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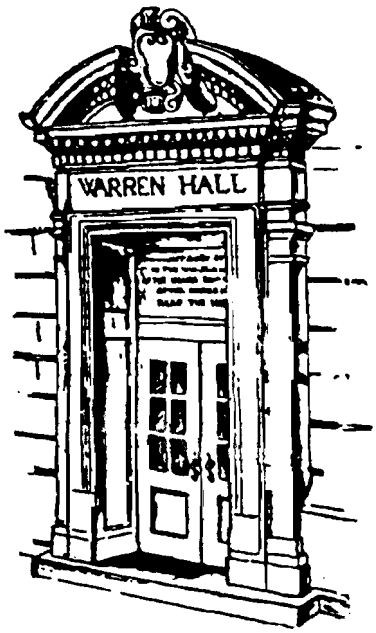

Working Paper

Department of Agricultural, Resource, and Managerial Economics
Cornell University, Ithaca, New York 14853-7801 USA

SPICING UP INDIA'S PEPPER INDUSTRY: AN ECONOMIC ANALYSIS

Satoshi Koizumi

Advisor: Thomas T. Poleman

ABSTRACT

This study examines whether India, a dominant producer of high-quality pepper, should consider the fast-growing, low-end pepper market as the primary target for its exports in the next 20 years. The analysis concludes that it would be more advantageous for India to shift its primary target of pepper exports from the high-end to the low-end market by switching to the alternative intensive production system.

CORNELL
UNIVERSITY

Department of Agricultural, Resource,
and Managerial Economics

Warren Hall
Ithaca, NY 14853-7801
USA

Facsimile: 607 255-9984
Phone 607 255-4463

Thomas T. Poleman
Professor of International
Food Economics

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Pepper may well have originated in India, and the Malabar Coast has figured in the pepper trade since at least Roman times. Every schoolchild knows it was the destination Vasco da Gama sailed around Africa to reach and, had not the Americas got in the way, was the intended goal of Columbus.

Indian pepper retains its reputation for quality and can be found in grinders on the very best tables the world over. Its superior pungency, aroma, and flavor are in part attributable to the fact that, almost alone among peppers, the vine in India is allowed to climb a living tree rather than a wooden or concrete stake. If this tree, *Murik*, is a rich source of piperine, it also competes with the vine for soil nutrients; pepper yields in India are the lowest in the world.

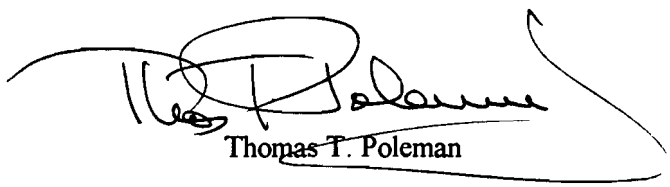
While the demand for pepper has grown dramatically during the last 50 years and is projected to continue to do so, the nature of the market is changing. The food processing industry, not the gourmet's table, is the principle taker in Europe and North America, and price rather than quality holds the greatest appeal to the growing markets of the developing countries.

Whether India should consider reorienting its pepper economy to meet this fast-growing, low-end sector of the market is the subject of Satoshi Koizumi's paper. He explores the trade-offs between the traditional low-yield, high-quality system of production with a possible high-yield, low-quality alternative, not unlike that practiced elsewhere.

Mr. Koizumi spent three months in India researching the topic and thanks are due those who guided and aided his work. His affiliation with the Centre for Development Studies in Kerala was made possible by Professor Chandan Mukherjee. Professors P. S. George and K. J. Joseph helped design his field survey. In Nedumkandam he was guided and assisted by Mr. Thomas Raju and Mr. T. J. Thomas. Almost a year was required to persuade the Government of India to grant Mr. Koizumi a research visa and I wish to acknowledge the role of Dr. Rita Sharma in shaking loose this pointless logjam. Lillian Thomas prepared this version of the paper with the same skill and devotion she has shown my students for over 30 years. Thank you all.

Comments and suggestions are welcome. Please send them to:

Mr. Satoshi Koizumi
1-23-18 Tsumada-nishi
Atsugi, Kanagawa 243-0815
JAPAN

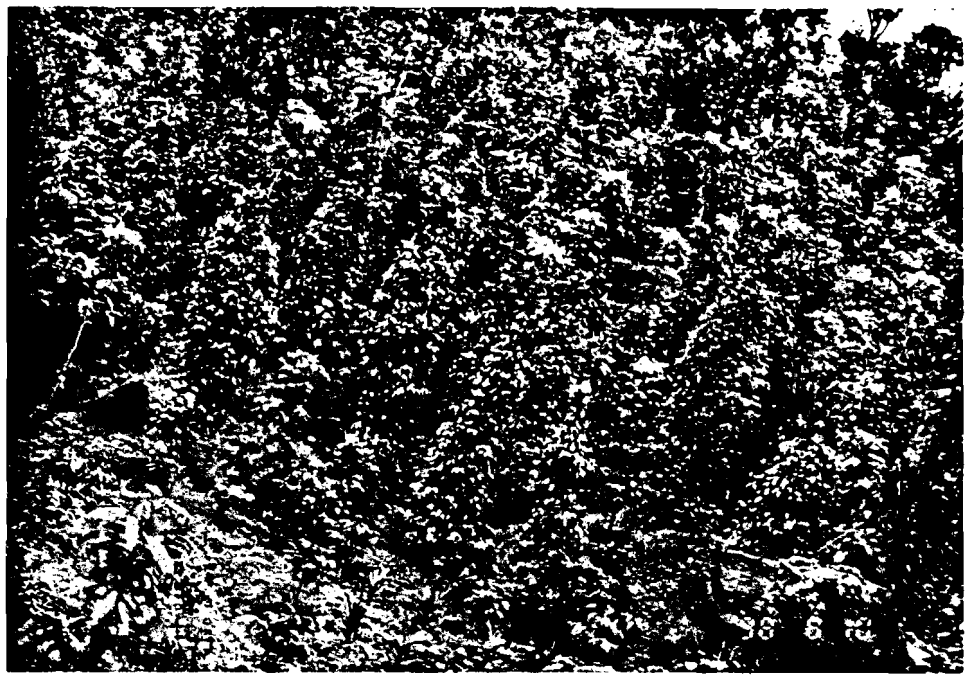


Thomas T. Poleman

TELEX: WUI 6713054 E-Mail: TTP2@CORNELL.EDU

PHOTOGRAPH 1 (left)
Pepper is a perennial vine crop. Each spike may have 50-60 Peppercorns.

PHOTOGRAPH 2 (below)
Harvested fresh green peppercorns are sun-dried to make black pepper.

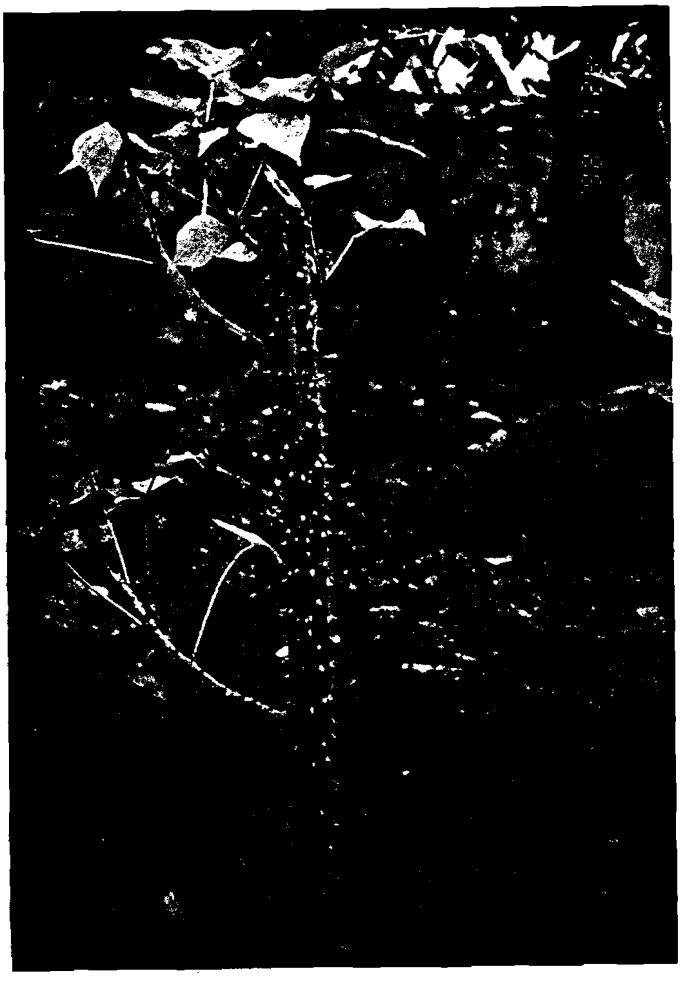


PHOTOGRAPH 3
Stage one: In India, pepper is grown predominantly in mixed cropping, but in newly cleared land, pepper mono cropping can be found.

PHOTOGRAPH 4
Stage two: Once enough capital is accumulated from pepper cultivation, other crops are added to the farm to develop more complex and profitable mixed cropping system. This is mixed cropped farm of pepper and coffee.

PHOTOGRAPH 5 (above)
Stage three: a fully developed typical pepper mixed-cropped farm.
Pepper, banana, coconut, clove, arecanut, and cardamom can be seen in this picture. This is very different from the scene in a Malaysian pepper farm.

PHOTOGRAPH 6 (left)
A typical intensive pepper mono-cropping
farm in Sarawak, Malaysia.
What makes Indian pepper farmers grow
pepper in mixed cropping?
Why is mono-cropping dominant in Malaysia?



PHOTOGRAPH 7 (above)
Type of support stands makes all the difference. In Malaysia, wooden stakes are used as pepper support stands, while live trees are used in India (left). Live tree stands suppress pepper's yield; thus, profitability. Therefore, Indian farmers cannot depend on pepper alone.

PHOTOGRAPH 8 (left)
Murik: the most-commonly used pepper support tree in India. Indian farmers use *Murik* because of its availability and other positive features. But the main reason is prohibitively high cost of wooden stakes.

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GLOSSARY

ASTA	American Spice Trade Association
CRB	Commodity Research Bureau
ERS	Economic Research Services, US Dept. Agriculture.
FAO	United Nations Food and Agriculture Organization
FAOSTAT	FAO's online statistical database
ha	hectare
IPC	International Pepper Community
kg	kilogram
MT	metric ton
Murik	Erythrina Indica, a leguminous tree commonly used as a pepper support tree in Kerala
VOC	the Vereenigde Oost-Indische Compagnie, the Dutch East India Company

CHAPTER ONE
INTRODUCTION

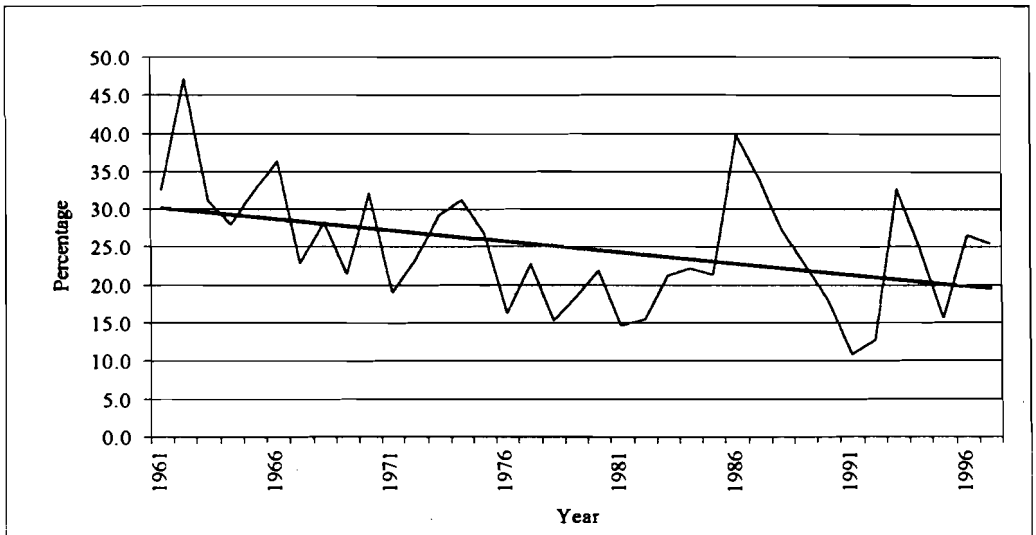
India is missing out on the opportunity to take advantage of the fast-growing international pepper market. Once dominant, India's export share has declined from almost half of the world's total in 1962 to a quarter in 1997 (Figure 1). This is not because the absolute volume of Indian pepper exports declined, but rather, that its export growth was much slower than that of its competitors. The world total export of pepper tripled from about 50,000 metric tons (MT) in 1961 to 150,000 MT in 1997. On the other hand, Indian exports slightly more than doubled from roughly 17,000 MT to 38,000 MT during the same time period.

Indian pepper production and exports remained at the same level from the early 1960s until the middle of the 1980s, allowing competitors to capture shares of the expanding global market. Small harvests in consecutive years in major producing countries pushed pepper prices high in the middle of the 1980s; this price hike stimulated production by Indian pepper farmers, and since then Indian production has gone up significantly. The expansion of Indian exports in the world pepper market, however, has been less successful than the expansion of production.

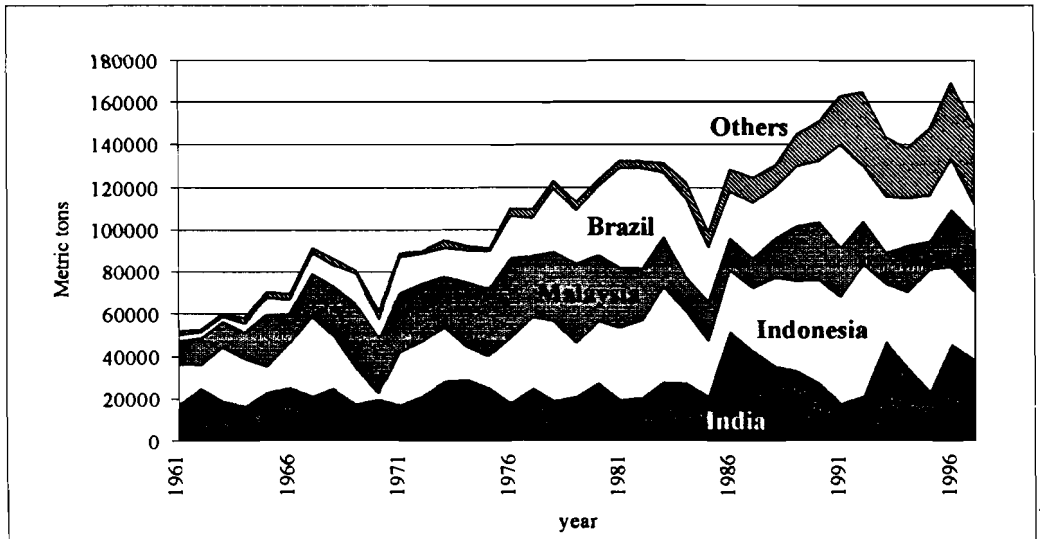
One of the reasons for the stagnation of Indian exports is that Indian pepper is relatively expensive. India has been able to increase its export share whenever the price gap narrows. The existence of large bilateral governmental purchase agreements between India and the countries of the former Soviet bloc had kept the price of Indian pepper high. Since the major export destination of Indian pepper was the former Soviet bloc until 1989, the Indian pepper industry was partially insulated from international competition, and as a result, the production cost of Indian pepper remained high.

