country	Starting Date	Completion Date
1. China	October 2002	October 2003
2. Malaysia	October 2002	October 2003
3. Philippines	November 2002	December 2003
4. Korea	December 2002	November 2003
5. India	February 2003	February 2004
6. Bangladesh	March 2003	March 2004
7. Mongolia	March 2003	March 2004
8. Nepal	March 2003	March 2004
9. Sri Lanka	March 2003	March 2004
10. Vietnam	March 2003	March 2004
11. Indonesia	April 2003	April 2004
12. Fiji	To be negotiated	-
13. Papua New Guinea	To be negotiated	-
14. Thailand	To be negotiated	-

Table 2. Priority research topics identified by the participating countries

RESEARCH AREAS	COUNTRIES / PRIORITY RATING (1- HIGHEST, 5-LOWEST)**													
	Indonesia	India	Malaysia	Mongolia	Nepal	Philippines	Korea	Sri Lanka	Vietnam	Fiji	PNG	Bangladesh	China	Thailand
I. INFORMATION														
a. Development of databases*	1	1	1	1	1	1	1	1	1					
b. Indigenous knowledge documentation	3	3	2	3	1	2	2	2	2					
c. Information sharing	2	2	2	2	3	2	2	2	2					
d. Exposition/exhibit	4	5	3	3	3	3	4	3	3					
e. Development of public awareness materials	2	1	3	2	3	1	3	2	2					
f. Publication and information	3	4	2	3	3	2	3	2	1					
II. CHARACTERIZATION														
a. Development of descriptors*	1	1	1	2	4	1	1	3	1					
b. Morphometric characterization method*	2	1	2	2	1	1	1	1	2					
c. Molecular markers characterization method	1	1	2	3	2	2	3	2	2					
d. Farmers' protocol characterization method	2	2	3	2	2	2	4	2	1					
III. CONSERVATION														
a. *In situ* conservation	1	1	1	2	1	1	1	1	1					
b. Cryopreservation	3	4	3	4	3	4	3	3	3					
c. Establishment of field genebank	1	1	1	1	1	1	1	1	1					
d. Establishment of seed storage genebank	3	1	3	2	2	3	4	1	2					
e. *In vitro* conservation	2	3	3	3	3	2	3	3	3					
IV. POLICY														
a. Development of strategies and models for benefit sharing	1	2	4	3	1	1	3	1	1					
b. Policy support	2	1	4	2	2	2	1	2	1					
c. Biopiracy – sharing of information and advice	2	1	4	2	2	2	1	2	1					
d. Legislation /administrative orders	2	1	4	2	2	2	1	2	1					
V. FUNDING														
a. Trust fund model – linked to social equity and benefit sharing	1	1	4	4	3	3	1	3	3					
b. Donor linkages	1	2	2	1	2	1	2	1	1					
VI. LINKAGES														
a. Small producers -Private sector links	1	2	3	2	1	1	2	1	2					
b. Industry-Govt. Links	1	1	4	3	2	2	1	1	3					
VII. CAPACITY BUILDING														
a. Technology transfer	2	1	2	2	2	2	4	2	2					
b. Using medicinal plants in sustainable livelihoods of communities/farmers	3	2	3	3	2	2	3	2	2					
c. Training	1	2	2	3	2	1	1	1	1					
d. Seminars/workshops	1	3	2	2	3	2	3	2	3					
e. Scientist exchange	2	2	2	2	2	2	1	1	1					
VIII. NETWORKING														
a. Projects	2	1	2	2	2	1	1	1	1					
b. Countries	1	1	1	1	2	1	1	1	1					

* Funding included in Year 3–4 of the IPGRI-RDA project

** The remaining 5 countries (Fiji, Papua New Guinea, Bangladesh China and Thailand) will identify priorities at a later date

ANNEXES

- **ANNEX 1:** Asia-Pacific Medicinal Plants Research Meeting Programme
- **ANNEX 2:** List of participants to the Asia-Pacific Medicinal Plants Research Meeting
- **ANNEX 3:** Transcript of the welcome remarks by Dr Dae-Geun Oh, Director, International Technical Cooperation Center, RDA, Republic of Korea
- **ANNEX 4:** Transcript of the welcome remarks by Dr Percy Sajise, Regional Director, IPGRI-APO
- **ANNEX 5:** Transcript of the welcome remarks by Dr Syed Kamaruddin Syed Wazir, Chief Operating Officer, MIGHT, Office of Science Adviser, Prime Minister's Department, Government of Malaysia

Annex 1

Asia-Pacific Medicinal Plants Research Meeting Programme

Asia Pacific Medicinal Plants Research Meeting
Putra World Trade Center
Kuala Lumpur, Malaysia
7-9 April 2003

