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Production of Medicinal and Aromatic Plants in Southeast Asia*

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Abstract

Southeast Asia is unique among geographical regions of the world since it possesses (i) high biological diversity, (ii) high cultural diversity, (iii) ancient civilization, and (iv) abundant raw material for modern drug manufacturing and flavor and fragrant industries.

Collecting naturally-occurring medicinal plant has taken place since prehistoric time in Southeast Asia. At present, such activity, although limited in amount in most countries, is still carried on with the objectives of using them in traditional medicine or for processing into pharmaceutical products. Such activity generates income to the native people, provides raw material for them at low cost, and can have access of material not available through cultivation. However, it also creates problems in genetic erosion, especially with its uncontrolled quantity of collection, and unsustainability. The situation is different in the case of aromatic plants since most of them have been cultivated from time immemorial, and the end products (essential oils) have been used in the manufacture of perfume and other fragrant materials; some are used as spices and herbs in cooking.

Cultivation of MAP in Southeast Asia is characterized by the following criteria: (i) subsistence cropping systems, (ii) scattered farming areas, (iii) poor quality, and (iv) lack of integration. The advantages of commercial cultivation of medicinal plants include: (i) help conserving endangered species in their natural habitat, (ii) permit production of uniform material, (iii) provide good income to the farmers, (iv) provide opportunities for value-addition through processing, (v) provide a better environment through utilizing waste and unproductive lands, and (vi) provide continuity of supply.

The present paper describes commercial production of MAP in six Southeast Asian countries, namely Lao PDR, Indonesia, Malaysia, Philippines, Thailand and Vietnam with a discussion on limitations and new hope for their production.

Keywords: *Biological diversity, cultural diversity, herbal medicine, medicinal plant, aromatic plant, flavor, fragrance, essential oils, spices, herbs, Southeast Asia.*

Introduction

What are Medicinal and Aromatic Plants?

Medicinal and aromatic plants (MAP) are two related groups of plants having in their parts chemical constituents which are active in curing ailments (i.e. MP) or in providing flavors and/or fragrances (i.e. AP).

Generally speaking, medicinal and aromatic plants are distinct enough to be classified into two different categories, if their main uses are taken into consideration. Aromatic plants which possess aromatic compounds in their parts can be further subdivided into three subgroups based on their main uses. Thus, major groups of MAP include:

Medicinal Plants: These are plants possessing active ingredients used mainly in preventing or curing ailments. They may, and

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usually do, have certain other properties which permit them to be used otherwise, e.g. as botanical pesticides, preservatives, incenses, herbal teas, natural dyes, spices, etc.

Aromatic Plants: These are plants possessing aromatic compounds used mainly as flavors (e.g. in spices and herbs) and fragrances (e.g. in perfumery, cosmetics, soaps). However, from ancient times, these plants have also been used as raw materials for pharmaceuticals, cosmetics, botanical pesticides, air fresheners, disinfectants, insect repellents, herbal teas, etc. Based on their main uses, aromatic plants can be subdivided into three subgroups:

Essential-Oil Crops: These are crops possessing essential oils which are volatile in room temperature. These compounds are synthesized and stored in special structures known as glands which are located in different parts of plants such as leaf, shoot, flower, fruit, seed, bark, and root. These essential oils can be extracted by various physical and chemical processes such as steam distillation, maceration, expression, solvent extraction, and enfleurage.

Spices: These are non-leafy parts (e.g. bud, fruit, seed, bark, rhizome, bulb, etc.) of plants used to add flavoring or aroma to food and beverages although many can also be used as a herbal medicine. Essential oils and oleoresins can also be extracted from certain spices.

Herbs: These are leafy or soft flowering parts of plants used to add flavor or aroma to food and beverage. These are normally known as culinary or kitchen herbs, in contrast to other herbs which are terms used for different purposes such as medicinal herbs, cosmetic herbs, sweet herbs, hot herbs, etc. Certain herbs can also be used as herbal medicine. In fact, the terms 'herb' and 'herbal' are more popularly used to mean medicinal plants than the real meaning described earlier. Leafy or soft flowering parts of certain spices, e.g. coriander, can be treated as herbs.

Importance of MAP in Southeast Asia

Southeast (SE) Asia abounds with large number of MAP since it has suitable climatic conditions. Great genetic diversity also exists in the Region resulting from diverse habitats. SE Asia also is a region of great cultural diversity. This is because, since the dawn of history, biodiversity and humanity have become inextricably linked. Human cultures have adapted to many diverse habitats. Areas of high biodiversity such as tropical rain forests of SE Asia are among the most culturally diverse, with large number of distinct communities inhabiting adjacent areas, each with its own language, culture, as well as systems of traditional medicine, cooking, and perfumery.