Another important reason for the price premium on Indian pepper is that Indian pepper is reputed to have superior pungency, aroma and flavor. Therefore, the finest whole peppercorns found in grinders on dining room tables are Indian peppercorns. The growth in this kind of high-end market, however, is limited. Today, most pepper demand comes from developing countries and food processing industries in the industrialized countries. Demand for pepper oleoresin and ground pepper from the food processing industry is growing fast, and these products can be made from pepper of lower quality. Therefore, the most rapidly growing section of the pepper demand is for cheap pepper. The question is whether India, which is currently dominant in the high-end pepper market, should consider the low-end market to be the primary target of its pepper exports for the next twenty years.

Demand for high quality pepper in 2020 will come only from the retail sectors in the North American, Western European, and Oceania markets, and will expand about 30,000 MT from near 50,000 MT in 1997 to roughly 80,000 MT in 2020. In contrast, demand for low quality pepper will expand five times faster, increasing about 150,000 MT from roughly 140,000 MT in 1997 to about 290,000 MT in 2020. On the supply side, if India remains in the high-end market, it is likely to face strong competition from Indonesia and Sri Lanka. There will be a relatively small expansion of demand for high quality pepper, and production and exports from these two competitors are expected to increase significantly. On the other hand, in the low-end market, production and exports will increase substantially only in Vietnam due to various difficulties in other producers of low quality pepper.



India's Share of World Pepper Exports, 1961-1997



World Pepper Exports, by Country, 1961-1997

Figure1. World Pepper Exports by Country, and India's Declining Share, 1961-1997

Source: FAOSTAT, http://apps.fao.org/

Note: Since FAOSTAT has consistent data of the longest period in various aspects of this study, FAOSTAT is used most frecuently throughout the paper. Since FAOSTAT has data from 1961 to 1987 or 1998, most data presentations in this paper have the same time range, unless otherwise noted.

Although the low-end market appears to be more promising, the economics of pepper cultivation must also be analyzed in order to determine what changes would be needed if India switches the primary target of its exports from the high-end market to the low-end market and to examine whether such changes are worthwhile. First, to be competitive in the low-end market, prices of Indian pepper must be brought down.

The production cost of one kilogram of black pepper in India is 30-40 percent higher than the world average. The high production cost of Indian pepper is a result of India's strikingly low yield. The average Indian pepper yield is about 300 kilograms per hectare (kg/ha). In contrast, the average pepper yield in Malaysia, Indonesia, and Brazil is about 1,300 kg/ha, which is more than four times higher than the Indian yield. The difference in the yield can be explained in terms of two major factors. First, pepper is cultivated in monocropped fields in most countries, while mixed cropping is dominant in India. Therefore, the number of pepper plants per hectare is smaller in India. Second, Indian farmers use a live tree, called Murik (Erythrina Indica) as a support stand, on which the pepper vine climbs. In other countries, a wooden stake or cement pole is used. Because Murik competes with the pepper plant for soil moisture and nutrients, pepper yield per plant is also lower in India. In addition, Murik is responsible for the price premium on Indian pepper. Murik enhances the pungency of pepper grown on it because the bark of Murik contains a high level of the pungent agent piperine and the pepper plant absorbs piperine from its adhesive roots around Murik's stem.

One of the reasons why Indian pepper farmers employ mixed cropping is that mixed cropping provides greater income stability than mono cropping. Since most Indian pepper farmers are poor and own very small parcels of land, they can not rely on only one crop whose price may be volatile. Moreover, Indian farmers have developed a combination of crops that generates a higher expected return per unit of land than pepper mono cropping.

Although many Indian farmers know that using Murik reduces pepper yield, they continue to use Murik because they can not afford the large setup costs associated with wooden stake use. Murik is practically free since it can be propagated easily by simply sticking a cut branch into the ground. One wooden stake, on the other hand, costs around 60 Rupees, which is about 60 percent of the wage for a whole day's labor. Indian pepper farmers are doing their best in the given economic environment. What if, however, wooden stakes were used? When non-living materials are used as support stands, yield per pepper plant increases two to four times (Menon, Nair, and Sharma, 1982). Therefore, pepper's expected return per unit of land would become so high that mono cropping could generate a higher expected income than mixed cropping. In addition, if wooden stakes were used in India, pepper would contain a lower level of piperine, and thus prices for Indian pepper should become very competitive.

Although the imputed net return per hectare of a monocropped pepper farm using wooden stakes is much greater than that of a mixed-cropped pepper farm using Murik, several problems must be addressed. First, erosion might be problem if mono cropping is employed because most pepper farms are located on hillsides; thus terracing would be needed. Second, it would be difficult to promote pepper mono cropping without providing safety-net measures, such as crop insurance, to small-scale farmers; under mono cropping, there is a risk of income shortage. Third, a monocropped pepper farm using wooden stakes requires huge initial setup costs. An initial investment would not be heavy burden, if it were evenly spread throughout the pepper plant's long economic life. An improved yield would make the burden even lighter. At present, however, it is difficult for poor Indian farmers to borrow a substantial amount of money for extended periods of

time at a reasonable rate. In addition, labor and fertilizer demand would increase and push operational costs up substantially. Therefore, improvements of credit accessibility for small-scale farmers in both long-term and short-term loans are suggested.

This study investigates the international pepper economy from both supply and demand sides to examine whether the high-end or low-end market is more advantageous for India. It also analyzes what changes have to be made if India switches from the high-end to the low-end market. The traditional extensive pepper cultivation system practiced in India is investigated to understand the system's underlying rationale. The trade-off associated with replacing Murik with wooden stakes is also discussed. Chapter Two reveals the supply side of the pepper trade, and examines the prospects of production and exports from India's competitors in the high-end and low-end market in 2020. Chapter Three describes the demand side of the pepper trade and consumption trends. In order to examine India's potential in the high-end and low-end markets, demands for high quality and low quality pepper in various regional markets in 2020 are estimated. Chapter Four gives an in-depth analysis of pepper cultivation system in India, suggesting the reasons why mixed cropping is dominant in India and clarifying why Indian farmers use Murik. Furthermore, a hypothetical situation substituting wooden stakes for Murik is simulated in terms of costs and profit. The probable socioeconomic effects associated with this technical change are also examined.

CHAPTER TWO
SUPPLY SIDE OF THE WORLD PEPPER ECONOMY

This chapter has four sections. Section A provides background of the history of black pepper trade. Section B describes the agronomy of the pepper plant, from environmental requirements to cultivation practices. Section C analyzes the behavior of the world pepper price movement. After the discussion of prices, section D investigates pepper producers' cultivation practices, production and exports. The world's major and minor pepper producers' production and export potentials are examined to determine India's competitive situation in the high- and low-end market.

Section A. History of the pepper trade[1]

The pepper plant is native to the Western Ghats Mountains in Southern India. A Hindu sacred book, written as far back as the sixth century BC, reveals that pepper was already widely cultivated as a spice in India at that time. The first description of pepper in Europe appeared in a medical book written by Hippocrates (460-375BC); pepper was first introduced to the ancient Greeks as medicine. The spice was carried by Persian caravans from the Malabar Coast to Damascus, then taken by the Phoenicians to Greece by sea. Syrian merchants developed the pepper trade over the Indian Ocean.

For a long time, Arab spice traders enjoyed a monopolistic trade by keeping the sources of spices secret from the Romans. However, when the Roman Empire captured Cairo and discovered the sea-route from the Red Sea to India, the Arabian spice monopoly died. Despite direct trade with India, pepper was still so precious that it was used as money; pepper was used to pay rent, taxes, and even ransoms.

It is thought that pepper was taken by Hindu colonists to Java between 100 BC and AD 600, and pepper cultivation began in Java, Sumatra, and Malaya. Chinese merchants became dominant in the East Asian spice trade.

By the Middle Ages, pepper had been established as an element of great importance in the European diet. Salt and pepper were used to preserve meat. Pepper was used to make dull meals more palatable, and to mask the smell of old meat. However, it remained very expensive. When Alexandria fell to the Arabs in 641, the Arabs regained control of the spice trade. By this time, pepper was mostly carried by sea from the Malabar Coast to Cairo through the Red Sea, then overland to Alexandria. Venetian merchants controlled the Alexandria-Venice route and monopolized the spice trade in Europe. This lucrative spice trade brought Venice prosperity.

Ironically, it was a book written by a Venetian explorer that eventually destroyed the Arab-Venetian spice monopoly. When Marco Polo published his book about his journey to East Asia in 1299, European countries were shocked to learn about the abundant spices in Asia, and started to search for a non-Arab route to the spice-rich Asian countries. In 1453 when Constantinople (now Istanbul) fell to the Turks, the overland spice supply route was also taken under the Arabs' control. This was the final blow to Europe's already-tight spice market, and the prices of spices rose sharply. The quest for a direct route to India became the top priority of European countries.

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[1] This section draws heavily on Boorstin (1983), Gotoh (1998), Purseglove, *et al.* (1981), Pearson (1941), and *The Economist* (Dec. 19, 1998). The following web sites were also used: *www.mccormick.com* and *www.astaspice.org* and *www.sbfoods.co.jp/spice/*

It is arguable when the Age of Exploration began, but one of the candidates is the expedition by Dias. Bartholomeu Dias, backed by Portuguese Prince Henry the Navigator, opened the sea route from Europe to Indian Ocean around the southern tip of Africa in 1488. Ten years later, Vasco da Gama of Portugal finally reached Calicut, a spice trade port on the Malabar Coast, by rounding the Cape of Good Hope. When he returned Lisbon in 1501 with a large amount of spices, the price of pepper in Lisbon fell to one-fifth that in Venice. The Arab-Venetian monopoly finally collapsed. The prosperity of Venice and Alexandria gradually evaporated. Before Gama reached India, Christopher Columbus, financed by Spain, courageously sailed to the unknown western territory in order to find a direct sea route to India. As a result he discovered the New World in 1492, although until he died he believed he had reached India. Columbus could not find black pepper in America, but chillies (capsicum) were introduced to Europe along with many new crops from the New World. This historical episode explains why chillies are sometimes called pepper or red pepper. Even after Gama reached India through the eastward route, Spain clung to the possibility of discovering the westward route to India and financed Ferdinand Magellan's explorations. Knowing from his earlier voyages that the Moluccas Islands, the so-called Spice Islands, in Indonesia were located just the south of the island of Guam, he sailed westward from Europe heading for Guam, and miraculously passed through the narrow fjord at the southern tip of the South American continent to the Pacific Ocean. Although he himself was killed in the Philippines, his crew reached the Moluccas, and brought tons of spices to Europe.

Spain, however, was more interested in gold and silver in the New World than oriental spices. Portugal took advantage of this fact to become a spice monopolist. Portugal occupied cities of the Malabar Coast: Goa, Calicut, and Cochin, as well as Ceylon (now Sri Lanka), Malacca, Java, and Sumatra. When the Moluccas Islands were occupied in 1514, Portugal completed its monopoly of the spice trade. Since Malacca had already been well developed by Chinese merchants as an entrepot of various spices, not just pepper, Portugal chose Malacca as their main port in Asia. As a result, the center of pepper trade and production shifted to Malacca from the Malabar Coast. The amount of pepper traded in the world in the middle of the sixteenth century was estimated to be 1,500 MT, about one percent of today's trade volume. Even so, Portugal enjoyed the fruits of their monopoly and Lisbon became the one of the most prosperous cities in Europe.

Early in the seventeenth century, the Dutch drove the Portuguese from Indonesia and established the Dutch East India Company (the Vereenigde Oost-Indische Compagnie, VOC) to control the spice trade. The VOC's first conquest was Banda Island in the Moluccas Islands, the only place that nutmeg and mace were produced. The VOC's method of monopolization was cruel. The VOC killed every male over the age of fifteen in the Banda Islands. Village leaders were tortured and decapitated, their heads displayed on long poles. The population of the islands declined from 15,000 to 600 in just fifteen years. The VOC destroyed all clove trees in its territory and concentrated in the plantation of one island. The death penalty was imposed on anyone caught growing or possessing nutmeg or clove without authorization. All nutmeg was soaked in lime before export to make sure no fertile seed escaped the VOC's hands.

The Dutch also occupied major pepper-producing regions in Indonesia such as Lampung in Sumatra, and tried to expand the plantation fields. Although the Dutch captured much of the pepper trade, they couldn't succeed in establishing a monopoly as they did in clove and nutmeg because pepper was already cultivated in other regions. The VOC became the world's largest corporation and eventually suffered from the huge burden of defense expenditure. At one point, the VOC had 50,000 employees, 30,000 soldiers, and 200 ships. It finally went bankrupt in 1799, just

two years after the first American pepper trader made a 700 percent profit by selling pepper bought directly from the natives of Sumatra. Nevertheless, the Dutch East Indies remained the largest pepper producer until the Second World War; in the 1930s, they produced around 60,000 MT of pepper, about 70 percent of the world production.

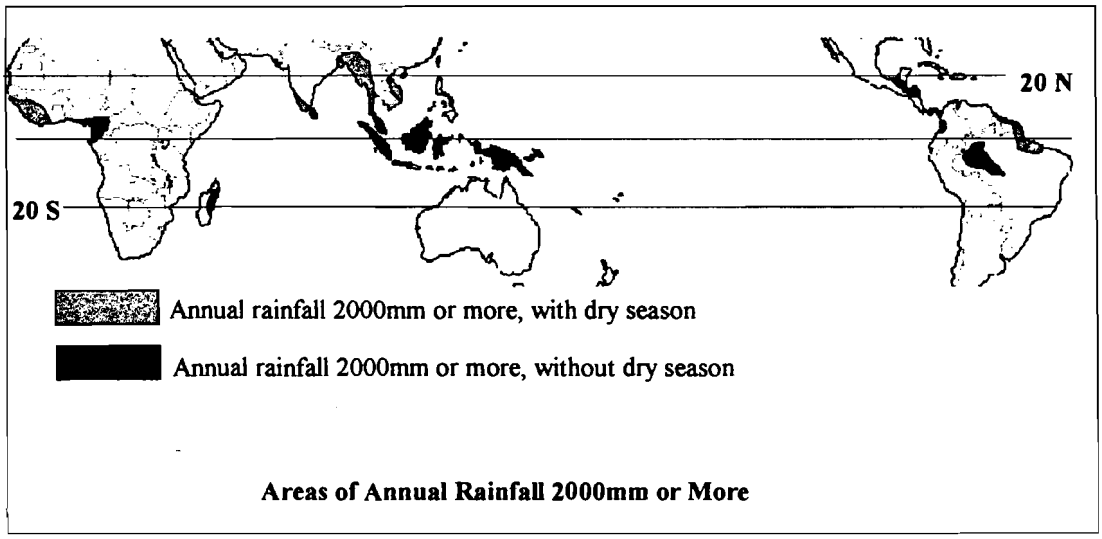
The Japanese drove the Dutch from Indonesia during the war in the Pacific in the 1940s. As a result, most pepper plantations in Sumatra and Java were neglected and ruined. Most pepper fields in Malaya and Borneo were also devastated during the Japanese invasion. World pepper production fell sharply. After the surrender of the Japanese to the Allied Forces in 1945, Indonesia's war for independence against the Dutch delayed the recovery of pepper production in Indonesia. World pepper production was 38,000 MT in 1947, and Indian production accounted for 30,000 MT of the total. This was a great opportunity for India to increase pepper production and trade, but Indian production remained stagnant at 30,000 MT until the middle of the 1980s. As pepper gardens in Indonesia and Malaysia gradually recovered from the damage inflicted during war, India's temporary dominance eroded. While Southeast Asian countries were on the way to recovery, Brazil increased pepper production and filled the gap between supply and demand. The increase of pepper production in Brazil was spectacular. Production increased from an insignificant level in the late 1940s to an astounding 60,000 MT, twice the size of Indian production, by the early 1980s.

