Spice Production in Asia - An Overview*

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Abstract

Spices are non-leafy parts of plants used as a flavoring or seasoning. They are used to add flavor to foods and beverages, and as herbal medicines. Asia is known as the 'Land of Spices' as it is the place of origin, production, consumption and export of most spices. Out of the world's 70 plant species grown as spices, 13 are considered major spices produced in Asia. They are briefly described below:

***Black pepper** (Piper nigrum) is the whole dried fruit of a perennial climber. India and Indonesia together produce about half of the world's total production of 180,000 t. **Cardamom** is a group of herbaceous plants of the ginger family whose fruits are used as spices. Small cardamom (Elettaria cardamomum) grown in India and Sri Lanka is by far the best quality of all. Others include large cardamom (Amomum subulatum), Bengal cardamom (A. aromaticum), Siam cardamom (A. krervanh), and bastard cardamom (A. xanthioides). India and Sri Lanka are the major producers of cardamoms. **Cinnamon** and **cassia** are related plants of the genus Cinnamomum whose bark is used as a spice. Important species include the true cinnamon (C. verum), cassia (C. cassia), Indonesian cassia (C. burmannii), Vietnamese cassia (C. loureirii), and Indian cassia (C. tamala). India and Sri Lanka are the major producers. **Chili pepper** is obtained from dried fruit of Capsicum annuum and C. frutescens. C. annuum or sweet pepper, which is less pungent, is used to make paprika pepper for flavoring and coloring western foods, while C. frutescens or bird pepper is more pungent and can be made into cayenne pepper to flavor more spicy oriental hot foods. **Cloves** come from unopened flower buds of Syzygium aromaticum. In Asia Indonesia, India, Malaysia, and Sri Lanka produce clove, but greater quantities are produced in other continents, viz. Madagascar, Tanzania and the West Indies. **Coriander** is the dried seed of Coriandrum sativum, a herbaceous plant. India is the largest producer followed by Pakistan and Thailand. **Cumin** (Cuminum cyminum) is an annual herb whose fruits are pungent and highly aromatic. India and China are the main producers. **Garlic** (Allium sativum) is an annual herb whose underground bulb is used as a spice. Major producing countries are India, Korea, and Thailand. **Ginger** (Zingiber officinale) is a perennial herb whose underground rhizomes, young and old, are used as a spice. India and Thailand are the major producers. **Nutmeg** and **mace** are two spices derived from an evergreen tree (Myristica fragrans). Indonesia produces three-quarters of the total world output, while Grenada is second. **Turmeric** is the underground rhizome of Curcuma longa. It is used as a spice, natural colorant and herbal medicine. India is the major producer and exporter of turmeric. **Vanilla** comes from a pod of an orchid plant (Vanilla planifolium) whose fragrance reveals itself after a series of successive treatments and fermentation in the sun. Indonesia is the biggest producer in Asia, but much smaller than Madagascar, the world's largest producer.*

** Unpublished paper presented at the IBC's Asia Spice Markets '96 Conference, Singapore, 27-28 May 1996.*

The paper also discusses the constraints faced by Asian spice growers which are: (a) biotic – including diseases, pests and lack of genetic variability, (b) abiotic – drought, flood, fire, storm, soil toxicity, (c) socio-economic – marketing, quality control, competition with other crops and synthetics, and lack of labor/capital, and (d) technological - lack of technologies and technology transfer.

Keywords: *Flavoring, seasoning, Spice Isle, Spice Route, Spice City, black pepper, cardamom, cinnamon, cassia, chili pepper, clove, coriander, garlic, ginger, nutmeg, mace, turmeric, vanilla.*

Introduction

What are Spices?

Spices are non-leafy parts (e.g. bud, fruit, seed, bark, rhizome, bulb) of plants used as a flavoring or seasoning, although many can also be used as a herbal medicine. A closely related term, 'herb', is used to distinguish plant parts finding the same uses but derived from leafy or soft flowering parts. The two terms may be used for the same plants in which the fresh leaves are used as herbs, while other dried parts are used as spices, e.g. coriander, dill.

Importance of Spices

Spices have a profound influence on the course of human civilization. They permeate our lives from birth to death. In everyday life, spices succor us, cure us, relax us, and excite us. Ancient peoples such as the Egyptian, the Arab and the Roman made extensive uses of spices, not only to add flavor to foods and beverages, but as medicines, disinfectants, incenses, stimulants and even as aphrodisiac agents. No wonder they were sought after in the same manner gold and precious metals.