Objectives:

1. To provide opportunities for medicinal plants researchers to share information on the status of medicinal plants research in their respective countries;
2. To update work plans of participants in the IPGRI–RDA medicinal plants project; and
3. To identify priority areas for research and mechanisms for collaboration in project implementation and fund generation

Participants:
Invited participants from Bangladesh, Indonesia, India, Malaysia, Mongolia, Nepal, the Philippines, South Korea, Sri Lanka, Vietnam, Papua New Guinea, Malaysian Herbal Corporation (MHC), the Food and Agriculture Organization (FAO) and the International Plant Genetic Resources Institute (IPGRI)

PROGRAMME

Day 1 (Monday, 7 April 2003)

I. Opening Session *(Chair: Dr Pons Batugal)*

0900 Opening remarks - Dr Pons Batugal (IPGRI Project Coordinator)
Remarks - Dr S. Kamaruddin (CEO, MHC)
- Dr Oh Dae-Geun (Director, IICC, RDA)
- Dr Percy Sajise (IPGRI-APO Director)

0930-1000 Coffee/Tea Break

II. Background Papers *(Chair: Dr Uday R Sharma)*

1000-1030 - Rationale for conservation of medicinal plants – *Dr. V Ramanatha Rao and Dr R K Arora – Paper to be presented by Mr Hong Lay Thong*
1030-1100 - Inventory and documentation of medicinal plants in the Asia Pacific region – *Dr Pons Batugal*
1100-1130 - MIGHT's programme on medicinal plants and NATPRO – *Dr Syed Kamaruddin*
1130-1200 - Medicinal plants in the Asia Pacific Region: Opportunities and issues – *Dr Keith Chapman (FAO) and Mr Narong Chomchalow - Paper to be presented by Dr Pons Batugal*

1200-1330 - LUNCH

III. Country Papers - South Asia (*Chair: Dr Jocelyn Eusebio)*

1400-1430 - Status of medicinal plants research in Bangladesh and plans for inventory and documentation of medicinal plants – *Dr Md Mamtazul Haque*

1430-1500 - Status of medicinal plants research in India and plans for inventory and documentation of medicinal plants – *Dr Satyabrata Maiti*

1500-1530 - TEA/ COFFEE BREAK

1530-1600 - Status of medicinal plants research in Nepal and plans for inventory and documentation of medicinal plants – *Dr Uday R Sharma*

1600-1630 - Status of medicinal plants research in Sri Lanka and plans for inventory and documentation of medicinal plants – *Dr DSA Wijenesundara*

1800-2100 - Welcome dinner hosted by RDA

Day 2 (Tuesday, 8 April 2003)

IV. Country Papers – East Asia (*Chair: Dr Satyabrata Maiti)*

0830-0900 - Status of medicinal plants research in Mongolia and plans for inventory and documentation of medicinal plants – *Dr Noov Bayarsukh*

0900-0930 - Status of medicinal plants research in South Korea and ongoing inventory and documentation of medicinal plants – *Dr Cha Seon Woo*

0930-1000 - COFFEE/ TEA BREAK

V. Country Papers – Southeast Asia *(Chair: Dr Pons Batugal)*

1000-1030 - Status of medicinal plants research in Peninsular Malaysia and ongoing inventory and documentation of medicinal plants – *Dr Chang Yu Shyun*

1030-1100 - Status of medicinal plants research in the Philippines and ongoing inventory and documentation of medicinal plants – *Dr Jocelyn Eusebio*

1100-1130 - Status of medicinal plants research in Indonesia and plans for inventory and documentation of medicinal plants – *Dr Nurliani Bermawie*

1130-1200 - Status of medicinal plants research in Vietnam and plans for inventory and documentation of medicinal plants – *Dr Nguyen Van Thuan*

1200-1230 - Potential commercialization of Tongkat Ali: Prospects and Challenges – *Dr Azizol Abdul Kadir, Phytes Biotek, Malaysia*

1230-1330 - LUNCH

VI. Current & future plans for collaboration *(Chair: Dr Satyabrata Maiti)*

1330-1400 - Database development for medicinal plants – *Dr Paul Quek and Dr Lee Sok Young*
1400-1500 - Identification of priority research areas and possible collaborative projects: discussion on mechanisms for collaboration on fund generation and implementation – *Dr Pons Batugal*

1500-1530 - COFFEE/ TEA BREAK

VII. Work plan formulation (*Chair: Dr Oh Dae-Geun)*

1530-1630 - Explanation of purpose of meeting – *Dr Cha Seon Woo*
Work plan timetable of activities – *Dr Pons Batugal/ Mr Jeffrey Oliver*
Report preparation, content and style – *Mr Jeffrey Oliver*
Books and other references on medicinal plants
Meeting recommendations