Section B: Agronomy of Pepper

Black and white pepper are products of the same plant, Piper nigrum. Piper nigrum is a perennial vine climber that originated in the tropical rainforest of the Malabar Coast in southern India. Pepper requires heavy rainfall and a high air temperature. Pepper can be cultivated as far as 20 degrees north and south of the Equator, and at an altitude of up to 1,500m (Pruthi, 1993). All major pepper production areas are within this range (Figure 2). Pepper requires 2,500mm or more of annual rainfall for optimal cultivation, but it can also survive with 1,500mm annual rainfall. It is better for the plants to have an even distribution of rain throughout the year, but pepper can tolerate a dry season as long as the wet season brings enough moisture. Among the four major regions of pepper cultivation, Kerala and Belem (Brazil), have the dry season, while Sarawak and Lampung (Indonesia), have an even distribution of rain. Pepper can be cultivated on many types of soil, as long as the soil has good drainage. Prolonged water-logging conditions often cause foot-rot disease, the most common and serious threat to pepper plants. To ensure good drainage, pepper farms are often established on hillsides. Since pepper originated as a wild plant growing in the shade of tropical rainforests, it grows better when it has some protection from strong sunshine. Pepper is vulnerable to direct exposure to strong sunlight, especially when the pepper vine is at a young stage.

A pepper plant can grow as high as 10m, and its stem can grow to 5cm in diameter at the base. The plant's height is usually restricted to 3-5m by controlling the height of support stands. The leaf is heart-shaped or oval with a pointed tip, and is 5-15cm long, and 5-10cm wide. The surface of leaf is dark green and smooth. The fruit is 4-6mm in diameter, borne in 5-15 cm long spikes. Each spike may have 50-60 single-shell fruits. It takes about three years to harvest the first crop after it is planted. It is possible to harvest the plant for up to 25 years or even more, but the harvest after the twentieth year is small and uneconomical.

There are many varieties of pepper plants cultivated throughout the world. The following are descriptions of some of the major varieties. Balamcotta is a northern Kerala variety with the



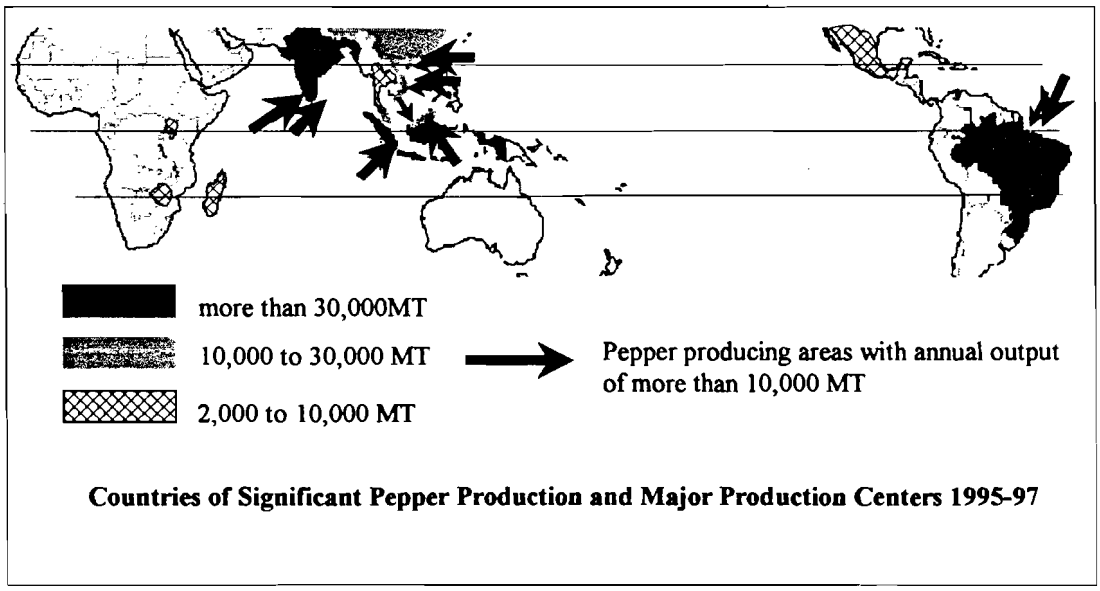


Figure 2: Areas of Abundant Rainfall and Pepper Production

Sources: FAOSTAT, http://apps.fao.org/; T. Gotoh,1983, Koshou ; Teikokushoinn, 1984, Sinshoukoutousekaichizu

largest leaves among the pepper varieties; it is tolerant to moisture shortage and also less susceptible to disease. Karimunda is a southern Kerala variety, and is the most widely cultivated throughout Kerala. Karimunda has relatively long spikes, around 10cm, and gives good yield; it is also reputed to be less susceptible to disease (Pruthi, 1993). Singapura, also known as short-leaf pepper, is the main variety in Sarawak, and Belem, Brazil. Compared to Indian varieties, Singapura bears shorter spikes, 5-8cm, in larger numbers. Singapura's berries are relatively small and mild. About 90 percent of Indonesian pepper plants are Kurinci, which is reputed to be very pungent, despite its small berry size (Gotoh, 1983).

Among the many diseases that can affect pepper plants, foot rot disease is the most devastating one in all pepper producing regions around the world. The causal organism is a soil fungus, which can spread quickly in the wet environment of the rainy season. Once affected, xylem vessels in the plant's roots systems are clogged by the fungus, and thus water and nutrients are unable to reach the part of pepper plant above the ground. Affected pepper vines dry out within two weeks (Pruthi, 1993). Effective prevention measures have not yet been developed. When compared to the devastation caused by diseases, the damage inflicted by insects is much less significant. Among the insects that can damage the pepper plant, the tingid bug is the most notorious. This small black bug with two bumps on its shoulders sucks the sap from the spikes before the berries are set, and the attacked spikes turn brown and die. Regular spraying of pesticide can significantly reduce the risk of tingid bug infestation.

Black pepper is prepared by sun-drying immature pepper berries. As drying proceeds, pepper berries turn from green to black. White pepper is prepared from the matured pepper berries, which are yellow or red in color. The matured berries are soaked in fresh water for a week to ten days, and the softened outer tissue is scrubbed off. Then only the shells are sun-dried to make white pepper (Gotoh, 1998). A limited quantity of white pepper is prepared by mechanically grinding off the outer particles of black peppercorns. This type of white pepper possesses a very smooth surface and creamy white color, while the previous type of white pepper is grayish white. White pepper is preferred in Western European countries for its mellow flavor, mild pungency, white color, and absence of black particles (Pruthi, 1993). White pepper fetches a higher price than black pepper. A small quantity of green pepper and pink pepper is also produced and traded. Green pepper is made from the freeze-dried immature green berries of pepper, and pink pepper is made from the freeze-dried matured red berries. The main market of these products is also Western Europe.

There are several more highly-processed pepper products, which are made out of black pepper or white pepper. Pepper oleoresin is the solvent extraction of black pepper, and contains piperine and chavicine, which are responsible for the pungency of pepper. Pepper oleoresin is prepared as follows. The desired solvent, alcohol, acetone, or hydrocarbon is pumped into an extractor and the extraction is repeated until the pulverized black pepper has exhausted its oleoresin content. The solvent, containing the oleoresin, is distilled in a vacuum to separate the oleoresin and the solvent. Pepper oleoresin is manufactured primarily in the industrialized countries, and it is a preferred form of pepper in food processing industries due to its ease of handling. Another processed product of black pepper is essential oil of pepper, which is manufactured by steam distillation of powdery ground pepper. Essential oil of pepper is colorless to pale green liquid possessing the characteristic aroma and flavor of pepper without the pungency. The main users are the food processing industry and perfumery (Merican, 1986).

There are two primary cultivation methods used to grow pepper. The extensive pepper cultivation method was developed in Kerala and brought to Java by early Indian immigrants between 100 BC and AD 600. The extensive method was developed by duplicating the natural habitat of pepper vines in the forest of the Western Ghats Mountains in southern India, and this type of cultivation uses living trees for support stands. A leguminous tree called Murik (Erythrina Indica) is widely used. Murik's bark contains the pungent agent piperine, and the pepper vine absorbs piperine through its adhesive roots around Murik. Thus, peppercorns grown on Murik contain a high level of piperine and are more pungent than peppercorns grown on other kind of support stands (Gotoh, 1998). Since a support tree competes with the pepper plant for soil moisture and nutrients, average pepper yield is just 0.5-1.5kg per plant, which is considerably lower than that of the intensive method. The extensive method is largely employed in India, Sri Lanka, and Indonesia. Pepper is grown in mixed-cropped fields in India, Sri Lanka, and parts of Indonesia. Fertilizers are usually not applied, and weeds cover the pepper field.

On the other hand, an intensive pepper cultivation method was developed by Chinese immigrants in Sarawak during the eighteenth century. Since the ruler of Sarawak at that time, Rajah Brooke, limited the size of land parcels that Chinese immigrants could own, the Chinese had to make the most out of their small landholdings. Later, the intensive method was brought to Brazil by Japanese immigrants during the 1930s. Most Malaysian and Brazilian pepper is produced by the intensive method. Pepper is monocropped in the intensive farms. The intensive cultivation uses support stands made out of non-living materials, such as wooden stakes, in order to allow all available soil moisture and nutrients to go to the pepper plants. Chemical fertilizers are used heavily in the intensive cultivation. For example, in a typical Malaysian pepper garden, 2kg of fertilizers are used per one pepper plant, or 4,000kg per one hectare of pepper garden (Wong, 1986). Herbicides are also often used for weed control. As a result, average yield is as high as 3-5kg per plant.

Due to its superior pungency, the retail sector in the industrialized countries prefers pepper gown by the extensive cultivation method. However, demand for high quality pepper from this kind of high-end market is growing more slowly than demand from developing countries and the industrial sector for low quality pepper grown by the intensive cultivation method.

Section C: Cycles of pepper prices

Price movement influences pepper production and exports. When world pepper prices are high, new vines are planted and fertilizer usage goes up; also pepper exporters try to reduce their stocks during the high price period. Then, as the newly planted vines start to yield, production increases and pepper prices fall. When world pepper prices are low, pepper vines are neglected and fertilizer usage decreases. Pepper production stagnates or even declines, tightening the supply situation until pepper prices rise again. This cycle of pepper production and prices continues.

Pearson studied the cycles of pepper production and prices from 1818 to 1941, and concluded that the average length of the pepper cycle was 14.5 years (Pearson, 1941). Before World War II, the Dutch East Indies (Indonesia after 1945) was producing more than three-quarters of world pepper, but almost all the pepper farms in Indonesia were ruined during the war. This massive destruction of pepper farms caused a serious pepper shortage, and pushed pepper prices to more than six times the long-run average price (Figure 3). In 1956, world pepper production finally recovered to the pre-World War II level and prices returned to the long-run

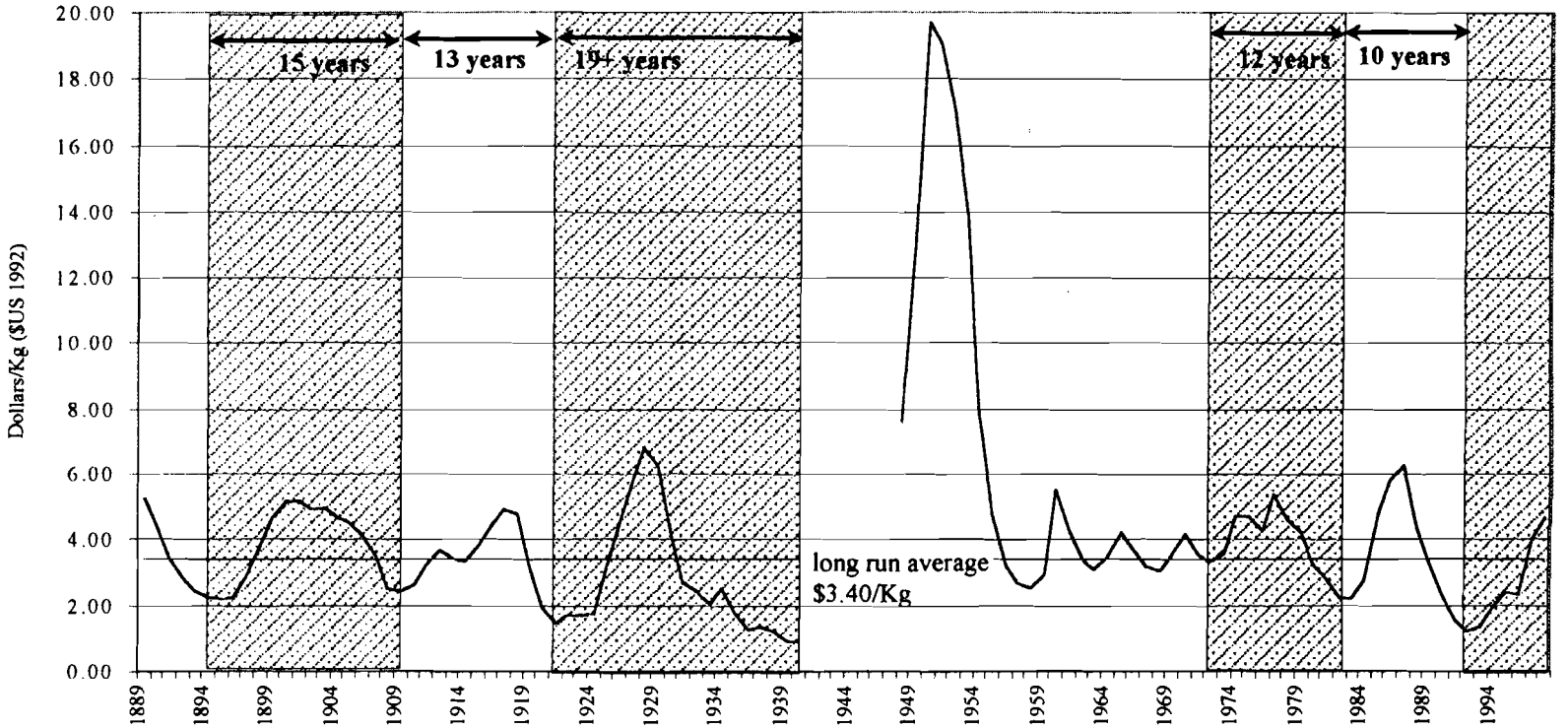


Figure 3. Real Prices of Black Pepper in New York, 1889-1998

Note: Long run average price was calculated from the period during 1889 to 1998 excluding 1941-55.