Spices in Asia

The Land of Spices

From ancient times to the present, Asia has been well known as the 'Land of Spices'. The Maluku Islands of Indonesia, also known to English speakers as the Moluccas, are referred to as the 'Spice Islands'. It is the most popular of all terms used to describe the land of spices although this term could be applied to Sumatra as well as Sri Lanka, the latter also referred to as the 'Spice Isle'. Melaka (or Malacca), the most famous city known for its spice trade, is called the "Spice City", while the sea route that has linked Venice, Arabia, Sri Lanka, India, Malaysia (Malacca), Moluccas, and China through spice trading since the 16th century, is known as the 'Spice Route', ranking in importance next to the famous 'Silk Road'. For the Indians who produce and export the majority of spices for world markets, the term 'Spice Bowl of the World', is applied to the State of Kerala. Many of the world's finest spices like black pepper, cardamom, nutmeg, ginger and turmeric have been produced in Munnar, Devikulam and Peerumade, all located in Kerala.

List of Spices Produced in Asia

Internationally, there are about 70 plant species that have been grown for spices, the majority of which are in Asia. Although many other species have also been used as spices, they are either not commercially cultivated, or have only been collected from the wild. Table 1 shows those that are produced commercially in countries in Asia.

Countries of Production of Major Spices

Spices have been grown as traditional crops in some Asian countries for thousands of

years. No wonder only few countries, notably India, Indonesia and Sri Lanka, predominate commercial production of the major spices. However, it is difficult to obtain statistics of production from the producing countries, or from agencies, including FAO. The author has tried to give some indications of the present production of major spices in Asian countries as shown in Table 2.

Table 1. Plant species that are grown commercially as spices in Asia*

Common name	Scientific name	Part used
Anise	*Pimpinella anisum*	seed
Basil	*Ocimum basilicum*	leaf
Black pepper	*Piper nigrum*	berry
Caraway	*Carum carvi*	seed
Cardamom (large)	*Amomum subulatum*	capsule
Cardamom (small)	*Elettaria cardamomum*	capsule
Cassia	*Cinnamomum cassia*	bark
Celery	*Apium graveolens*	leaf & seed
Chili pepper	*Capsicum annuum*	fruit
Cinnamon	*Cinnamomum verum*	bark & leaf
Clove	*Syzygium aromaticum*	flower bud
Coriander	*Coriandrum sativum*	leaf & seed
Cumin	*Cuminum cyminum*	seed
Curry leaf	*Murraya koenigi*	leaf
Dill	*Anethum graveolens*	leaf & seed
Fennel	*Foeniculum vulgare*	seed
Fenugreek	*Triagonella foenumgraecum*	seed
Gamboge	*Garcinia cambogiana*	fruit
Garlic	*Allium sativum*	bulb
Ginger	*Zingiber officinale*	rhizome
Greater galanga	*Kaempferia galanga*	rhizome
Long pepper	*Piper longum*	leaf
Marjoram	*Marjorana hortensis*	leaf & stem
Mustard	*Brassica nigra*	seed
Nutmeg & Mace	*Myristica fragrans*	seed & aril
Oregano	*Origanum vulgare*	leaf
Parsley	*Petroselinum crispum*	leaf
Rosemary	*Rosemarinus officinalis*	flower/seed & leaf
Saffron	*Crocus sativus*	flower parts
Sage	*Salvia officinalis*	leaf & seed
Savory	*Satureja hortensis*	leaf
Star anise	*Ilicium verum*	fruit
Sweet flag	*Acorus calamus*	rhizome
Tamarind	*Tamarindus indicus*	fruit
Tarragon	*Artemisia dracunculus*	leaf
Thyme	*Thymus vulgaris*	leaf

Turmeric	*Curcuma domestica*	rhizome
Vanilla	*Vanilla planifolia*	pod

* *Revised from Nazeem (1995)*

Table 2. Producing countries in Asia of major spices

Country / Spice	BGD	CPR	IND	INS	ROK	MAL	PAK	SRL	THA	VIE
Black pepper		⊗	⊗	⊗		⊗		X	⊗	⊗
Cardamom			⊗	X		X		⊗	X	
Cassia		X		⊗						
Chili pepper	X	X	⊗	X	⊗		X	X	⊗	X
Cinnamon		X	X			X		⊗	X	X
Clove			X	⊗		X		X		
Coriander	X		⊗	⊗			X		X	
Cumin		X	⊗							
Garlic			⊗		⊗		X		⊗	
Ginger	X	X	⊗	X	X			X	⊗	X
Nutmeg				⊗		X		X	X	
Turmeric	X	X	⊗				X		X	
Vanilla		X		⊗		X				

Symbols: *Ä Major producer*
X Minor producer

Production of Major Spices in Asia

It is not an easy job to select among the list of spices produced commercially in Asia as major spices due mainly to the lack of production statistics. Based on available information, the author decided to select 13 spices (as listed in Table 2) and provide a brief description of each in the following paragraphs:

Black Pepper: Often referred to as the "King of Spices", black pepper is one of the oldest and the most widely used spices in the world. It is the whole dried fruit of a perennial climber, *Piper nigrum* Linn., a native of southern India and grown commercially in South and Southeast Asia, as well as Brazil and Madagascar.