With these biological and cultural diversities, it is not surprising that SE Asia is called 'The Land of Medicinal and Aromatic Plants'. Every ethnic group in every country has its own unique system of traditional medicine and of making use of aromatic plants in their traditional way of life, e.g. in making cosmetics, incenses, herbal teas, botanical pesticides, aromatherapy, and of making use of spices and herbs in flavoring its native dishes.

One of the most popular commodities exported from this Region since ancient time is spices. The Region abounds with numerous spices such that it is well known as the 'Land of Spices'. The Maluku Islands of Indonesia, originally known to English speakers as the Moluccas, have been referred to since the 16th century as the 'Spice Islands'. It is the most popular term used to describe the land of spices although this term could also be applied to Sumatra, another island of Indonesia. Melaka (or Malacca), the most famous city known for its spice trade, is called the "Spice City". The sea route that linked Venice, Arabia, Ceylon, India, Malacca, Moluccas, Sumatra, and China through spice trading since the 16th century is known as the 'Spice Route', ranking in importance next to the famous 'Silk Road'. At present, both spices and herbs have made SE Asian foods, particularly Thai foods, Indonesian foods, and Vietnamese food, very popular throughout the world since they are spicy and delicious.

Indigenous Species of MAP in SE Asia

Within the boundary of SE Asia, there exists the Indo-Malayan Center of Origin of Crop Plants. It is probably one of the most diverse centers of the world. Large diversity of crops, including MAP, is found within the

Region. It is impossible to list all indigenous species of MAP in SE Asia. Besides, not all are being recorded. All these constitute genetic resources which play significant roles in the improvement program of these crops to adapt themselves to new habitats of the future world. As for the present, due to population pressure and the need for more land to produce enough food crops, destruction of the natural habitat is taking place at an alarming rate. In addition, over-exploitation of naturally-occurring species of MAP is still going on in many countries of the Region. This is exacerbated by the cultivation in large areas of single improved varieties of MAP with very narrow genetic bases, most likely to succumb to epidemic diseases and pests. All these result in the loss of genetic resources of MAP, a phenomenon called "Genetic Erosion". Thus, there is an urgent need for the conservation of genetic resources of MAP in SE Asia.

MAP conservation methods are somewhat different although still based on the same principles of *ex situ* and *in situ* conservation. Storage of seeds in the genebank is the most practical method for those species with orthodox seeds; however, very few species of MAP can be propagated by seeds, but by other vegetative materials. Clonal materials are conserved in 'field genebank'. *In vitro* genebank is beginning to receive attention as they require less space and thus, less cost in maintenance. Various attempts have also been made to establish *in situ* conservation in several countries of the Region. The establishment of MAP gardens as a means of attracting interests of the people to pay more attention to natural products is mush-rooming in Thailand, with more than 100 such gardens being established throughout the country.

Collecting *vs* Growing MAP in SE Asia

Collecting MAP in SE Asia

Collecting naturally-occurring MAP has taken place since pre-historic time in SE Asia. The excavation of many archeological sites in the Region reveals that pre-historic people have made use of several species of MAP in their every day's life, such as medicines to cure their ailments, as herbs and spices to flavor their food, as incenses in their religious ceremonies, as aromas for their bath and as cosmetics to beautify their bodies. As the result of population explosion and the resulting forest clearing for food production, most SE Asian countries, which until recently have collected MAP from the wild, have almost halted such practice as they are quite scarce or non-existent. A few countries, notably Lao PDR, Cambodia, Vietnam, Malaysia and Indonesia, which are able to maintain high degrees of natural forest cover, are the ones which keep on collecting MAP from the wild. This is particularly true of medicinal plants and essential-oil crops, whereas herbs and spices are rarely collected from the wild.

Objectives of Collecting: The following objectives of collecting naturally-occurring MAP are envisaged:

- *For use in traditional medicine:* For native people who live in remote areas, as well as the poor people who cannot afford to buy expensive western drugs, traditional systems of medication in each country are the only means to cure illness. Such systems depend almost exclusively on medicinal plants. It is estimated that of the amount utilized in the preparation of traditional medicine, about 90 % are collected from the wild.