Sources: Commodity Research Bureau, Commodity yearbook. various issues; F.A.Pearson, 1941,Pepper,;US Bureau of Census, Historical Statistics of the US.; FAOSTAT, http://apps.fao.org/., US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

average. Although at this time Indonesian pepper production was still much lower than its pre-World War II level, India and Malaysia increased production to fill the demand.

After World War II, there seem to have been several short cycles, and the duration of each cycle has become longer since the middle of the 1970s. The series of short cycles before the middle of 1970s were not, however, comparable to pre-World War II cycles because they were caused by unstable production in Indonesia (Figure 4 and 5). In 1962, Indonesia had a bumper crop and increased the world pepper production by 60 percent. This sudden rise in production pulled the pepper prices down quickly. A massive disease outbreak in Indonesia disturbed the world pepper supply again in 1965, and pepper prices went high. Indonesia had another bumper crop in 1968, which brought pepper prices down, but in 1969, drought hit Indonesia, causing pepper prices to rise again (CRB, 1961-70).

The normal pepper cycle seems to have resumed in 1973 when the world pepper price started increasing. Even though the world pepper production was stable and increasing from 1973-1975, world pepper prices started climbing because of a world-wide fear of inflation that was caused by the oil shock in 1973 and influenced exporters to hold pepper sales and stimulated the importers to buy. High pepper prices in the early 1970s induced the rise of the Brazilian pepper industry, and world pepper production kept rising until 1980. The pepper price peaked in 1977, then began declining. The world pepper market was saturated by 1980 when the pepper price plunged below the long-run average. World pepper production gradually declined starting in 1980 due to low pepper prices.

The next cycle began in 1984, when India and Malaysia had small crops. In 1985, India, Indonesia, and Brazil all had small crops. The tight supply situation pushed the long-depressed world pepper prices up in 1984, and in 1985, the prices went above the long-run average. Prices continued to rise, and the second highest price since World War II was marked in 1987. Pepper prices above the long-run average induced new planting around the world in 1985. The first harvest of these new vines increased world pepper production significantly by 1988, and pulled the prices down. As new vines reached their full production in 1990, world pepper prices sank below the long-run average. Because of low pepper prices, production began falling in 1991. Pepper production in Brazil and Malaysia declined quickly as farmers significantly cut back fertilizer usage. As the supply situation tightened, the latest cycle started in 1993 when the world pepper prices started recovering.

Since there have been only two full cycles completed since the end of World War II, it is hard to determine if the length of the pepper cycle is still the same as it was before the war.

However, I suspect that the length of the pepper cycle grew shorter after World War II because the significant portion of the world pepper production after the war has been in the intensive pepper farms in Malaysia and Brazil. The farmers in these countries quickly adjust their pepper production by changing the amount of fertilizer according to the pepper prices. On the other hand, before World War II, most pepper was produced in the extensive farms in Indonesia where fertilizers were not applied. Therefore, a reduction in pepper production was not an option; instead, the production remained stagnant when prices were low, and growing demand eventually cleared excess pepper stocks. As growing pepper demand tightened the markets, pepper prices increased and caused the next surge of overproduction. In addition to the rise of the intensive pepper farms after World War II, the development of communication systems in producing

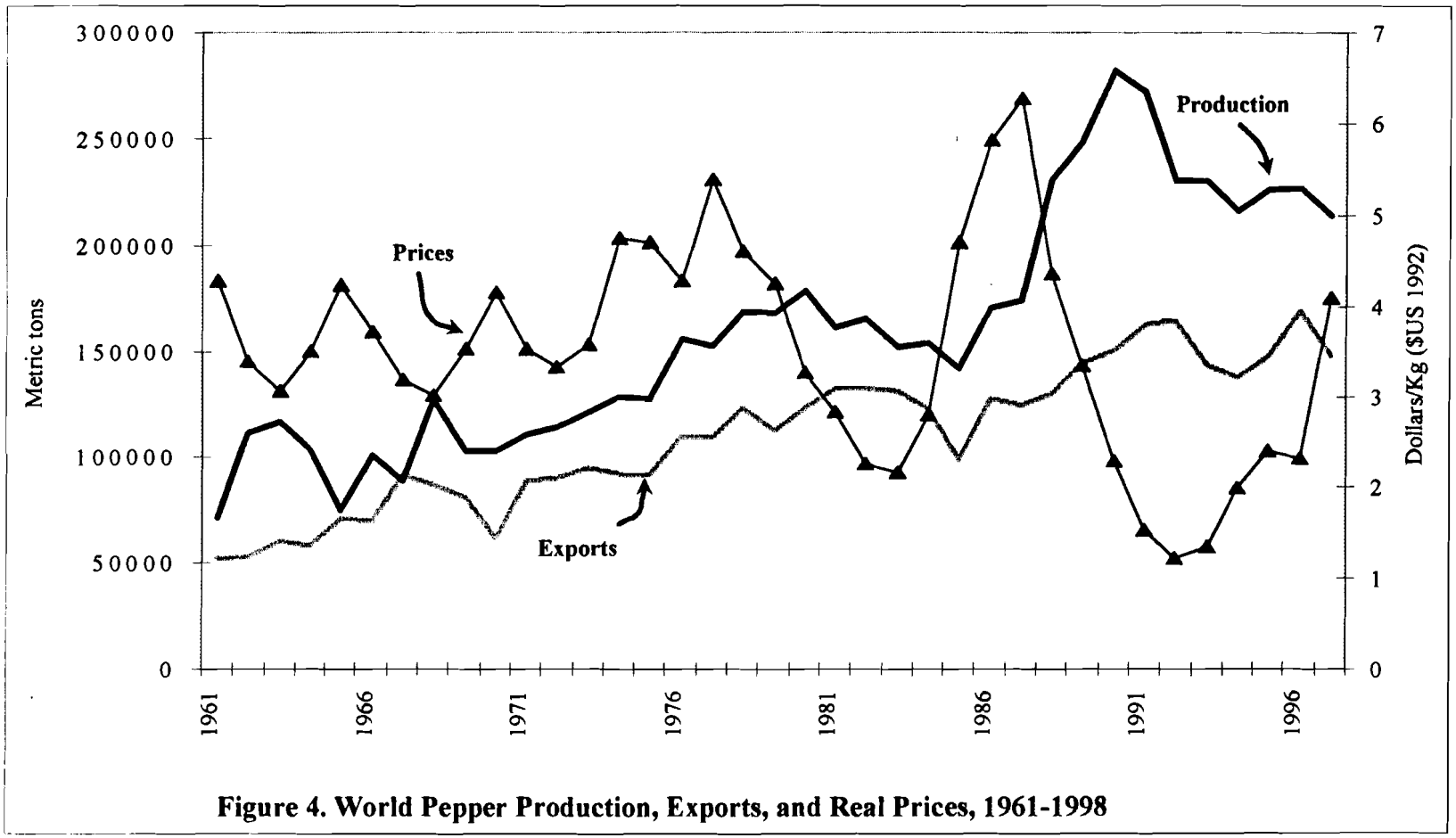


Figure 4. World Pepper Production, Exports, and Real Prices, 1961-1998

Sources: Commodity Research Bureau, Commodity Yearbook, various issues; FAOSTAT, http://apps.fao.org/, US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

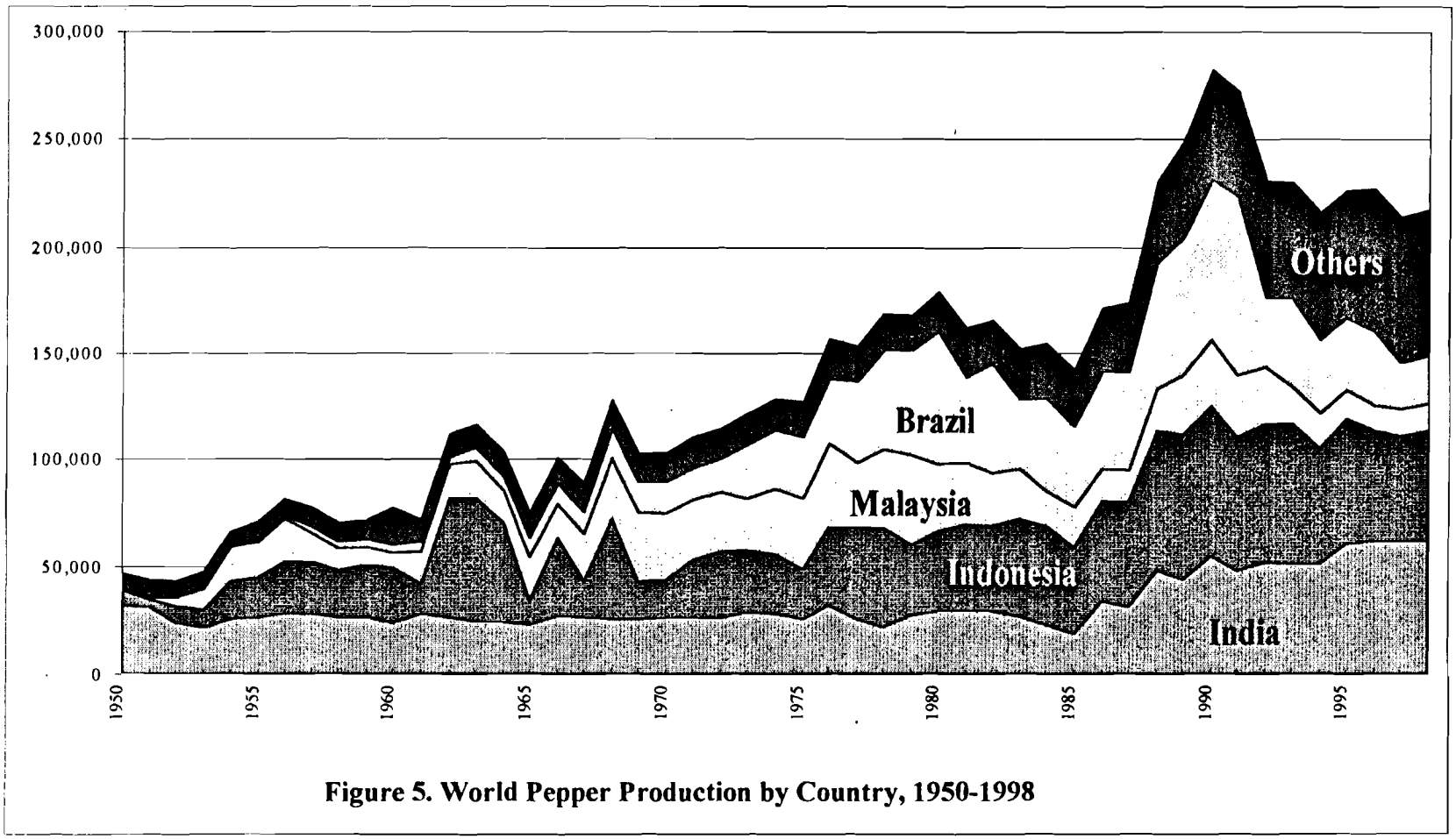


Figure 5. World Pepper Production by Country, 1950-1998

Sources: T.Gotoh, 1983, Koshou; FAOSTAT, http://apps.fao.org/

countries as well as in importing countries provides all parties in the pepper economy with better and faster information so that the necessary adjustments are made more quickly.

Pearson indicates that the time lag between price peak and the following production peak is about eight years. The time lag after World War II, however, seems to be shorter. In Figure 6, the deviations of the inflation-adjusted world pepper prices from the long-run average pepper price are plotted as the price cycle. Also, the deviations of the world pepper production from the production trend line (linear regression line) are plotted as the production cycle. If the time lag between the price peak and the following production peak is set to three years, instead of eight years, the patterns of the price and production cycles coincide. One possible explanation for the shorter time lag is the development of communication systems. Today's farmers can plant new pepper vines immediately after the pepper price climbs above the long-run average. Then, exactly three years later, when the gestation period is over, the world pepper production suddenly increases, and the pepper prices mark their peak and start declining. As soon as the prices sink below the long-run average, farmers can cut back fertilizer supply.

Pepper prices have been rising since 1992, and there is a question about when they will start declining. Since the world pepper prices went up above the long-run average in 1997, new pepper vines must have been planted around the world. After the three-year gestation period, world pepper production should increase substantially in the year 2000. Thus, I expect world pepper prices to continue to rise until 1999 and then sharply drop after 2000 (Figure 7). Since the year 1999 is already the seventh year of the price cycle and it will take five years for the prices to fall from the peak to the bottom if the pattern of the previous two cycles is followed, the pepper prices should hit the bottom in 2004. Hence, the length of the cycle that started in 1992 will be 12 years long. If the next price cycle follows the same pattern, it will start its cycle in 2004 and end in 2016 with the price peak in 2010.

Since pepper prices have been discussed in this section, the activities of the International Pepper Community (IPC) should be mentioned here. In order to promote the consumption and production of pepper, India, Indonesia, and Malaysia established the IPC in 1972. Unlike many other international commodity agreements, the IPC does not regulate production and exports of member countries. Instead, the IPC facilitates the exchange of agricultural research, gathers statistical information about the world pepper market, and encourage coordination of production among members. The IPC usually does not set floor prices to assure high export earnings, but rather, it lets prices fluctuate freely. One exception was in the late 1970s to the early 1980s. Due to aggressive sales from Brazil in the late 1970s, pepper prices fell to a significantly low level. Then, in 1981 when Brazil joined the IPC, the IPC did set the floor prices. However, due to stagnant production, pepper prices rose before the floor prices were actually imposed. Today, the IPC member countries include India, Indonesia, Malaysia, Brazil, Sri Lanka, and Thailand.