In cultivation, the pepper plant is normally grown with support, either on a living tree or a post (which can be made of cement or wood). It is trimmed to the height of the post that may be about 3-4 m tall, in order to allow easy picking. It has a shallow root system with most of the feeding roots distributed in the top 30-35 cm of soil. Two types of branches are produced, vegetative (climbing) and reproductive (fruiting). The fruits are borne in a cluster (spike) of 20-30 cm in length. Each fruit (drupe) is globose in shape and 5 mm (diam.) in size. It has a pungent taste that is used in flavoring food.

Propagation of commercially grown pepper proceeds through rooted cuttings. Seeds are not usually used for propagation, except in the breeding program. Flowering begins after about 18 months of growth. Many commercial varieties exist in all pepper growing countries. India and Indonesia are the largest producers of black pepper (Table 3), together growing about half of the world's total production of about 180,000 t. Outside Asia, black pepper is produced commercially in Brazil, Madagascar, and the Federated States of Micronesia.

The most severe constraint on black pepper cultivation is the phytophthora disease caused by *Phytophthora capsici*. No resistant variety has been found.

A number of pepper products have been derived, viz. white pepper, ground pepper, green pepper (frozen, freeze-dried, dehydrated), pepper oil and pepper oleoresin.

Table 3. Production of black pepper in Asia[1]

Unit: t

Year / Country	1992	1993	1994	1995*
China	12,321	9,100	10,000	10,000
India	52,010	55,000	50,000	50,000
Indonesia	62,000	235,000	42,500	40,000
Malaysia	26,000	17,600	16,000	15,000
Sri Lanka	3,255	9,000	5,000	5,000
Thailand	10,500	9,000	10,200	10,870
Vietnam	7,830	18,500	20,000	20,000

[1] ***Source:*** *Yong (1995); * Estimated*

Cardamom: Known as the 'Queen of Spices' cardamom is also an ancient spice. It is the dried fruit of many species of perennial herbs of the ginger family (Zingiberaceae). The most common species, *Elettaria cardamomum*, or small cardamom, is cultivated mainly in India and Sri Lanka. Other species include *Amomum subulatum* or large cardamom, grown in northern India and Nepal; *Amomum aromaticum* or Bengal cardamom grown in Southeastern India; *Amomum krervanh*, or Siam or Cambodian cardamom, growing wild under forest cover in Thailand, Cambodia, Lao PDR and Vietnam; *Amomum globosum* or Chinese cardamom grown in southern China, and *Amomum xanthiodes* or bastard cardamom grown wild under forest cover in Thailand.

In terms of quality, small cardamom is by far the best. It is being cultivated in highlands with artificial shade or trees. The multi-stemmed shrub starts to bear fruit after about three years and keeps bearing for 10-15 years. Fruit which is produced in cluster from the base of the plant are harvested when it turns brown, 4-5 months after flowering. The fruits are dried either in the sun or above fire to obtain dried seeds.

Cardamom is one of the most expensive spices used mainly for flavoring curries, cakes, bread, confectioneries, beverages and medicines. Ninety percent of world trade of cardamom is in whole form although there is increasing demand for ground and encapsulated spices, spice oil and oleoresins. Stringent phytosanitary standards in consuming countries have forced producing countries like India, Sri Lanka, etc. to produce other forms of spice products from cardamom.

Very little is known about production statistics except India that produced 3,550 and 4,250 t annually of large and small cardamoms, respectively, during the five-year period of 1984-94. Other Asian countries, notably Indonesia, Malaysia, Sri Lanka and Thailand also produce

cardamom but the amounts are quite small as compared to India. Outside the region, Guatemala is a major producer, and in the mid-eighties took India's dominant role as the largest producer of cardamom.

Cassia: Cassia and cinnamon are related plants whose dried barks are used as spices. They belong to the genus *Cinnamomum*, a large group of plants having essential oils and active ingredients for therapeutic uses widely distributed throughout tropical Asia, particularly Southeast Asia, South Asia and southern China. The major *Cinnamomum* species of international importance are *C. verum* (syn. *C. zeylanicum*) or true cinnamon; *C. cassia* or cassia, Chinese cassia or "Cassia lignea"; *C. burmannii* or Indonesian cassia or 'Cassia vera'; *C. loureirii* or Vietnamese cassia, and *C. tamala* or Indian cassia.

The terms 'cassia' and 'cinnamon', being plants of the same genus and having similar aromatic compounds (although with distinctive flavor and other characteristics), are often used interchangeably. Their major uses are in bakery goods, as seasoning for meat, fish, preserved fruits and vegetables, and in curry powders, beverages, tea, desserts, and pharmaceuticals.