VIII. Closing Session (*Chairperson: Dr Percy Sajise)*
1730-1800

Remarks - Representative from South Asia
Representative from East Asia
Representative from Southeast Asia
Representative from RDA
Regional Director, IPGRI- APO

Day 3 – (Wednesday, 9 March 2003)

IX. Field trip

0900-0930 - Travel to Forest Research Institute of Malaysia (FRIM)
0930-1100 - Visit FRIM research facilities and medicinal plants collection
1100-1200 - Travel to the Enstek, The Sci-Tech City
1200-1330 - Visit to the pilot facilities of Enstek (Sci-Tech City) followed by lunch hosted by Enstek
1330-1400 - Travel to IPGRI-APO office, UPM, Serdang
1400-1500 - Visit IPGRI-APO office
1500 - Depart for Legend Hotel

Annex 2

List of Participants to the Asia-Pacific Medicinal Plants Research Meeting

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Annex 3

Welcome remarks by Dr Dae-Geun Oh, Director, International Technical Cooperation Centre, Rural Development Administration, Republic of Korea[1]

Dr Percy Sajise, Director of IPGRI's Asia, the Pacific and Oceania Regional Office, distinguished guests and participants, ladies and gentlemen, a pleasant good morning.

I am delighted to be here with you at this Asia Pacific Medicinal Plants Research Meeting. It is my privilege to deliver a remark on behalf of the Rural Development Administration of Korea, which has maintained a strong partnership with IPGRI and Asian countries through the collaboration and exchange of scientists for many years.

This research meeting is based on the agreement between the RDA and IPGRI on 5th December 2001, and the main purpose of the agreement is to carry out the inventory, documentation, characterization, research for medicinal plants, and to develop a network among the Asia-Pacific countries. I am convinced that this IPGRI project on medicinal plants will provide mutual benefits to all the participating countries.

This meeting aims to provide opportunities for medicinal plants researchers to share information on the status of medicinal plants research in their respective countries. It is hoped that through our collective and conscious efforts, we could contribute significantly to achieve this objective. I also hope these collaborative endeavors may be sustained in the future.

I should like to express our deep appreciation to Dr Percy Sajise, Regional Director of IPGRI-APO and Dr Pons Batugal, the coordinator of this project. Let me also thank the invited participants who, despite the long journey and the threat of SARS, have gladly attended here today, to share with us their valuable experience and expertise.

Considering the warm hospitality and the excellent preparations offered to us by the competent staff members of IPGRI-APO, there seems every reason to believe that this will be a very successful meeting. I would like to extend my sincere thanks and congratulations to the organizers of this meeting for a job well done.

I wish you all a pleasant stay in this beautiful city, Kuala Lumpur, and a fruitful attendance to NATPRO 2003.

Thank you and good morning.

[1] Delivered during the opening of the Asia Pacific Medicinal Plants Research Meeting held at the Putra World Trade Centre (PWTC), Kuala Lumpur, Malaysia from 7 to 9 April 2003.

Annex 4

Welcome remarks by Dr Percy E Sajise, Regional Director, IPGRI-APO[1]

Dr Oh Dae-Geun, Director, International Technical Cooperation Centre, Rural Development Administration of the Republic of Korea, Dr Syed Kamaruddin, Chief Executive Officer, Malaysian Herbal Corporation, Malaysian-Industry-Government Group for High Technology (MIGHT), Dr Pons Batugal, IPGRI-APO Project Leader on Medicinal Plants, distinguished participants and country Project Leaders for the IPGRI-RDA Medicinal Plants Project, my colleagues in IPGRI, guests, ladies and gentlemen, good morning.

At the outset, and in behalf of International Plant Genetic Resource Institute, I would like to thank Rural Development Administration, Republic of Korea represented this morning by Dr Oh for the valuable help in providing the funds and technical assistance in the implementation of this Medicinal Plants Project which is participated in by 14 countries in the Asia Pacific. I would also like to express our appreciation for the willingness of the 10 national coordinators of this project from 10 participating countries to come and participate in this meeting in spite of the threat and risks with this SARS problem. However, it is also an opportunity to point out the importance of medicinal plants in relation to this problem. For example, in our recent trip to China, we were provided with some herbal tea medicine by our colleagues, which are known to improve the body's immune system against the cold virus which may have been responsible for our escaping the experience of having to cope with SARS. But that will be another story. Unfortunately, four country coordinators could not participate in this meeting for various personal and official reasons although they have indicated officially their intention to participate in the project.