Section D: World pepper production and exports

This section discusses the general trend of pepper production in the world since 1961, and peculiarities of each of the substantial pepper producing countries. India's competitors' production and exports prospects are examined to determine India's potential in the high-end and low-end markets toward 2020. World pepper production has almost tripled from about 70,000 MT in 1961 to about 210,000 MT in 1997 with an average annual growth rate of three percent. The four major producers are India, Indonesia, Malaysia, and Brazil. As other countries have begun to emerge as substantial producers, the Big Four's share in the world pepper production has been declining from

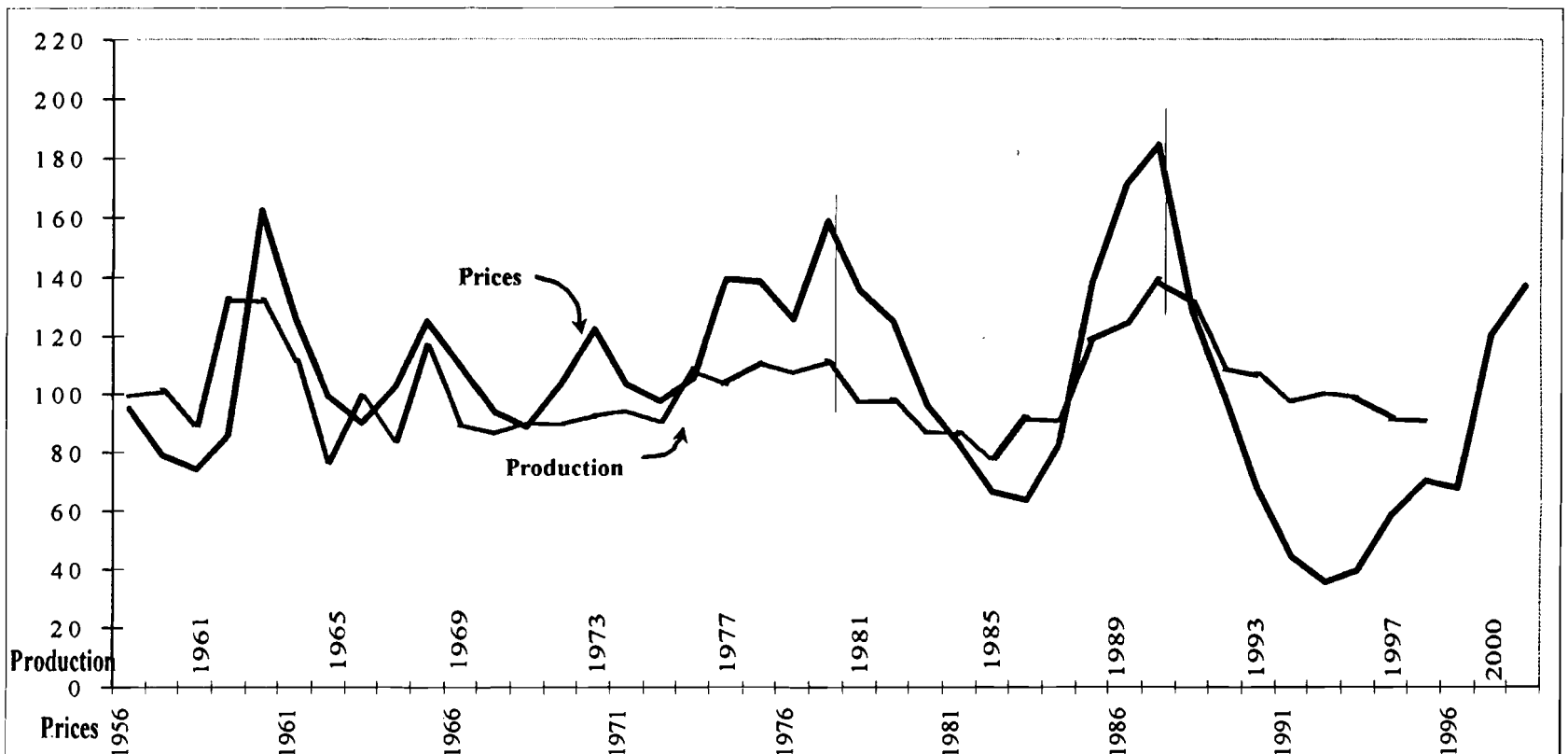


Figure 6: Deviation of prices from the long-run average and three years lagged deviation of production from the long run trend line, 1956-1998

Note: Deviations of the world pepper prices from the long run average price are plotted as price line. Deviations of the world pepper production from the long run production trend (linear regression line) are plotted as production line.

Sources: Commodity Research Bureau, Commodity Yearbook:, various issues; T. Gotoh, 1983, Koshou FAOSTAT, http://apps.fao.org/; US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

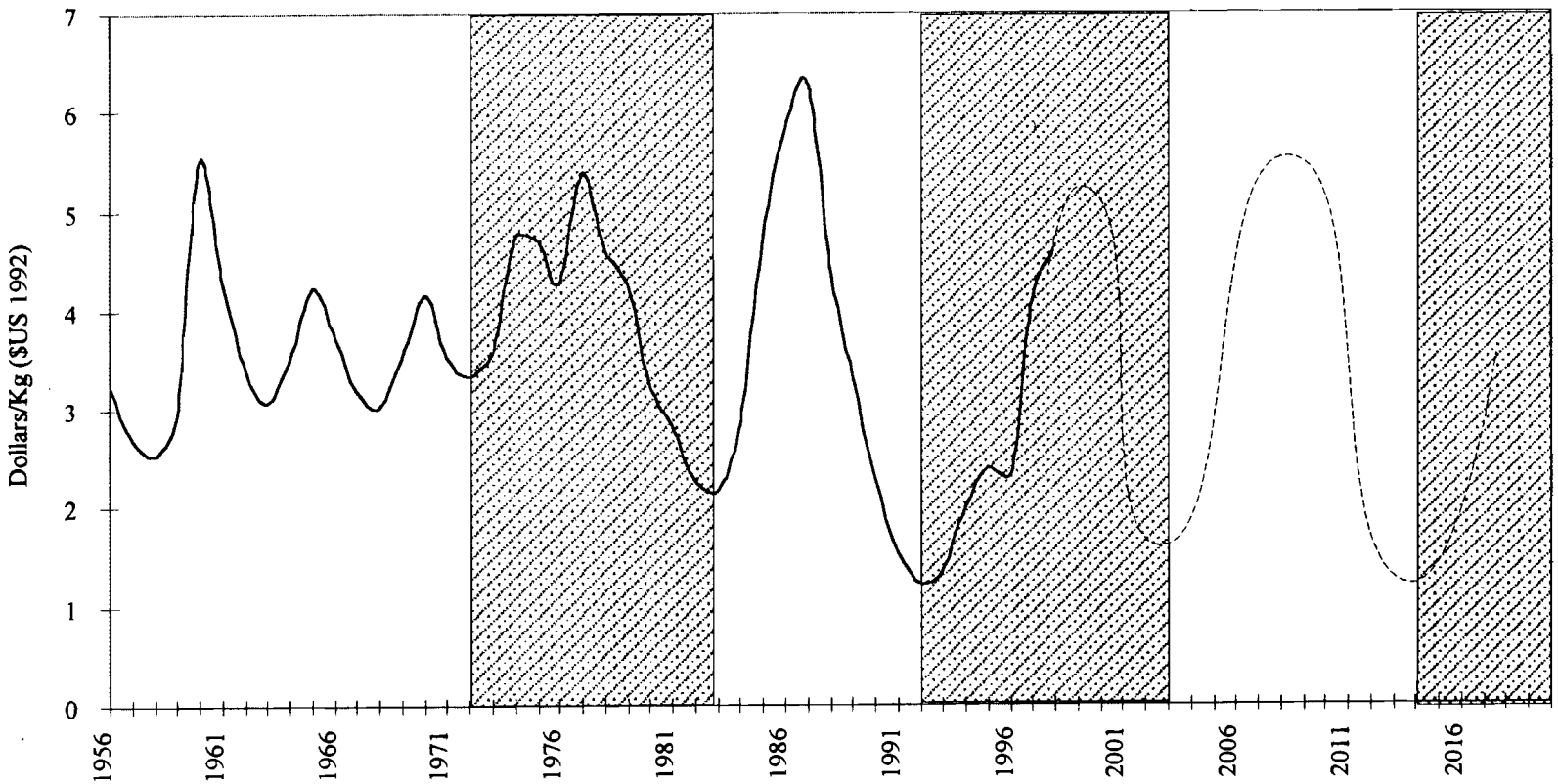


Figure 7: Real Prices of Black Pepper in New York During 1956 to 1998, and Projected Pepper Price Cycle From 1999 to 2020

Note: Price cycles are estimated by the author for 1999-2020.

Sources: Commodity Research Bureau, Commodity Yearbook, various issues; T. Gotoh, 1983, Koshou; US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

more than 90 percent in the early 1960s to two-thirds in 1998. Although there are more pepper producing countries in the world than before World War II, there are still fewer than twenty countries that can produce more than 1,000 MT annually.

There has been a rise and fall in the prominence of the major pepper producers. Indonesia was virtually the sole producer of pepper before World War II, when most pepper plantations in Southeast Asia were neglected and ruined. Then India and Malaysia emerged as major producers while Indonesia struggled for political stability during the 1960s. A period of high pepper prices during the late 1970s induced the rise of the Brazilian pepper industry. A pepper price hike in the late 1980s stimulated Vietnamese pepper production, and Vietnam's pepper production surpassed Malaysia's in 1993. During the high price period in the late 1970s, world pepper production increased as the result of improved pepper yield per hectare, which was due in turn to the increased usage of fertilizers in the intensive farms (Figure 8).

On the other hand, during the next high price period in the late 1980s, both the expansion of area under pepper cultivation and the improvement of yield contributed to the growth of pepper production. It is hard to tell how much future increase in pepper production will come from farm land expansion and how much from yield improvement. One country may emerge as a substantial producer by improving yield, while another may increase production by simply planting more pepper vines. Among the major four pepper producing countries, India has the largest potential to increases pepper production further. India, Indonesia, and Brazil may be able to expand the area under pepper cultivation, but the prospect of yield improvement is greatest in India because almost all pepper farms in India are extensive.

Among the world's substantial pepper producing countries, pepper cultivation methods, major export destinations, quality of pepper, types of pepper products, size of domestic demand, and potential to expand production vary from country to country. The rest of this section examines each substantial pepper producing country in order to assess India's competitive situation in 2020 in both the high-end and low-end markets.

Major Producers

India

Pepper produced in India is almost exclusively black pepper, and white pepper production is very limited. Since white pepper is prepared from matured pepper berries, Indian farmers are afraid of shortening the pepper plant's life by letting pepper berries stay longer on the spikes, a practice which puts much stress on the pepper plant (Purseglove et al., 1981). The extensive pepper cultivation method is used in India; therefore, live trees are used as support stands, and fertilizer application is an uncommon practice. Pepper plants are mostly grown in the mixed-cropped farms in Southwestern India, the state of Kerala. Mixed cropping is the dominant practice in Kerala, while mono cropping is commonly employed by other major producers. The reasons why Indians grow pepper in mixed cropping will be discussed in detail in Chapter Four.

India's pepper production was relatively flat from 1961 to 1987 (Figure 9). The high price period in the late 1980s stimulated Indian pepper production, and the production level doubled from 30,000 MT to 60,000 MT within a decade. Most of the increase in Indian pepper production came from the expansion of the area under pepper cultivation (Figure 10). However, the pepper yield per hectare remained very low.

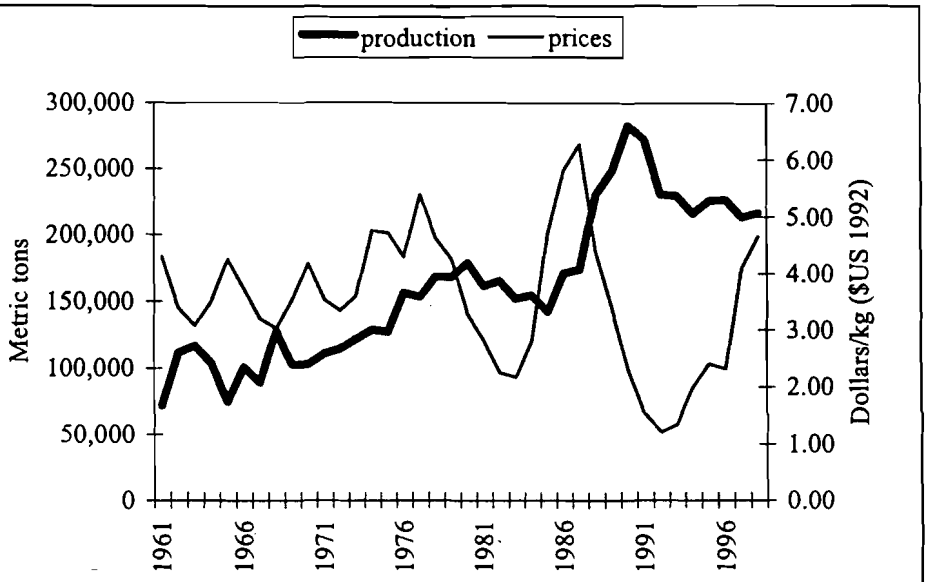


Figure 8-a. World Pepper Production and The Real Prices of Pepper, 1961-1998

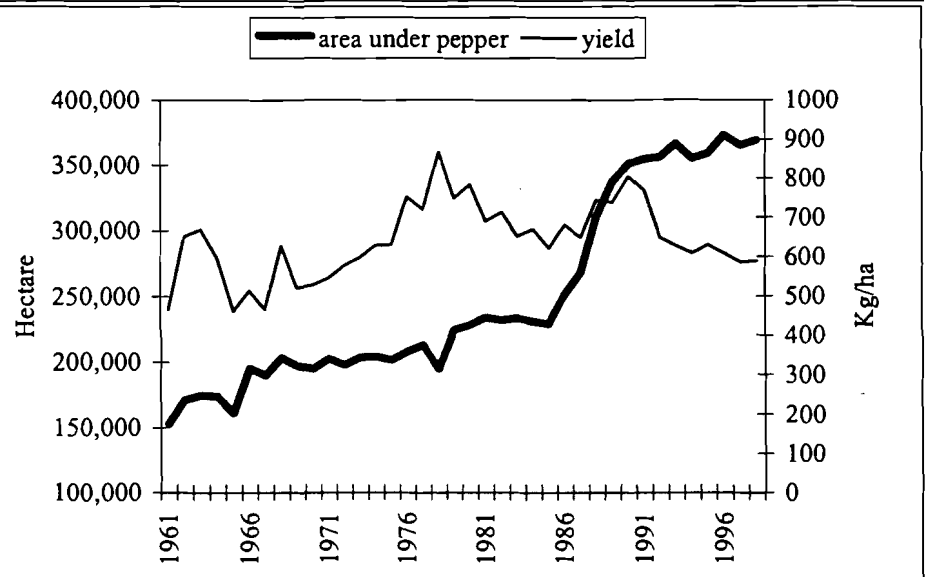


Figure 8-b. World's Area Under Pepper Cultivation and Average Yield Per Hectare, 1961-1998

Sources: FAOSTAT, http://apps.fao.org/;
Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov.