Within the cassia group, *C. cassia*, the specific epithet from that the common name 'cassia' derives, is the source of internationally traded cassia oil. It occurs wild as a bush in the mountains of southern China but is now cultivated for oil production, mainly in the provinces of Guangxi and Guangdong. Other commercial cassias are from Indonesia (*C. burmannii*), Vietnam (*C. loureirii*), India and Nepal (*C. tamala*), all of which come from cultivation. Most cassia plants are large trees, reaching a height of 10-20 m. The part that is harvested for use is the bark which can easily be stripped off the living plant, or preferably in cultivation, by cutting small-sized stems for stripping off the bark. Most *Cinnamon* species usually coppices well and commercial production of the bark spices entails cutting the stems low down after an initial establishment period and harvesting the bushy re-growth stems at regular intervals thereafter. The barks are stripped and formed into hollow quills of the spices. The leaves, twigs and fragments of bark are distilled to obtain cassia oil.

The annual world trade of cassia is between 20,000 to 25,000 t, of which Indonesia accounts for two-thirds and China for most of the remainder. About 2,000 to 3,000 t of cassia bark are exported from Vietnam annually (Sial 1995). It is quite difficult to obtain production statistics from these producing countries shown as blanks in Table 4.

Table 4. Production and export of cassia in Asia.

Unit: t

Year / Country	1992	1993	1994	Annual average of export
China				6,600-8,300[1]
Indonesia[2]	29,364[2]	33,322[2]	33,465[2]	13,300-16,600[1]
Vietnam				2-3,000[3]

[1] *Estimated*

[2] ***Source:*** *Central Bureau of Statistics, Directorate General of Estate, Jakarta (courtesy Dr. Pasril Wahid, Director, CRIIC, Bogor)*

[3] ***Source:*** *de Beer (1993)*

Most of cassia entering the international markets is used as spice. Only small quantities of cassia oil are exported. There is also some production of oleoresin for flavoring purposes. Barks also find local use as a herbal medicine in China and other Southeast Asian countries.

Chili Pepper: Chili pepper is one of a very few spices that did not originate in Asia, but in the New

World. Columbus, discovering America, took it to Spain in 1492 and called it pepper because he found it while searching for black pepper. As its pungent taste was liked by most people in the tropics, and as it is quite adaptive to tropical climate, it soon spread all over tropical Asia soon after its introduction in the early 16th century.

Chili pepper is a product of two related species of *Capsicum*, namely *C. annuum* and *C. frutescens*, whose active compound responsible for hot taste is 'capsicin'.

C. annuum is an annual herbaceous plant which grows to a height of 30-90 cm and bears many-seeded fruit usually borne singly or occasionally in clusters at the nodes. Fruit is extremely variable in size, shape, and color (ranging from blue to green, orange, red, yellow, violet, cream, white and black). The large-sized fruit having no or little pungent taste are called bell pepper and are used as vegetable or salad. Another less pungent type having bright red color, called paprika pepper after grinding, is used as flavoring and coloring agent in many western foods.

C. frutescens, known as the bird pepper, is a perennial, sub-shrub that lives for 2 to 3 years. While similar in appearance to *C. annuum*, slight differences in flower characters are noticeable. Its fruits are usually small, narrow, and extremely pungent. Little variability exists within the species, but its fruits vary enormously in intensity of flavor and pungency.

They are used both fresh and dried as a condiment in most Asian countries. Ground dried fruit, known as cayenne pepper, are used in such dishes as curries, and several native dishes of tropical Asian people.

As with other spices, production statistics of chili pepper are difficult to obtain (Table 5). India is by far the largest producer of chili pepper. For this reason, it is known as the "Universal Spice of India" (Nazeem 1995).

Table 5. Production of chili pepper in Asia

Unit: t

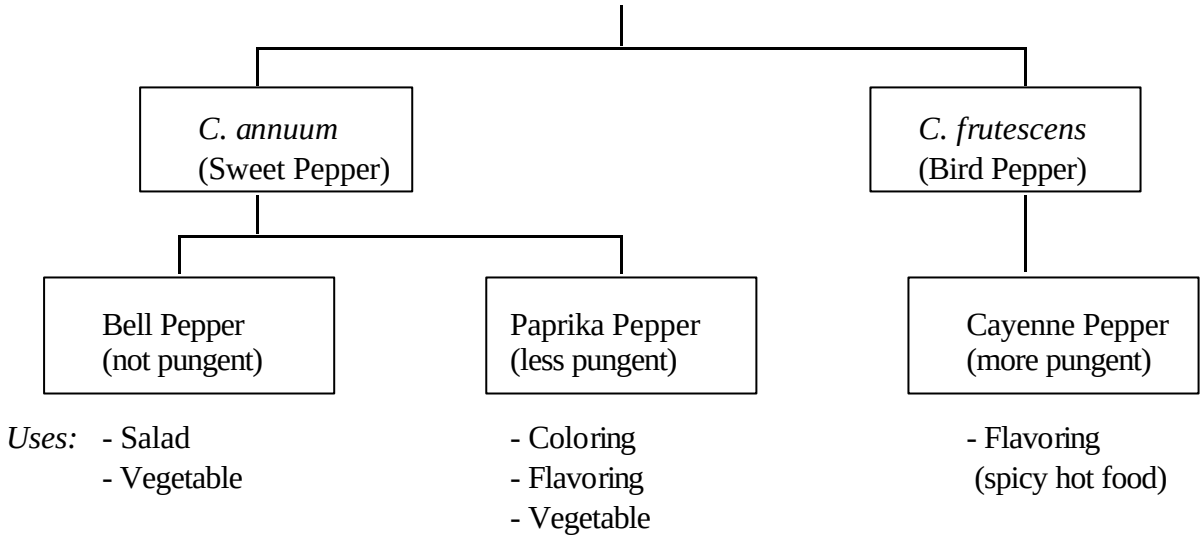
Year / Country	1992	1993	1994	1995	Aver. annual production
India					776,500[1]
Korea, Rep. of	171,790[2]	187,043[2]	176,269[2]		159,642[5]
Pakistan				94,870[4]	
Thailand			181,856[5]		