As you may already know, medicinal plants from the commercial point of view, is a source of very big revenue involving pharmaceutical products. To small and poor households in many parts of the Asia, Pacific region who have problems of access to medicine, medicinal plants, which are part of their homegarden, forms an integral and valuable part of their repertoire of biodiversity. My son, who is a medical doctor, attests to this during their experience in conducting rural medical service as part of their medical training. He was assigned to a remote village in the Philippines and he observed that poor village households is almost fully dependent on these medicinal plants for coping with ordinary health problems as it is difficult and expensive to go to the town pharmacies to gain access to these medicines. I am sure this same scenario is repeated many times in remote and marginal households of many Asia-Pacific villages. However, much of this knowledge are indigenous or traditional knowledge handed down from one generation to another and the commercialization of medicinal plant materials are in fact initially dependent on these kinds of knowledge system which has been formalized in many other parts of the world such as China, India, and in many of the countries involved in this joint medicinal plant project of IPGRI and RDA.

For a long time, because of the sensitivity of Intellectual Property Rights issues attached to the commercial value of medicinal plants, IPGRI did not venture to promote collaborative PGR research in this area. However, realizing that this is a very important component of plant genetic resources for national and global development, we finally initiated a project which was fortunately taken up for

[1] Delivered during the opening of the Asia Pacific Medicinal Plants Research Meeting held at the Putra World Trade Centre (PWTC), Kuala Lumpur, Malaysia from 7 to 9 April 2003.

funding by RDA. The beginnings of our effort in medicinal plants is premised on the fact that there are areas of importance which countries can collaborate and which can only enhance its conservation and use without dwelling on the issue of IPR. One is the development of a common data and information base which will allow countries to know what they have in common or what they have which is distinct without removing the materials from where it is—this is this project. What will come out of the knowledge of what you have and what you are interested in will hopefully become the basis for future collaboration and spin off activities which are acceptable and of mutual benefit. Another one is this concern for the rapid dwindling of medicinal plants collected from the wild, i.e. tongkat ali, in Malaysia. IPGRI would like to look at this problem and get engaged in a collaborative research with interested countries on sustainable use and regeneration of these materials. We will be able to do this kind of research consistent with the provisions of Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture as medicinal plants are excluded from the list of crop species in the IT and will still follow the arrangements under CBD which emphasizes national sovereignity as the jurisdiction for medicinal plants.

I am very happy that RDA and IPGRI can jointly conduct this meeting with our partner countries and wish you all a successful meeting. This meeting is also being held back to back with the Natural Products Exposition 2003 which will provide you with more important insights on the role of plant genetic resources in natural products and agroindustry for economic development.

Please enjoy your stay in this beautiful country and may I reiterate a wish that we will all have a successful meeting.

Thank you and good day.

Annex 5

Welcome remarks by Dr. Syed Kamaruddin Syed Wazir, Chief Operating Officer, Malaysian Industry-Government Group for High Technology, Office of the Science Advisor, Prime Minister's Department, Government of Malaysia[1]

Malaysian Industry-Government Group for High Technology (MIGHT) is a partnership between the industry and the public sector in Malaysia working in synergy to prospect for business and investment opportunities through the harnessing of high technology. In 1998, MIGHT established the MIGHT Interest Group (MIG) in Herbal Products as a spin-off from the MIG Pharmaceuticals upon recognition of the rich biological resources available in Malaysia. Members of the MIG comprising of key representatives from ministries, universities, research institutions and key players had successfully drawn up the National Herbal Products Industry Outlook.

The National Herbal Products Industry Outlook provides an overview of the herbal industry in Malaysia and globally. It also provides input and recommendations to help develop the local herbal industry in Malaysia. A study conducted by MIGHT Interest Group (MIG) in Pharmaceuticals in 1998 reported that the local pharmaceutical market in 1997 were made up of US$ 0.32 billion for the western drug products and US$ 0.53 billion for the traditional medicine. The total value of the market growth for herbs and medicinal plants in 1998 was estimated at 15%-20% annually.

However, the report observed the lack of coordination activity among various entities in the industries and there was no strong platform for local companies and overseas companies to seek local markets to promote products/services. MIGHT would like to have greater collaboration with research institutes, universities and other agencies. MIGHT recommends the establishment of a dedicated body that coordinates the activities of all stakeholders and promotes the local herbal industry. Through the Asia Pacific Natural Products Expo and Conference (NATPRO), MIGHT's National Herbal Products Industry Outlook hopes to create a knowledge community on the herbal industry, thus creating greater awareness into the opportunities in industry.

On behalf of the Government of Malaysia in general and MIGHT in particular, I wish you all a successful meeting.

[1] Delivered during the opening of the Asia Pacific Medicinal Plants Research Meeting held at the Putra World Trade Center (PWTC), Kuala Lumpur, Malaysia, 7 - 9 April 2003.