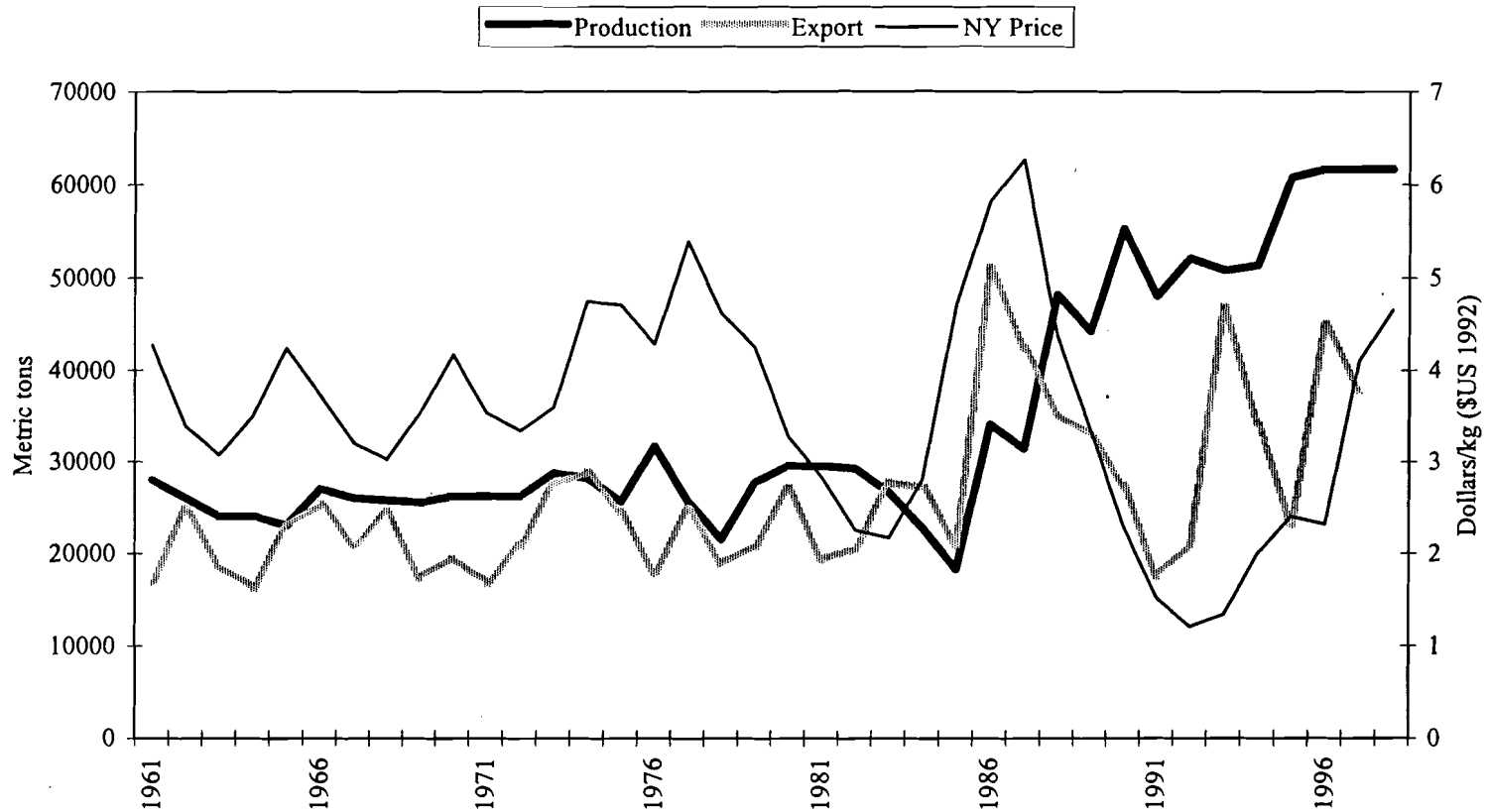


Figure 9. India: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

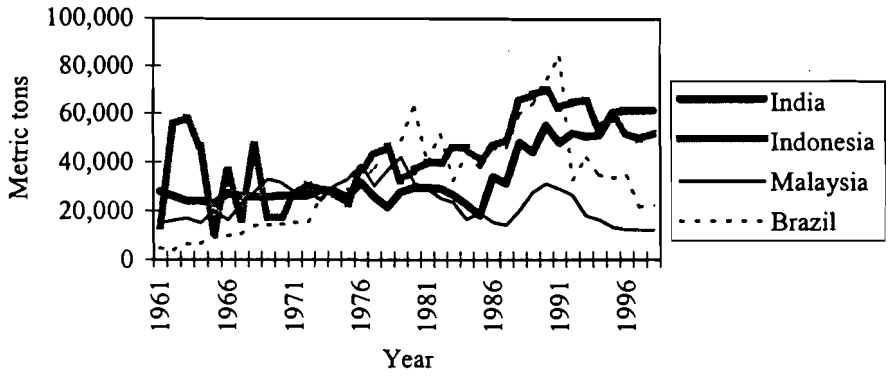


Figure 10-a. Major Producers' Production, 1961-1998

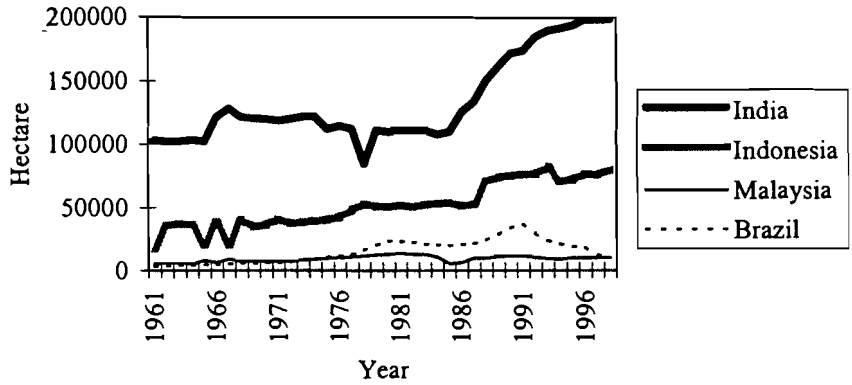


Figure 10-b. Major Producers' Area Under Pepper Cultivation, 1961-1998

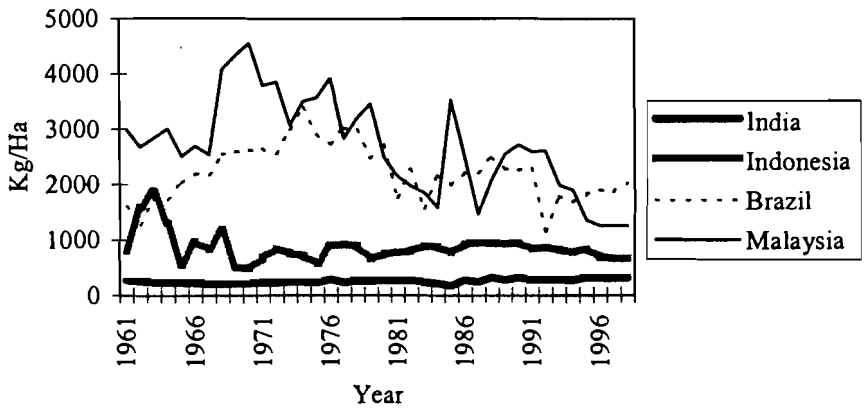


Figure 10-c. Major Producers' Yield Per Hectare, 1961-1998

Sources: FAOSTAT,http://apps.fao.org/

The development of Indian pepper exports had been uneventful until the price hike in the late 1980s. World pepper prices climbed above the long run average in 1985, but India couldn't increase its exports because it had produced small crops in the previous three consecutive years (Commodity Research Bureau (CRB), 1987). With a good harvest in 1986, pepper exports from India jumped to a record high of 50,000 MT. This figure implies that India reduced its domestic pepper stocks because the export amount was much higher than production in 1986. In 1987, even though the world pepper prices were at a peak, pepper exports from India declined because that production was down slightly and domestic pepper stocks were getting scarce. Considering India's domestic market size of 19,000-22,000 MT in the late 1980s, Indian pepper exports returned to an appropriate level in 1988 and 1989.

In 1989, the former Soviet Bloc fell apart. As a result, Indian pepper exports suffered severely from 1990 to 1992 because the majority of Indian pepper exports had been shipped to the former Soviet Bloc through bilateral governmental purchase agreements. Indian exports to this region shrunk 12,600 MT from 20,600 MT in 1988-1990 to only 8,000 MT in 1993-1995.

Partly because the production costs of Indian pepper are high, and partly because of its superior quality, Indian pepper usually fetches a higher price than competitors' pepper, no matter where the market is on a price cycle (Figure 11). Therefore, it was hard for India to find alternative markets for its pepper. Eventually India developed marketing channels to the North American market, where wealthy and sophisticated consumers appreciate high quality Indian pepper. Since then, the North American market has been the major destination of Indian pepper exports (Figure 12).

Indian pepper exports increase whenever the price premium on Indian pepper becomes smaller (Figure 13). For example, in 1993, Indian pepper price became very competitive, and Indian pepper exports increased substantially. The price premium on Indian pepper became high again in 1995, and Indian pepper exports declined.

Because Indian pepper industry had been partially insulated from international competition by the huge bilateral governmental purchase agreement with the former Soviet bloc, the production cost per kilogram of black pepper in India was reported to be 39 percent higher than the world average in 1980 (George, Nair, and Pushpangadan, 1989). One of the reasons for high production costs in India appears to be low yield. Indian pepper yield per hectare was about 300kg on average in 1994-1998, while the average yield of the other three major producers was about 1300 kg (FAOSTAT, 1999). The reasons for low yields in India will be investigated in Chapter Four.

Since most pepper farms in India are extensive, the yield of pepper is quite low. Therefore, the potential to expand pepper production by improving yield is substantial. At the same time, the potential to expand the area under pepper cultivation is equally substantial. Although Kerala is well-populated, there is still much forest left which is available to be cleared for farming. India can choose either expansion option depending on market prospects. If it is more advantageous to capture the demand in the high-end market, India can increase production of high-quality pepper by planting more pepper in the traditional mixed-cropped farms using Murik trees as support stands. On the other hand, if it is more desirable to shift from the high-end market to the low-end market and to capture the faster demand expansion in the low-end market, India can produce cheaper pepper in great quantities by switching to intensive cultivation using wooden stakes. Which strategy India should take depends on the production and export potentials of

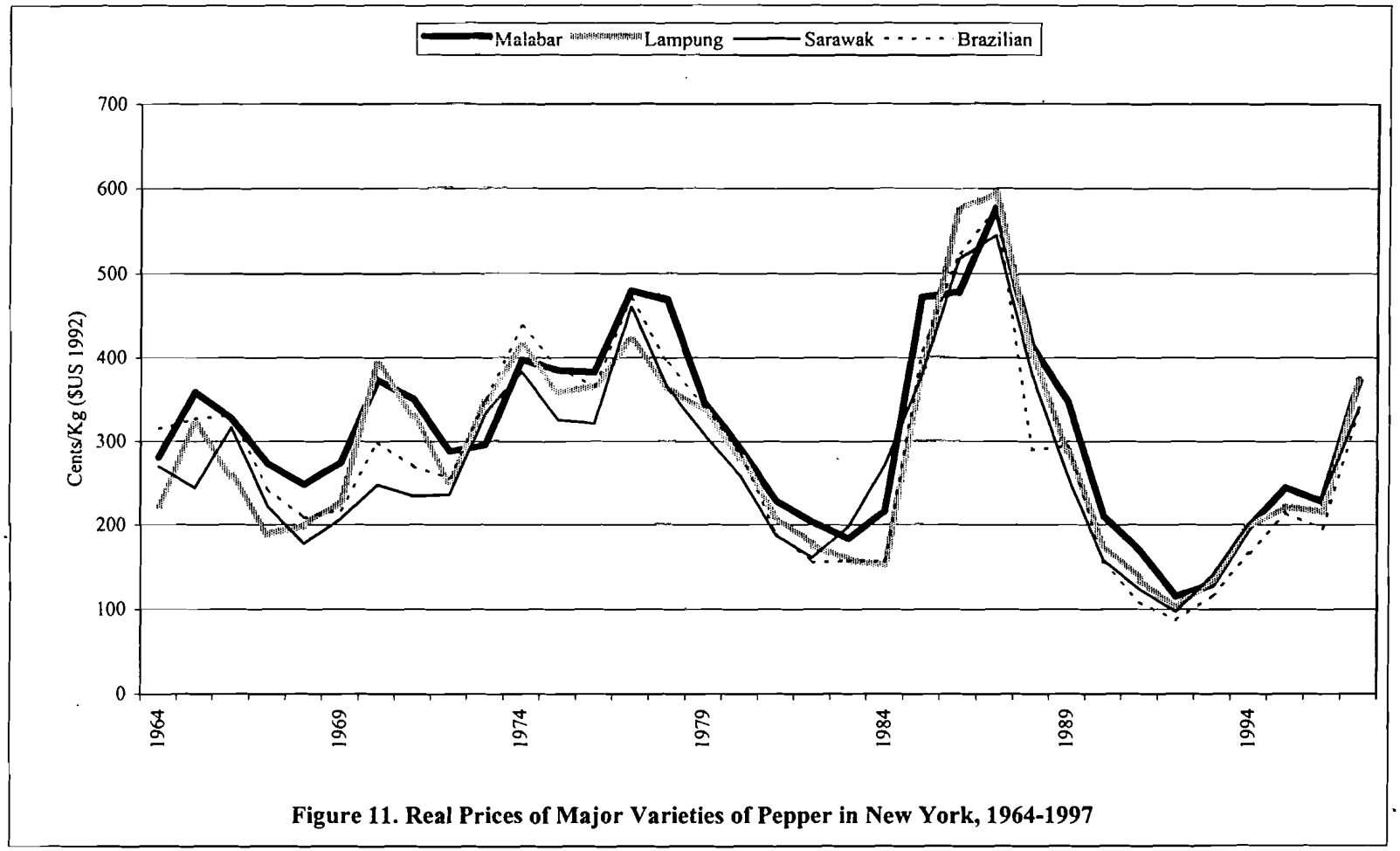


Figure 11. Real Prices of Major Varieties of Pepper in New York, 1964-1997

Sources: FAO, Commodity Outlook Review, various issues; International Pepper Community, Pepper Statistical Yearbook 1995/96: US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