[1] **Source:** Nazeem (1995); period: 1989-94.
[2] **Source:** Office of Agriculture and Fisheries Statistics (Courtesy Prof. Hyung-Joon Chi, Seoul National Univ., Seoul, Rep. of Korea).
[3] **Source:** Ditto; period 1989-94.
[4] **Source:** Pakistan Agriculture Information Centre (Courtesy Dr. S. Fazal Hussain, DG, PCSIR Laboratories, Peshawar, Pakistan).
[5] **Source:** Dept. of Agricultural Extension, Bangkok

Different terms used for both species and their uses are shown in the diagram below:

Different types of chili pepper and their uses

Chili Pepper



Cinnamon: As stated earlier, both cinnamon and cassia, derive from the bark of *Cinnamomum* spp., and have similar properties, but cinnamon is always thought to be superior in quality. The true cinnamon, *Cinnamomum verum*, which originated in Sri Lanka and south India, has been introduced to many other countries, notably Madagascar and Seychelles, but Sri Lanka still contributes 80 to 90% of the world trade (Sial 1995). Its annual production during 1993-95 were 9,600 t (1993), 10,500 t (1995) and 11,200 t (1995) while its exports were 8,728 t (1993), 9,016 t (1994) and 9,852 t (1995) (*Source:* Export Development Board, Colombo). As in the case of other cassias, the true cinnamon is obtained from the bark of small stems of cultivated cinnamon trees which have been cut down after an initial establishment period and the bushy re-growth stems are harvested at regular intervals thereafter. In Sri Lanka, a first harvest may be obtained after 3-4 years although both quality and yields improve with subsequent cuttings. The stems are cut during the rainy season to facilitate peeling of the bark. Strips of bark are then formed into compound quills or sticks of 1m length.

Other products of cinnamon include bark oil, leaf oil, and ground cinnamon bark. Bark oil is produced by distillation of chips and variable amounts of 'featherings' (pieces of inner bark from twig and twisted shoots) and 'quillings' (broken fragments of quills). Leaf oil is produced by distillation of leaves left after trimming the cut stems, as well as those obtained from pruning. They are allowed to dry for a few days before distillation. Ground bark is becoming more popular as ingredient to add flavor to various condiments and desserts such as in cakes, especially rich fruit cakes, biscuits, cookies and pudding.

Clove: A native of the Moluccas, well known as 'Spice Islands' since colonial time, clove (*Syzygium aromaticum*) has been one of the world's most sought-after spices, causing many voyages, adventures and battles.

The clove tree is a large, evergreen tree producing flower buds that are used as spice and medicine from time immemorial. In its native habitat, the trees grow in volcanic, loamy soil. Propagation is made from seeds or grafts. The seeds germinate within 4 to 6 weeks. The seedlings can be transplanted in the field with spacing of 6-8 m apart. When the trees are about of 5 years old, they start to flower. The unopened flower buds, borne in cluster, are to be picked before the pinky-green blossoms open. This operation is rather labor-intensive since it is done by hand picking, i.e. by brushing clusters against the palm. When dried, the buds turn dark brown and retain only one-third of their original weight.

Cloves are used to add flavors as well as to decorate several kinds of foods such as baked ham. Ground cloves are used with dried fruit in cakes, steamed puddings and mincemeat. In

Indonesia, cloves are used to 'flavor' tobacco, known as *'Kretek'*, to give a strong clove aroma. Its essential oils are used in dental treatment.

In addition to Indonesia, cloves are grown in India, Malaysia, and Sri Lanka, but production in the Asian countries is quite small as compared to that in countries in other regions, namely Madagascar, Tanzania (especially in Zanzibar), and the West Indies. Statistics of production are available only from Sri Lanka that produced 1,900, 1,100, and 1,400 t in 1993 to 1995, respectively. During this period, the following amounts were exported: 1,650 (1993), 971 (1993) and 1,116 t (1995) (Source: Export Development Board).