- *For use in traditional perfumery or cooking:* These are aromatic plants which are found scattering in the wild in small quantity and are collected for use in traditional perfumery and cooking, e.g. sweet flag in Lao PDR, cinnamon in Lao PDR and Thailand, cassia in Vietnam, cassia vera in Indonesia, etc.

- *As raw material for processing:* A few countries in the Region still maintain natural forests where a number of aromatic plants are growing in pure stands (e.g. *Pinus* spp.), or scattered in larger number such that native people can earn a good income by collecting raw materials from the wild and sell them to essential-oil extraction or other factories. Examples can be seen in northern Thailand where turpentine is obtained from two native species of *Pinus,* namely *P. khasya* and *P. merkusii.* Similarly, cajuput oil is

commercially extracted from *Melaleuca leucadendron* trees which occurs naturally in the wild in Indonesia. Commercial utilization of naturally-occurring aromatic plants is now facing a number of constraints particularly the lack of raw materials to feed the factories. Moreover, such an operation may not be sustainable since over-exploitation of raw materials may lead to scarcity or even extinction of the species.

Advantages of Collecting Naturally-Occurring MAP: The following advantages are envisaged in collecting naturally-occurring MAP:

♦ *Generating income for native people:* In the hilly and mountainous regions, collecting naturally-occurring MAP will supplement the meager income from subsistence farming, particularly if there is an establishment of distillation or small processing units by local people in these areas. Such small enterprise would uplift the income of the local people through collecting material from the wild, gaining value addition from local processing, and saving on high cost of transport bulky material on rugged terrain to be sold in the city.

♦ *Provide raw material at low cost:* Collecting naturally-occurring MAP provides raw material for pharmaceutical or essential-oil factories at low costs, particularly where cheap labor is also available and the supply is large enough for sustainable production.

♦ *Access of material not available through cultivation:* This applies particularly to medicinal plants where traditional medicine requires large number of plant materials, many of which are available only from the wild. Collecting this type of medicinal plants is important to traditional doctors who depend on the supply of such material.

Disadvantages of Collecting Naturally-Occurring MAP: The following disadvantages are envisaged:

♦ *Genetic erosion:* Greedy collecting results in the scarcity of supply. This is true for commercial collecting of medicinal plants for export to pharmaceutical companies. These plants are collected vigorously, damaging not only the ones being collected, but also their neighboring plants. It often happens that these materials are radically plucked out down to the last specimens of the species. As a consequence, many species are now in danger of extinction.

♦ *Uncontrollable quality and quantity:* As would be expected, both quality and quantity of materials collected from the wild cannot be controlled. Often the materials are mixtures of various kinds of plants which may look alike, but in fact, they are not. The quantity collected depends on several factors such as climatic condition which affect their growth as well as their accessibility.

♦ *Unsustainability:* As forests in most SE Asian countries are disappearing at a fast rate, the supply of MAP growing in these forests is obviously unsustainable.

Measures to Conserve Naturally-Occurring MAP: Realizing the fact that naturally-occurring MAP are threatened, several measures have been taken by various agencies. Among them are:

♦ *Systematic and reasonable collecting:* Sustainable collecting can be achieved if it is done properly. Mutual benefit for the collector and local processor result if proper harvesting techniques as well as appropriate methods of post-harvest treatment are used. Such practice would provide an incentive to the collectors for conservation of the species for future collecting.

♦ *Reduction of pressure on collecting:* Cultivation, whether on small scale, backyard garden, subsistence farming, or large scale, can reduce the pressure on naturally-occurring MAP.

♦ *National legislation:* In order to conserve naturally-occurring MAP, national legislation should be enacted in all SE Asian countries. Many countries in other regions of Asia have already passed such legislation such as China ("Protection of Wild Medicinal Plant Resources" - Chen 1996), India (Banning export of all wild medicinal plants - Uniyal 1993), Sri Lanka ("Action Plan for Conservation of Biodiversity" - Arambewela 1996). In SE Asia, the Congress of Thailand recently passed the bill "Protection of National

MAP Resources, their Traditional and Other Uses and the Rights of Communities to Make Free Use of the Resources of Their Soil".

♦ *International regulations:* It is a common practice of international conferences to come up with a 'declaration', 'resolution', or 'accord', in which measures to conserve MAP are included. Amon these are "The Maastricht Declaration", "The Manila Declaration", "The Bukit Tinggi Declaration", "The Chiang Mai Declaration", "The Melaka Accord", "The Washington Resolution", "The Convention on Biodiversity" and "Agenda 21", all of which focussed on the conservation of biodiversity, including MAP germplasm, and the measures to conserve MAP.