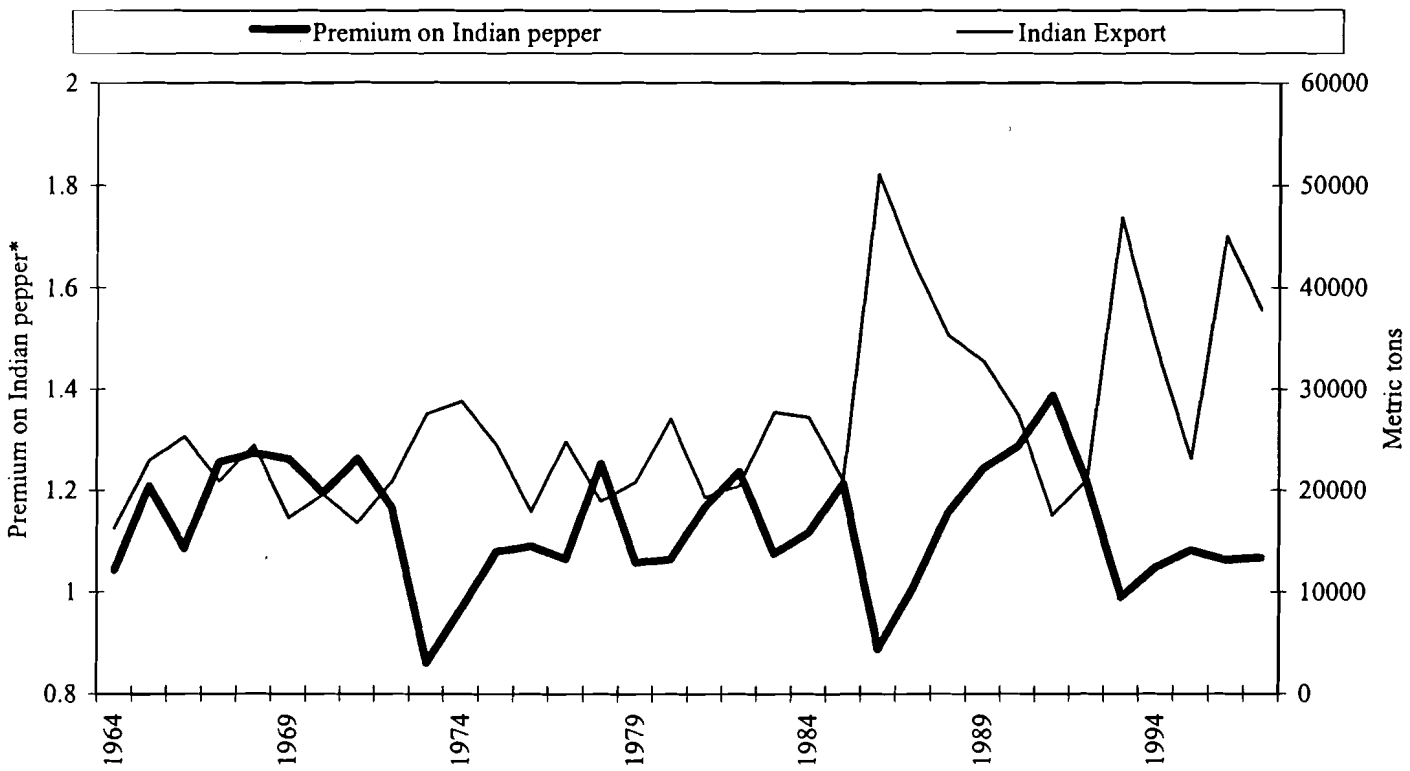


Figure 13. India's Pepper Exports and Premium on Indian Pepper

Note: Premium on Indian pepper = ratio of Indian pepper price over the average price of Indonesian, Malaysian, and Brazillian pepper
Sources: FAO, Commodity Outlook Review, various issues: International Pepper Community, Pepper Statistical Yearbook 1995/96:
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/: FAOSTAT, http://apps.fao.org/

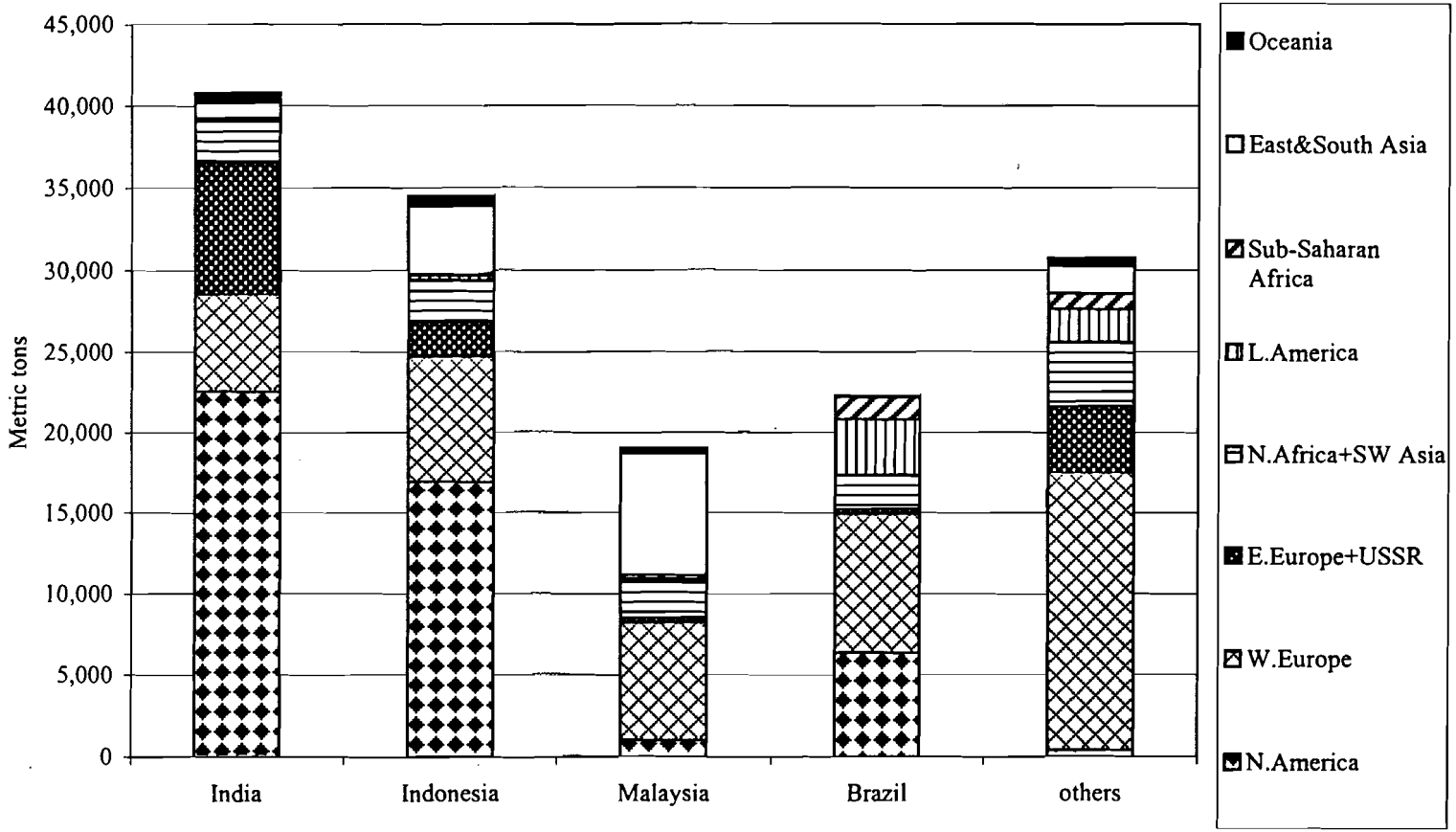


Figure 12. Destinations of Shipments From Major Pepper Exporters, 1993-1995 Average

Source: International Pepper Community, Pepper Statistical Yearbook 1995/1996

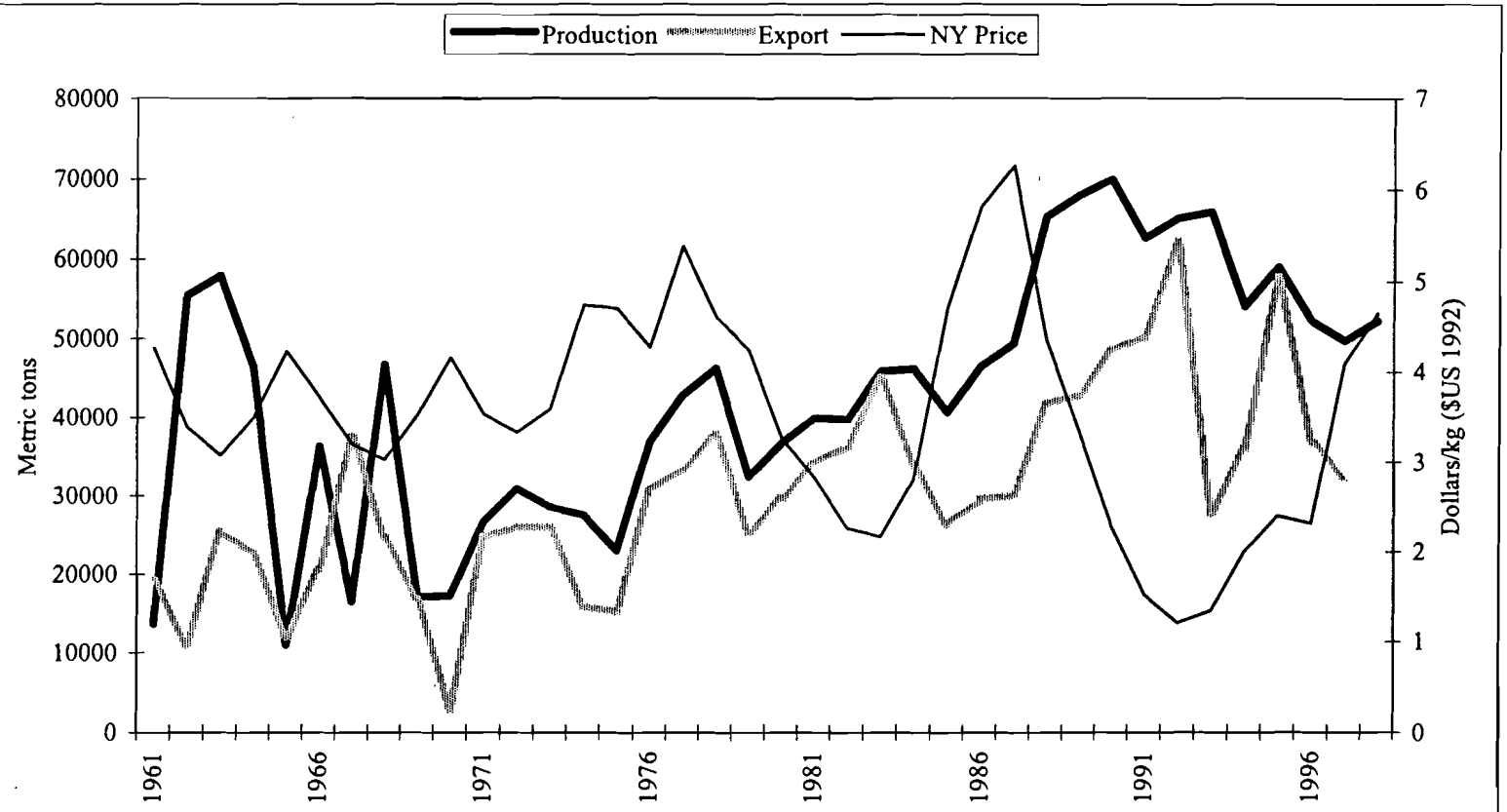


Figure 14. Indonesia: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

India's competitors in each market. In the high-end market toward 2020, India's major competitors will be Indonesia and Sri Lanka, while in the low-end market, India will have to compete with Vietnam.

Indonesia

Indonesia is the second largest pepper producer in the world, and it is the largest white pepper producer. About half of pepper produced in Indonesia is white pepper. White pepper and black pepper are cultivated in different areas and by different methods. White pepper is produced by Chinese immigrants on the islands of Bangka and Belitung, which are located between Sumatra and Kalimantan. The intensive method is employed, and concrete poles are used as support stands. On the other hand, most Indonesian black pepper is produced in Lampung province, the southern-most province of Sumatra. The monocropped pepper plantations in the northern part of Lampung account for most of the production. In some parts of southern Lampung, extensive mixed cropping pepper farms similar to those of Kerala can be found. The common support stand in Lampung is Murik, the same legume tree that is used in Kerala.

Indonesian pepper production was unstable during the 1960s (Figure 14). The area under pepper cultivation expanded and yield per hectare was significantly improved in 1962, but an outbreak of foot rot disease in 1965 and 1967 forced farmers to burn significant part of their pepper plantations to prevent further spread of the disease (Figure 10). Severe droughts in 1969 and 1970 reduced harvests considerably (CRB, 1971). During the high pepper price period in the late 1970s, both the expansion of the area under pepper cultivation and the yield improvement contributed to the growth of Indonesian pepper production. During the late 1980s' high price period, yield didn't change, but the area of pepper farmland expanded.

The major destination of Indonesian black pepper exports is the North American market, while most white pepper goes to the Western European market (Figure 12). Pepper exports from Indonesia were unstable during the 1960s. During the 1960s, more than one-quarter of Indonesian pepper exports were directed to Singapore, but the role of Singapore gradually diminished after 1970 when the Indonesian government put all pepper exports under its direct control. In the middle of the 1990s, less than 10 percent of Indonesian pepper was exported to Singapore. In 1986, the United States' Food and Drug Administration found Indonesian pepper contaminated by salmonella, and all shipments from Indonesia were detained several months at the US ports for inspection. As a consequence, many American spice importers avoided Indonesian pepper for several years after this incident.

Since Indonesian pepper farmers also use Murik as support stands, Indonesian black pepper also contains a high level of the pungent agent piperine. Indonesian black pepper, however, contains less volatile oil than Indian pepper. Indonesian black pepper is reputed to be second-best quality pepper only after Indian pepper, and thus it is Indian pepper's strongest competitor. Indonesian pepper exports, particularly black pepper, sharply declined when the Indian pepper exports captured the significant part of the North American market in 1993 during a period when the price premium on Indian pepper had been reduced. The reverse phenomenon was observed in 1995 when the price premium on Indian pepper increased. Indonesian pepper exports increased, and Indian pepper exports declined.