Coriander: Coriander (*Coriandrum sativum*) is a herbaceous annual plant with fan-shaped feathery leaves and clusters of pale mauve flowers. Its aromatic leaves are used as a herb in many oriental dishes and soups, but in terms of international trade, it is mainly grown for the round, aromatic seeds, which are used as a spice.

Coriander is a native of the Middle East but is now widely cultivated in most Asian countries. Cultivation is done by sowing the seeds in rows 30 cm apart on raised beds. The plants will grow to about 30-90 cm in height. Flowering and seed set will take place within a few weeks after seeding. Harvesting of seeds can be done by cutting the clusters as soon as the seeds start to ripen. Hang them upside-down in the room to dry, then shake them on a sheet of paper. Collect the seeds and store them in airtight container away from sunlight and heat.

The seeds are used in dishes as varied as sauces, pickles, chutneys, cakes and some confectionery and candy. In spiced sausages and meat products, coriander seeds add flavor and pungency, making the food more spicy.

India is by far the largest producer of coriander seeds, with 147,900 t produced annually (Nazeem 1995) while Thailand and Pakistan produced 12,197 and 31,000 t, respectively in 1995. Other Asian countries producing coriander are Bangladesh, China and Indonesia, but no production statistics are available.

Cumin: Another native plant of the Middle East, cumin (*Cuminum cyminum*) is an annual herb mainly grown for its fruits which are a pungent and highly aromatic spice. In cultivation, seedlings are transplanted on to raised beds. The plants grow 30-60 cm high on very slender stems and are delicate. When the plants begin to wither, the stems are cut below the clusters of fruits and hanged in a room to dry.

The seeds should be warmed slightly before use to increase the aroma. Two forms of cumin are prepared, whole or ground. They are used to flavor curries, bread, pickles, chutney, sausages and other meat products.

Only two countries in Asia produce cumin on a commercial scale. India, which produces an annual average of 64,889 t during the five-year period of 1989-94 (Nazeem 1995), is the probably largest producer of cumin in the world. The other is China, but no production statistics is available.

Garlic: Garlic (*Allium sativum*) is one of the most ancient crops known to man. It was cultivated as early as 4,000 years ago and used as food, spice and medicine since then. It is an annual herb of the onion genus that includes onion, leek, chive, shallot, etc. all of which possess a characteristic pungent aroma. It is grown from seeds or bulblets (also known as cloves) which are segments of the underground bulb of garlic, each surrounded by a thin white or pinkish sheath. Leaves are flat and narrow, with acute apex. The bulbs are harvested when the above-ground parts start to wilt, dried in the room and can be kept for a long time.

The bulbs contain several active compounds including allicin, diallyl disulphide, allyl propyl disulphide and other sulfur compounds, all of which contribute to the unique penetrant odor of garlic which has acted as a major constraint upon consumption.

As spice, garlic is used to flavor many dishes in various forms: fresh, dried, chopped, fried, mashed, ground, etc. The freshly harvested bulbs can be pickled in vinegar, syrup or brine. Ground

garlic has been produced to be used in food industry as well as in pharmaceuticals. It can also be sliced. Garlic oil that is produced through steam distillation, is quite useful as antiseptic; it also has anti-bacterial properties. It has been proved that garlic inhibits the formation of cholesterol, suppresses blood-clotting, eases asthma, prevents heart attacks and strokes, and inhibits the growth of cancerous tumors.

Garlic is cultivated in most countries both in the tropic and temperate zones. In Asia, it is commercially grown in China, Indonesia, Pakistan, Republic of Korea, Thailand, and India. The last three are major producers whose annual productions are 415,690, 382,672, and 364,000 t, respectively (Table 6). Unfortunately, no production statistics are available from other countries.

Table 6. Production of garlic in Asia.

Unit: t

Year / Country	1992	1993	1994	1995	Aver. annual production
China					364,000[1]
India	464,649[2]	392,908[2]	382,344[2]	-	
Indonesia				76,890[4]	415,690[3]
Korea, Rep. of				382,672[5]	
Pakistan					
Thailand					

1 Source: Nazeem 1995, period 1989-94.
2 Source: Office of Agriculture and Fisheries Statistics, Korea.
3 Source: Ditto; period 1989-94.
4 Source: Agriculture Information Centre, Pakistan.
5 Source: Office of Agricultural Statistics, Thailand.

Ginger: Originating in Southeast Asia and cultivated in ancient China and India, and the first spice imported into Europe, ginger, *Zingiber officinale*, is now being cultivated in most tropical countries. It is an erect, perennial herb growing to a height of 60-120 cm from thick, knobby, underground rhizomes. In cultivation, ginger normally grows as an annual on raised beds, and does not set seeds. Thus, propagation is done by vegetative means from small pieces of rhizomes.

Young rhizomes are marketed whole soon after digging for use in pickling while mature rhizomes are dried and marketed in whole as well as ground form. The latter is obtained by scraping, boiling and peeling and then grinding. Ground ginger is used in cakes, puddings, biscuits, and candy. Preserved, candied and crystallized ginger is processed from the fresh, young rhizomes and is eaten as sweetmeats or as a garnish for cakes and desserts. Ginger is also used as herbal medicine, e.g. as a remedy for digestive disorders. Ginger oil is used in the production of the soft drink known as ginger ale.