It is interesting to note that medicinal plants have received more attention during these international conferences, probably because they are more in danger of extinction than aromatic plants, as can be seen from the following slogans: "Saving Lives by Saving Plants"(IUCN 1993), "Medicinal Plants Need a Cure" (Uniyal 1993), etc.

Growing of MAP in SE Asia

Being ancient indigenous crops of the Region, many species of MAP have been cultivated in SE Asia from time immemorial. They were mainly grown in the backyard garden for home consumption. Very few, however, were commercially grown on a small or medium scale. Only recently that certain selected species of MAP have started to be grown commercially on a large scale for industrial exploitation. The two groups of MAP differ somewhat in the status of their cultivation in SE Asia.

Medicinal Plants: Except for a few traditional medicinal crops, many of which can also be used as spices like turmeric, garlic, cloves, etc., most medicinal plants are relatively new crops for cultivation in SE Asia. Thus very few farmers are engaged in their cultivation. They are only grown by small-holders in subsistence farming systems, using primitive cultivars, and grown in mixed cropping pattern. It is not surprising that their yield is quite low. Moreover, such farms are quite scattered which results in difficulty in collecting harvested raw material by the middlemen. The materials harvested are also of low quality as the result of using unimproved varieties, poor cultural techniques, and poor post-harvest handling. Even when grown as commercial crops, they are normally grown as intercrops with no integration between primary (food) crops and medicinal plants.

As the supply of medicinal plants collected from the wild is decreasing, commercial cultivation has started to become increasingly popular among farmers in certain SE Asian countries who have been encouraged to cultivate medicinal plants. Such a practice has considerable advantages such as: (i) conserving endangered species in their natural habitat, (ii) permitting production of uniform material, (iii) providing good income to the farmers, (iv) giving opportunities for value-addition through processing, (v) making effective use of waste and unproductive lands (since, being high-value crops, the farmers can afford to provide high-cost inputs to the land), and (vi) providing continuity of supply to the factories.

As compared to other .crops, including aromatic plants, medicinal plants have so far received much less attention in their genetic improvement. This is evident in the number of named cultivars used in commercial cultivation in SE Asia which is surprisingly low. This is due to the lack of germplasm conservation, facilities, breeders and of demand for large-scale cultivation. There are several approaches to obtain improved cultivars of medicinal plants. These are: (i) introduction from other countries, (ii) selection from already existing variants, (iii) conventional breeding, and (iv) biotechnological approaches. The situation is much better in other countries in Asia such as China and India where large number of improved cultivars of numerous medic-inal plants are being cultivated on a large scale.

Along with genetic improvement, cultural improvement also contributes significantly to the success of commercial cultivation of medicinal plants. Several approaches have been suggested to improve the cultivation of medicinal plants. They are: (i) good agro-technological practices, such as

proper soil preparation and fertilizer application, the use of good planting material, plant spacing, control of weeds, insects and diseases, proper time and techniques of harvesting, etc. (ii) the use of proper cropping patterns, such as intercropping, crop rotation, relay cropping, etc., and (iii) selection of suitable sites having suitable soil and climatic conditions for particular medicinal plants.

Aromatic Plants: Aromatic plants which include essential-oil crops, spices and herbs have been cultivated in Southeast Asia for a long time, particularly in Indonesia, Malaysia, and Thailand. Many species of aromatic plants (e.g. citronella, vetiver, lemongrass, basil, ylang ylang, cinnamon, eucalyptus, patchouli, etc.), and spices (pepper, ginger, vanilla, chili pepper, turmeric, garlic, coriander, cassia, cloves, nutmeg and mace, etc.) are cultivated on a large scale. However, there are still some which are cultivated on a small scale, through subsistence farming practices using intensive labor, primitive cultivars and improper post-harvest techniques. Generally speaking, herb cultivation is a small-scale operation, usually done in home gardens or small farms. Yet they are quite important as flavoring agents in cooking numerous native dishes. These herbs include basil, holy basil, coriander, celery, lemongrass, shallot, 'Makrut', kitchen mint, etc. Vietnamese use extraordinary amount of herbs in their foods, although the Indonesian and Thai also use a lot of herbs in their dishes.

The advantages of aromatic plant cultivation are exactly the same as those of medicinal plants. However, it must be stressed that, as aromatic plants have been traditionally cultivated in many SE Asian countries, there is less danger that their genetic resources will become extinct. It is only the species which are mainly collected from the wild, like cassias and cinnamon in Cambodia, Lao PDR, Thailand, and Vietnam, which are under genetic erosion from greedy collecting.

As far as genetic improvement is concerned, the situation for aromatic plants in general is much better than medicinal plants for the simple reason that they have been cultivated for a long time. However, such improvement was done mainly through selection of superior varieties or clones of naturally-occurring ones rather than through intentional breeding. Only a few aromatic crops in the Region have been the subject of conventional breeding. These crops are pepper, chili pepper, basil, Japanese mint, etc. Introduction from other countries is the most common practice used by many countries since it is the easiest and least time- and effort-consuming. Moreover, introduced varieties normally yield standard marketable products.

The same principles of cultural improvement can be adapted from those of medicinal plants for aromatic plants although most farmers who cultivate aromatic plants have already been aware of such approaches as they have been growing the crops for quite a long time. However, for newly introduced crops, or crops which have been subject to large-scale cultivation, there is a need to train the farmers on how to improve their cultivation. The most important criterion is the quality of the products, be it essential-oil crop, spice, or herb, since poor quality products have really no place in the markets.

Major Commercial MAP in SE Asia

In spite of the fact that the Region abounds with large numbers of species of MAP and that MAP have been used traditionally in the Region from time immemorial, commercial production of MAP in most SE Asian countries, except for cinchona, some spices, and a few essential-oil crops in Indonesia, has been established only recently.

Country-wise Production of MAP in SE Asia

In November 1996, the author organized the First Asian Symposium on Industrial Utilization of Medicinal and Aromatic Plants (ASIUMAP-1) at the FAO Regional Office for Asia and the Pacific. During the meeting, the experts representing six SE Asian countries, namely Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam presented their country reports which included sections on production of MAP, the summaries of which are presented below:

Indonesia: Most MAP now cultivated in Indonesia are indigenous species, except for a few, such as *Cinchona* spp., *Piper nigrum, Chrysanthemum cinerariaefolium, Buplerum*

falcatum, etc. (Pasril and Djiman 1996). The agro-ecological zones for cultivation of MAP vary, mostly in the upland tropical rainforest, with wide range of altitudes (0-1,500 m above mean sea level) such as in Irian Jaya, one of the most promising areas for pyrethrum cultivation. Both genetic and cultural improvements have been undertaken in Indonesia. They include germplasm collection, selection and breeding of cultivars, the provision of good planting materials, the manipulation of cropping systems in suitable land and climate. Good management, sufficient capital and proper market information have also been sought. Improved technology for cultivation has shown improvement in yields. For example, for *Angelica acutiloba,* the optimum yield of dry root (3.99 t/ha) and ethanol extract content (44.83 %) grown on andosol soil, were at 10 months after planting. It was also found that cropping systems involving MAP provide many possible combinations during the crop life cycle. As for medicinal plants, more attention was given to the quality of raw material rather than the yield. Intercropping of *Orthosiphon aristatus* under papaya or other tree crops showed no sinensetine content in the leaf while the yield of monocropped plants showed sinensetine contents in HPLC test.

A list of major MAP produced in Indonesia (Pasril and Djiman 1996) is given below:

Scientific name	Common name	Indonesian name	Family	Part used
Amomum cardamomum	cardamom	Kalolaga	Zingiberaceae	seed
Cananga odorata	ylang ylang	Kenanga	Annonaceae	flower
Cinnamomum burmanii	cassia vera	-	Zingiberaceae	bark
Cinchona spp.	cinchona	Kina	Rubiaceae	root bark
Curcuma domestica	turmeric	Kunyit	Zingiberaceae	rhizome
Cymbopogon nardus	citronella	Serai wangi	Gramineae	leaf
Kaempferia galanga	galangal	Kencur	Zingiberaceae	rhizome
Melaleuca brachteata	melaleuca	Kayu putih	Myrtaceae	stem, bark
Orthosiphon aristatus	orthosiphon	Kumis kucing	Lamiaceae	leaf
Piper betel	betel vine	Sirih	Piperaceae	leaf
Piper nigrum	black pepper	Lada	Piperaceae	fruit
Pogostemon cablin	patchouli	Nilam	Lamiaceae	leaf
Vanilla planifolium	vanilla	Vanili	Orchidaceae	fruit
Vetiveria zizanioides	vetiver	Wangi	Poaceae	root
Zingiber officinale	ginger	Jahe	Zingiberaceae	rhizome

Lao PDR: At present there is no commercial production of MAP in Lao PDR (Southavong 1996). Most of the raw materials used in three government-owned and two private pharmaceutical companies were obtained from wild harvests. The Research Institute of Medicinal Plants has initiated projects for commercial production of artemisinine from *Artemisia annua,* to be used as a new antimalarial drug. Pilot plant extraction of essential oils has also been performed. Although a number of promising species have been identified, commercial production of these raw materials cannot be initiated due to the lack of manufacturers and investment.