Crop improvement programs in ginger are hampered by the lack of seed set leading to limited variability. Novel techniques, e.g. the use of somaclonal variation, are now being attempted to increase variability that could be exploited to produce high-yielding, high-quality clones, and in particularly, to develop clones resistant to rhizome rot and bacterial wilt.

Few statistics on production are available. Major producing countries are India with an average annual production of 156,180 t and

Thailand that produced 187,826 t in 1995. Republic of Korea also produces a considerable quantity, viz. 47,809 t in 1992; 40,396 t in 1993; and 45,886 t in 1995 with an average annual production during 6-year period (1989-94) of 39,935 t (Table 7).

Table 7. Production of ginger in Asia

Unit: t

Year Country	1992	1993	1993	1995	Average annual production
India					156,180[1]
Korea, Rep, of	47,809[2]	40,396[2]	45,886[2]		39,935[3]
Thailand				187,826[4]	

[1] ***Source:*** *Nazeem (1995); period 1989-94.*
[2] ***Source:*** *Office of Agriculture & Fisheries Statistics, Korea.*
[3] *Ditto; Period 1989-94.*
[4] ***Source:*** *Office of Agricultural Statistics, Thailand.*

Nutmeg and Mace: Nutmeg, *Myristica fragrans*, is an evergreen tree indigenous to the Moluccas (Maluku), a group of islands in eastern part of Indonesia. It has a yellow fleshy fruit about the size of a lime fruit. Inside the ripe fruit which normally splits open, the nutshell is covered by an interlaced membrane, the mace; and inside the shell, the kernel of the fruit is the nutmeg. When it is harvested, the mace is bright red, but it mellows to golden yellow when dried. Both the kernel (nutmeg) and its surrounding membrane (mace) are used as spices. The plant is unique among spice crops in that it produces two separate and distinct products.

The trees are propagated by seeds. In cultivation, seeds are allowed to germinate in the shade and seedlings are transplanted to the fields, at the spacing of 7 x 7 m where they can bear fruit for as long as 90 years. The male and female flowers are borne on separate plants, but will not be obvious until they flower at the age of 5-8 years. Only one male is needed for 10 female trees while the rest are cut down. Shoots from a male tree can be grafted on to female trees so that the latter can produce fruits. A clone can also be established by the use of cuttings. Harvesting is done either by collecting the fallen ripe fruits, or shaking the fruits into baskets attached to long poles. The nuts are spread out to dry in the sun, then the mace is removed by hand, flattened and dried in the sun separately. When the nuts are dry enough for the kernel to rattle in the shells, they are cracked open and the kernel removed.

In addition to Indonesia that produces three-quarters of the total world output and export, Grenada is second in rank, while other Southeast and South Asian countries produce small amount, mainly for domestic consumption. In 1990, Indonesia produced 15,000 t. The figures for 1992-94 are: 17,316 (1992), 20,911 (1993), and 23,792 t (1994) (*Source:* Central Bureau of Statistics, Jakarta). Sri Lanka produced 850, 790 and 910 t during 1993 to 1995, respectively (*Source:* Export Development Board, Colombo).

Nutmegs are sold whole and the best way to use them is by grating the kernel progressively as it is needed. The spice is used to give pleasant flavors to various desserts and beverages as well as food. Ground nutmeg is also available but is never aromatic. Mace is sold whole (called 'blade mace') or ground. Blade mace is often included in pickling spice blends. Ground mace enhances the

flavors of several desserts, and various meats, fish and shrimp dishes.

Nutmeg also consists of two types of oils: (i) the essential oil of nutmeg which accounts for 5-15% of the nutmeg seed, and (ii) the fixed oil of the nutmeg, sometimes called 'nutmeg butter', which accounts for 24-40% of the nutmeg seed. The essential oil is obtained by steam distillation of the nutmeg. It is a pale yellow liquid with a taste and odor of nutmeg, and can be used as a natural flavoring extract and as a perfume in the cosmetic industries. It is also used as a flavoring agent, replacing ground nutmeg in order to avoid leaving particles in foods and beverages.

The fixed oil is obtained through the use of hydraulic pressure and heat or a solvent, after essential oil is removed by steam distillation. Nutmeg-fixed oil finds very little commercial use except those that contain a substantial amount of essential oil having the same odor as nutmeg.

Turmeric: A native of tropical Asia, turmeric, *Curcuma domestica*, is a perennial herb of the ginger family. In cultivation, it is grown as an annual on raised beds for ease in harvesting its rhizomes that are turmeric of commerce. The plant is propagated by dividing suckers and by planting small pieces of the round orange rhizome. The rhizomes usually mature within 8-10 months after planting, when the above ground parts begin to wilt. Manually harvested rhizomes are boiled, cleaned and dried in the sun, then polished to remove the external surface layer. They lose three quarters of their original weight during processing. Before marketing, processed rhizomes are ground to a find powder.