Malaysia: Malaysia has several advantages in MAP production, viz. the abundance of genetic resources in their natural habitats, the preference by people for them as natural products, the existence of over 4000 Chinese and numerous Indian and Malay herbal stores, and over 1000 manufacturers of Malay herbal medicines (Abdul *et al.* 1996). Unfortunately, current production of traditional medicines or herbal products remains a small-scale home-based industry. Most of the raw materials used in processing herbal products are imported from other countries such as India, Indonesia and China, amounting to over RM 50 million in 1996. Clearly Malaysia has a high potential and a significant market for herbal production.

Commercial production of medicinal plants is required to fulfill the demand in raw materials. At present, black pepper is produced on a large scale in Malaysia. Others, such as turmeric, chili pepper, cardamom, cinnamon, nutmeg and ginger are also produced, but at a very small scale.

Philippines: The increasing demand for MAP in the Philippines has brought about the establishment of more production farms and expansion of the existing ones (de Padua 1996). Originally just for a steady supply of raw materials for the research laboratories, plantations of several species are now supplying the intake of processing and manufacturing plants and private companies. The three governmental manufacturing plants are all in operation and still cannot meet the demand for their herbal products. Available data on production of some MAP show a definite growth in the countryside. Plantations that have existed for longer than ten years continue to produce enough for a sustained livelihood of the communities. Production of aromatic plants is much higher than that of medicinal plants in most areas.

Pilot projects on selected essential oil crops started in 1991 in South Tagalog with the establishment of production farms in two provinces. They serve as the nucleus production area in the Region. A 27-ha production farm for *Citronella* is located in the Visayas, with farms of almost the same total acreage existing in South Tagalog where there are 8 ha under lemongrass, 3 ha under patchouli, and 5 ha under ylang ylang, all operational. There actually is much more hectarage devoted to aromatic plants in most Regions, but records are not available, while some of the farms have management problems.

A list of MAP commercially cultivated in the Philippines (de Padua 1996) is given below:

Scientific name	Common name	Local name	Family	Part used
Cananga odorata	ylang ylang	Ilang ilang	Annonaceae	flower
Canarium luzonicum	-	Pili	Burseraceae	nut
Catharanthus roseus	periwinkle	Chichirica	Apocynaceae	root
Cymbopogon citratus	lemongrass		Poaceae	leaf
Cymbopogon nardus	citronella		Poaceae	leaf
Hedychium coronarium		Kamia	Zingiberaceae	flower, rhizome
Jasminum sambac	Arabian jasmine	Sampaguita	Oleaceae	flower
Lagerstroemia speciosa		Banaba	Lythraceae	leaf, bark
Moringa oleifera	horseradish tree	Malunggay	Moringaceae	fruit
Ocimum basilicum	basil	Balanoy	Lamiaeae	aerial part
Pogostemon cablin	patchouli	Kabling	Lamiaceae	aerial part
Polianthes tuberosa	tuberose	Azucena	Amaryllidaceae	flower
Vetiveria zizanioides	vetiver	Mora	Poaceae	root

Thailand: Although medicinal plants have been utilized as herbal medicine since the dawn of history, only recently that commercial production has been initiated to satisfy the demand of raw materials for pharmaceutical manufacturing (Sinchaisri 1996). As far as aromatic plants are concerned, those which are used for essential-oil extraction have been cultivated on commercial scale for quite some time (Pongpangan *et al.* 1996). Thailand also produced a number of spices for both domestic consumption and for export, including black pepper, chili pepper, turmeric, garlic, ginger, coriander, and cardamom (Wasuwat 1993). A list of MAP produced commercially in Thailand is given below:

Scientific name	Common name	Thai name	Family	Part used
Allium sativum	garlic	Krathium	Alliaceae	bulb
Aloe barbadensis	aloe vera	Wan Hang Chorakhe	Liliaceae	leaf

Andropogon paniculata	'Fa Thalai Chon'	Fa Thalai Chon	Acanthaceae	aerial part
Areca catechu	arecanut	Mak	Palmae	nut
Amomum xanthioides	bastard cardamom	Reo	Zingiberaceae	fruit
Capsicum annuum	chili pepper	Phrik	Solanaceae	fruit
Capsicum frutescens	chili pepper	Phrik	Solanaceae	fruit
Cassia angustifolia	senna	Makham Khaek	Leguminosae	leaf, pod
Catharanthus roseus	periwinkle	Phaengphuai	Apocynaceae	root
Chrysanthemum morifolium	chrysanthemum	Kekhuai	Compositae	flower
Citrus hystrix	porcupine orange	Makrut	Rutaceaae	leaf
Climacanthus nutans	'Phaya Yo'	Phaya Yo	Acanthaceae	aerial part
Coriander sativum	coriander	Phak Chi	Umbelliferae	leaf, seed
Croton sublyratus	'Plao Noi'	Plao Noi	Euphorbiaceae	aerial part
Curcuma domestica	turmeric	Khamin	Zingiberaceae	rhizome
Cymbopogon citratus	lemongrass	Takhrai	Poaceae	leaf
Cymbopogon winterianus	citronella	Takhrai Hom	Poaceae	leaf
Hibiscus sabdariffa	roselle	Krachiep Daeng	Malvaceae	epicalyx
Jasminum sambac	Arabian jasmine	Mali	Oleaceae	flower
Michelia alba	'Champi'	Champi	Magnoliaceae	flower
Mentha arevensis	Japanese mint	Mint	Lamiaceae	aerial part
Ocimum basilicum	basil	Horapha	Lamiaceae	aerial part
Ocimum sanctum	holy basil	Kaphrao	Lamiaceae	aerial part
Piper nigrum	black pepper	Phrik Thai	Piperaceae	fruit
Pogostemon cablin	patchouli	Phimsen	Lamiatae	aerial part
Solanum trilobatum	'Mawaeng'	Mawaeng	Solanaceae	fruit
Zingiber cassumunar	'Phlai'	Phlai	Zingiberaceae	rhizome
Zingiber officinale	ginger	Khing	Zingiberaceae	rhizome

Vietnam: At present, production of herbal medicines by state pharmaceutical factories and a few private companies serve the need of the Vietnamese people (Chan 1997). It is estimated that the requirement of medicinal plants for use by 20,000 healers is at least 3000 t/yr. In addition, the demand of raw materials for the production of cosmetics and fragrant products is increasing every year due to the rise in per caput income of the Vietnamese people.

In the past, commercial-scale production of MAP was effected by state or collective farms. Recently, new guidelines generated more tangible results. For example, cultivation can be done by households through contract; good quality seeds are supplied by research institutions to obtain high quality of the products and to avoid variety degradation; post-harvest processing and extraction are organized collectively with advanced technology. In the last 5-year period (1990-95). The main products are:

Scientific name	Common name	Vietnamese name	Family	Part used
Angelica acutiloba	angelica	Duong qui	Umbelliferae	leaf
Artemesia annua	'Qin Hau Su'	Thanh cao	Compositae	aerial part
Catharanthus roseus	periwinkle	Dua can	Euphorbiaceae	root
Cinchona ledgeriana	cinchona	Cankina	Rubiaceae	bark
Cinnamomum cassia	Vietnamese cassia	Que	Lauraceae	bark
Cymbopogon citratus	lemongrass	Sa chanh	Poaceeae	leaf
Cymbopogon martinii	palmarosa	Sa hoa hong	Poaceeae	leaf
Eucommia ulmoides	gutta-percha tree	Do trong	Eucommiaceae	bark
Pelargonium nepalense	geranium	Lao quan thao	Poaceeae	flower
Hibiscus sabdariffa	roselle	Bup dam	Malvaceae	epicalyx
Melaleuca leucadendron	melaleuca	Tram gio	Myrtaceae	aerial part

Mentha arvensis	Japanese mint	Bac ha	Lamiaceae	aerial part
Ocimum gratissimum	lemon-scented basil	Huong nhu trang	Lamiaceae	aerial part
Plantago major	plantago	Ma de	Plantaginaceae	aerial part
Sophora japonica		Hoe	Leguminosae	pod
Stevia rebaudiana	stevia	Co ngot	Asteriacae	aerial part

Several R & D projects on MAP have been undertaken by various research organizations. The following achievements may be cited:

- Tissue culture technique was applied for the improvement of *Mentha arvensis* and *Costus speciosus*. This technique is largely applied for the amelioration, multiplication and breeding of MAP and for the conservation of the clones of some selected species.

- Callus culture technique was applied for the production of biomass of *Panax pseudoginseng* and *Catharanthus roseus*.