For many centuries, turmeric has been used not only as a spice but as a natural colorant, the bright yellow powder of the ground rhizomes being one of the earliest known vegetable dyes. This yellow color results from the presence of a pigment called 'curcumin' which may be as high as 5-6%.

As spice, turmeric is used in adding unique flavor and color to oriental curries and various other dishes. It is also used in mixed pickles, particularly the mustard pickles, chutneys and Indian rice dishes.

Turmeric is also used as a herbal medicine in the treatment of ulcers and liver disorders. The anti-bacterial and antiseptic properties of turmeric are well known. Recently, scientists have discovered that turmeric is a natural protectant, having an effective cancer chemo-preventive agent. Curcumin and turmerin, the bioactive principles of turmeric, are said to be mainly responsible for the manifold medicinal properties of turmeric. No wonder it is now known as the 'Yellow Wonder'.

India is the major producer and exporter of turmeric with average annual production (during 1989-94) of 349,000 tons (Nazeem 1995). No production statistics are available from other producers which are Bangladesh, China, and Thailand, except Pakistan which produced 3,100 t in 1995 (Source: Pakistan Agricultural Information Center).

Vanilla: A native of Central America and Mexico, vanilla is one of the flavorings discovered by early explorers of the New World. It was brought to Europe by the Spaniards, who found the Aztecs using it as a flavoring for chocolate. It was introduced to the islands of the Indian Ocean, the West Indies and the South Sea Islands in the last century. Around 1840, commercial production of vanilla started in Madagascar and the Comoros Island. Now 80% of the world's crop is produced in Madagascar.

Delicate yet demanding, the vanilla plant can be damaged by cold or by extreme heat. It grows at altitudes between sea level and about 700 m. in light soil rich in humus and minerals, which can come from the breakup of volcanic rocks, from sandy river floods or from earth left unburned after forest clearance. Vanilla is fond of diffused light, such as that afforded by the shadow of a banana tree, and can be damaged by exposure to direct sunlight. Finally, it needs abundant rain (from 2,000 to 3,000 mm. annually) evenly distributed throughout the year. Once these conditions are met, the vanilla plant requires further care. Its flowers, which generally open out every other day, have to be artificially pollinated early in the morning when the air is still very humid. The resulting pods contain the aromatic compound, 'vanillin'. They

can be harvested in eight months. Each plant can bear from 600 g to 3 kg of green vanilla pods, which have practically no scent at the time of harvesting. Their fragrance reveals itself after a series of successive treatments, and fermentation in the sun. It takes 4.5 kg of green vanilla pods to obtain 1 kg of fragrant finished vanilla pods.

Vanilla is one of the most versatile of flavorings. It is used commercially in the manufacture of chocolate, ice cream, puddings and tobacco.

A few countries in Asia produce vanilla. These are Indonesia which is the biggest producer in Asia, followed by China and Malaysia. As the total world demand is quite small (around 1700 - 2000 t per annum), the market is quite lucrative. Madagascar, the world's largest producer of vanilla is fearing loss of its crucial vanilla trade as it is being taken over by Indonesia, China, and several island countries in the South Pacific. However, no statistics of production are available from any of these countries.

Constraints in Asian Spice Production

Although most of the world's important spice crops originated in Asia and, as such, it is the legendary source, the major producer and exporter, and also the major consumer of spices, there are still a number of constraints which hamper production and/or expansion of cultivation to satisfy the growing worldwide demand. These constraints can be grouped into four main categories: biotic, abiotic, socio-economic and technological. They are briefly described below:

Biotic Constraints: They are caused by biotic factors mainly diseases and pests, and the lack of genetic variability. Several devastating diseases are well known among spice growers. Sumatra disease of clove almost wiped out clove production in Indonesia. Foot rot disease of black pepper has caused severe damage to growers in India and elsewhere, and so far none of the existing genotypes have shown resistance to this disease. Many spice crops are propagated vegetatively, thus limiting the genetic variability, a prerequisite for crop breeding programs. The presence of two sexes on different plants in nutmeg makes it difficult to have fruit set without male trees, whose presence without any yield is a drawback in plantation. The need for artificial pollination in vanilla, a labor-intensive operation makes it uneconomic to produce this delicate spice in some countries where labor is a problem.

Abiotic Constraints: These are caused by various exogenous natural factors such as drought, flood, fire, storm, soil toxicity, etc.

Socio-economic Constraints: This type of hindrances is caused by problems in marketing, quality control, competition with other economic crops or synthetics, lack of labor and capital investment, etc.

Technological Constraints: These are problems resulting from the lack of technology transfer, or the lack of technologies themselves. These technologies include the creation of superior varieties, improved cultural practices and processing technology.

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