- Selection of high-quality MAP has been carried out since 1990 from *Artemesia annua* while improvement and standardization of *Angelica acutiloba, Angelica dahurica, Achyranthes bidentata, Rehmania glutinosa,* and *Mentha arvensis* are going on. However, the selection and breeding technology in the field of MAP is still at its preliminary stage.

- Harvesting of MAP in all state farms, which was mechanized 20 years ago, is now mainly performed manually for economical reason. In post-harvest treatment, the main drying process is sun-drying. Recently, however, some farms and institutions established small and medium drying houses using charcoal or electricity. A need for a polyvalent pilot drying plant which can be used for drying of every part of the plants and post-harvest treatment is the most acute one.

Discussion

Commercial Production of Indigenous MAP

Southeast Asia is a region of high biodiversity and cultural diversity with suitable climatic conditions for the cultivation of MAP. Medicinal plants have been utilized in the region from time immemorial. As technology and development are more advanced, the need for them is much greater and the chance to collect them from the forest is receding. Rural poverty and constant demand for cultivated land are threatening the forests which are the home of uncountable numbers of species. The only possible solution to save this precious inheritance of mankind is to cultivate them systematically. This approach will also provide socio-economic benefits to the rural people as well as satisfy the need of urban people who want to go "back to nature" with the supply of medicinal plants as raw material for pharmaceutical manufacture. Medicinal plants continue to play a significant role in the welfare of people of Southeast Asia as they have been for the past millennia. Due to the high demand of raw material for industrial processing, coupled with the loss of natural habitats of most medicinal plants which were once plentiful in the wild, large-scale cultivation of promising species has been attempted in several countries of the Region while collecting for industrial processing still continues in certain countries.

Medicinal plants have been brought into cultivation in Southeast Asia only recently. Unlike countries in other regions of Asia and other continents, they have not been subjected to intensive breeding programs. Thus, the yield and quality are quite low. In order to start any breeding program, germplasm collection and conservation are most essential. At the same time, breeding programs should be initiated and supplemented with R & D on agro-technology in order to obtain maximal yield and quality of the source of raw materials for pharmaceutical products.

As far as aromatic plants are concerned, the situation is somewhat better than for medicinal plants, at least in a few countries of the Region. Commercial cultivation has been attempted for quite some time and the Region is well known for its products of aromatic plants, particularly essential oils and spices. Yet when compared with other countries in Asia, particularly China and India, the Region is far behind in the development and commercial production of aromatic plant.

New Hope for the New Millennium

Medicinal Plants: Medicinal plants are man's best friend in time of need. Man has made use of them from time immemorial. As technology and development are more advanced, 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 which are the homes of uncountable numbers of species of invaluable medicinal plants. The only possible solution to save this precious inheritance of mankind is to cultivate them systematically. This approach will also provide socio-economic benefits to the rural people as well as satisfy the need of urban people who want to go "back-to-nature" with the supply of medicinal plants as raw material for pharmaceutical manufacture.

Medicinal plants continue to play a significant role in the welfare of people in Asia as they have been for the past several millennia. Due to higher demand of raw material for industrial processing, coupled with the loss of natural habitats of most medicinal plants which were once naturally occurring plentifully in the wild, large-scale cultivation of promising species has been attempted in several countries while collecting for industrial processing still continues in certain countries. The latter approach is likely to come to an end sooner or later due to over-exploitation, unless the campaign to conserve biodiversity puts a stop to it.

Aromatic Plants: The technique of essential oil extraction from aromatic plants have been known for thousands of year. These essential oil have been used in home-made perfumes, scented water, traditional medicine, etc. These plants were normally grown in the backyard and collected for use whenever there was a need. With the advance in industrialization, large-scale production of aromatic plants with modern facilities for processing and utilization has made aromatic plants and their products popular. However, as production costs become more and more expensive, it was necessary to come up with a practical solution, i.e. the invention of synthetic compounds which are almost the same as natural material. This has considerably reduced the uses of natural flavor and fragrant materials, especially in the non-food and other low-cost products. Several factors have contributed to the recent popularity of natural flavors and fragrances derived from aromatic plants. These are:

- *Back-to-Nature Campaign:* The growing dissatisfaction with synthetic chemical products in perfumery, food, cosmetic, and pharmaceutical industries has motivated many people to turn to natural flavors and fragrances obtained from aromatic plants.
- *Health Conscious:* Certain synthetic flavor and fragrant compounds used in various industries have been known to cause certain health hazards. Thus, these industries were forced to use natural materials even at a higher price.

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