Indonesian black pepper production is expected to increase further due to the expansion of the area under pepper cultivation outside Lampung. The government of Indonesia selected pepper

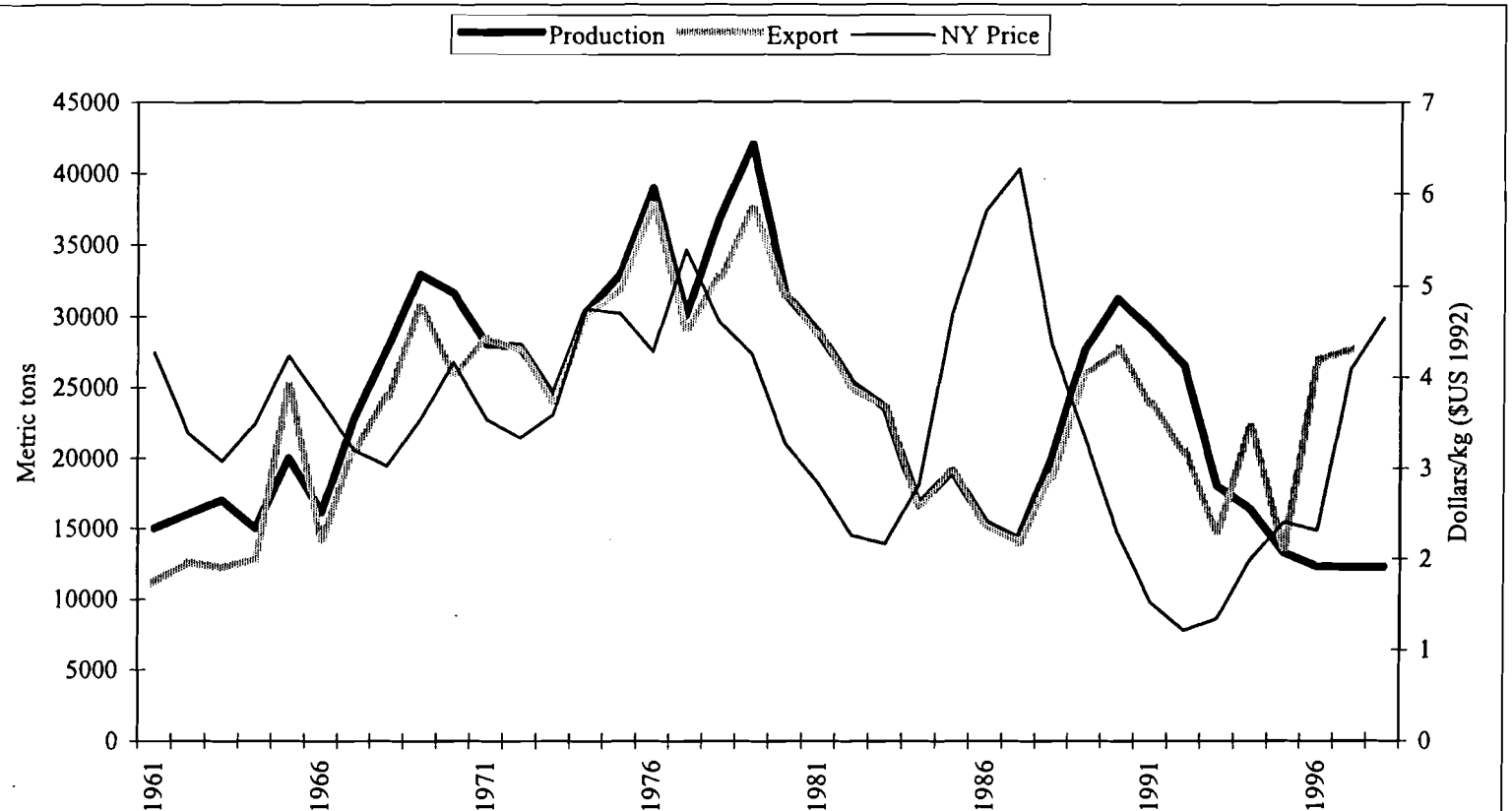


Figure 15. Malaysia: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

as one of the priority crops particularly under its transmigration program to Kalimantan and other islands. Black pepper production in east and west Kalimantan is increasing. Pepper demand in the Indonesian domestic market will increase to 25,000 MT by 2020 from 11,000 MT in 1997, but this is much smaller than the Indian domestic market in 2020, which will be roughly 44,000 MT. Therefore, if both Indonesia and India produce the same quantities in 2020 as they do in the late 1990s, Indonesia will have more exportable pepper than India.

Malaysia

The Malaysian pepper industry was established by Chinese immigrants during the eighteenth century, but most of these pepper farms were ruined during World War II. Unlike Indonesia, which suffered prolonged political unrest, Malaysia was able to increase pepper production quickly in the 1950s, and emerged as a major pepper producer. Most Malaysian pepper is produced in the state of Sarawak in East Malaysia on the huge island called Kalimantan, or Borneo. About one-quarter of pepper produced in Malaysia is white pepper. Both black and white pepper are grown in monocropped farms by the intensive cultivation method. Hardwood stakes are used as support stands, and one to two kilograms of fertilizer is applied per plant. In order to maximize pepper yield, weeds are also controlled by herbicidal sprays.

Malaysian pepper production increased as yield improved in the late 1960s, but the depressed pepper price during the early 1970s turned the Malaysian pepper production trend downward by discouraging the use of fertilizer (Figure 15). As the pepper prices recovered in the late 1970s, Malaysian pepper yield per hectare quickly increased as farmers increased the amount of fertilizer inputs. As a result, pepper production in Malaysia reached more than 35,000 MT from 1976 to 1979 except for 1977 when unfavorable weather caused a small crop (Figure 10). As world pepper prices continuously declined from 1977 to 1983, pepper yield per hectare in Malaysia also sharply declined.

The Malaysian pepper yield suddenly increased in 1985 for two reasons: first, weather conditions were favorable, and second, many Malaysian pepper farmers destroyed low-yielding pepper plants and shifted their cultivation to more profitable crops like cocoa in 1984 and early 1985 (Gotoh, 1998). Thus, the surviving pepper plants were more productive and the average pepper yield was improved.

In 1986 and 1987, high pepper prices induced farmers to plant new pepper vines in Malaysia. High pepper prices also encouraged farmers to use more fertilizer. Therefore, Malaysian pepper production increased as newly planted pepper vines started to yield in 1989. During the low pepper price period in the first half of 1990s, Malaysian pepper production again quickly declined due to the lowered yield. Malaysian pepper farmers are very commercially-oriented, and quickly adjust inputs according to the world pepper prices.

The major destinations of Malaysian pepper exports are Japan and Singapore. Because of the strong connection between Chinese immigrants in Singapore and Sarawak, exports to Singapore accounted for more than 80 percent of Malaysian exports until the middle of 1980s. Although half of pepper farmers in Malaysia are still Chinese, direct shipments to the countries of final consumption became more popular; as a result, Malaysian pepper exports to Singapore declined to about one-third of the total by the early 1990s.

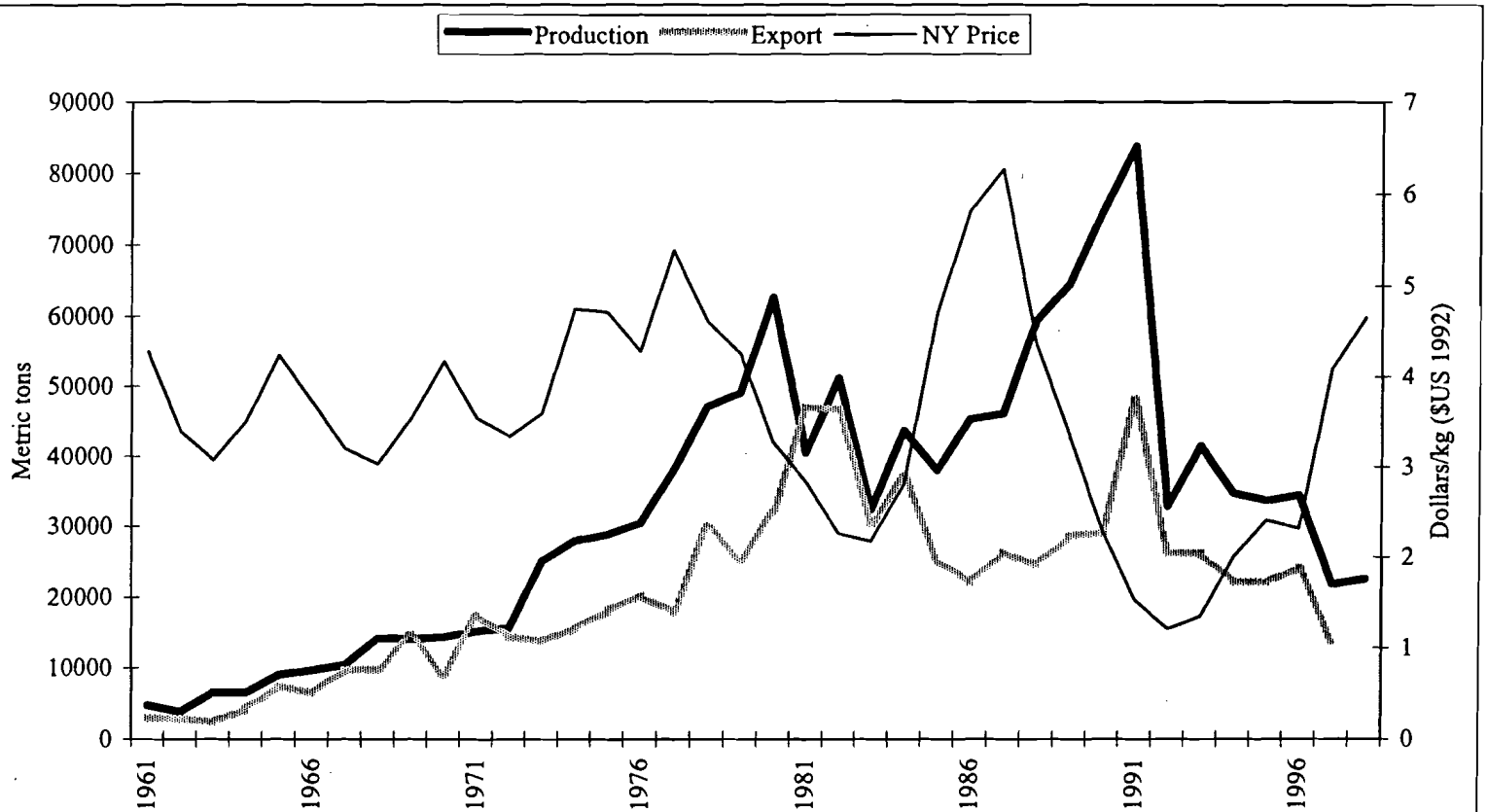


Figure 16. Brazil: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

Malaysian pepper production does not seem likely to increase significantly toward 2020 since pepper production costs are getting higher. Pepper is a very labor intensive crop, but the family size of the Malaysian pepper farmer is shrinking. More and more labor is absorbed in non-agricultural sectors, and causing a labor shortage; as a result, Malaysian pepper farmers have to pay more for farm labor. Therefore, strong production expansion is not likely to happen in Malaysia by 2020.

Brazil

Pepper was first brought to colonial Brazil by the Portuguese. During the Portuguese colonial period, Brazil was exporting pepper to Europe, but eventually pepper was replaced by rubber and the Brazilian pepper industry disappeared (Gotoh, 1983). In 1933, a Japanese businessman brought 20 Sarawak pepper vines to Japanese immigrants in Brazil, but only two of the plants survived. After World War II, Japanese immigrants planted pepper vines that had been meticulously propagated from the original two, and reestablished the Brazilian pepper industry in Belem and other Japanese towns in the Amazon region (Gotoh, 1983). During the 1970s, the Brazilian government encouraged Brazilian farmers to plant pepper and supported them financially and technically. As a result, pepper cultivation spread all over the state of Para and then to other states. About three-quarters of Brazilian pepper is produced in the state of Para, and the presence of the Japanese farmers is still strong in the Brazilian pepper industry. The cultivation method in Brazil is very similar to that in Malaysia. Hardwood stakes are used as support stands, and fertilizers are applied heavily. Most Brazilian pepper is black pepper, and white pepper accounts for less than ten percent of the total.

During the period from World War II to the middle of 1970s, the constant improvement of yield contributed to the rise of pepper production in Brazil (Figure 16 and Figure 10). During the high pepper price period in the late 1970s, yield remained relatively flat, but new pepper vines were planted in significant quantities. As a result, Brazil marked a production peak in 1980 at 63,000 MT. During the following low price period in the first half of the 1980s, yield declined 50 percent because farmers reduced fertilizer application. The low price induced a reduction in the application of fertilizer, and in addition, the termination of governmental subsidies to pepper farmers in 1980 affected yield. Then during the high price period in the late 1980s, the area under pepper cultivation expanded again, and Brazilian pepper production reached more than 83,000 MT by 1991. Yield, however, didn't recover during this high price period because Brazilian farmers couldn't get credit to purchase fertilizer. The interest rates in Brazil were very high during the late 1980s because Brazil was struggling to pay the foreign debt services by borrowing in the midst of so-called debt crisis (CRB, 1987). For instance, In 1988, the interest rate on Brazilian government's treasury bill, one of the key indicators of overall interest rates, was as high as 483 percent per year (International Monetary Fund (IMF), 1990). When world pepper prices were depressed again in the early 1990s, many Brazilian farmers started replacing pepper with other more profitable crops, and the area under pepper cultivation declined by more than 7,500 hectares in 1992. In addition to the reduced pepper area, unfavorable weather and reduced fertilizer application depressed yield. As a result of these negative factors, Brazilian pepper production was collapsed in 1992. After the poor weather in 1992, yield recovered somewhat and remained constant throughout the 1990s, but at a lower level than in the 1980s. The area under pepper cultivation, however, has been shrinking continuously, and thus Brazilian pepper production has been declining since the initial low point of 1992.

The major destinations of Brazilian pepper are Western Europe and North America. During the 1970s, Brazilian pepper exports increased at a slower rate than production and a huge stock was accumulated due to the buyer's unfamiliarity with the newly emerged Brazilian pepper. Brazilian pepper earned a good reputation by the early 1980s and captured a large segment of the world demand, but aggressive sales from Brazil depressed world pepper prices. From the middle of 1980 to the early 1990s, despite the great increase of production, Brazilian pepper exports were depressed again because wholesalers and exporters held back merchandise in fear of the political and economic uncertainty.

Brazilian pepper production toward 2020 is not likely to increase substantially. Even though pepper prices have been recovering since 1993, the area under pepper cultivation in Brazil has been continuously declining. Many pepper farmers have shifted from pepper to citrus cultivation because citrus is more profitable and requires less initial investment (Toniolo and Uhl, 1995). Furthermore, in a country where intensive cultivation is predominant, pepper yields tend to increase when prices increase, however, Brazilian pepper yields are not responding to the price recovery in 1997, when pepper prices went above the long-run average. With a flat yield and declining area under cultivation, Brazilian pepper production may decline even further.

Minor Producers

Sri Lanka

Pepper cultivation practices in Sri Lanka are similar to those in India. Most pepper farms are small and mixed cropped. As Murik is commonly used as support stand, Sri Lanka's pepper contains a high level of piperine. Sri Lanka's pepper production has been on the rise since the early 1970s, and gained speed in the late 1980s when world pepper prices were high (Figure 17). Most of the increase in production came from the expansion of the area under cultivation, and yield remained at a low level (Figure 18). Production reached 15,000 MT in 1994, surpassing Malaysia's production, and Sri Lanka became the fourth largest pepper producer in the world after Indonesia, India, and Brazil.

Exports from Sri Lanka, however, are much less than Malaysia's. Sri Lanka's per capita GNP (Purchasing Power Parity) in 1997 was US$2,460. With this level of income and the curry-based Ceylon cuisine, per capita pepper consumption is estimated to be 35-40g. Since Sri Lanka's population is 18 million, the domestic market should be 600-700 MT. Therefore, Sri Lanka should be able to export as much as 16,000 MT of its 17,000 MT production; however in 1997, it exported only 3,000 MT. The reason for Sri Lanka's unsuccessful exports is poor grading (CARE Sri Lanka, 1996). A sack of peppercorns from Sri Lanka is likely to contain more extraneous matter, such as spikes, rodent excreta, and dead insects, than a sack from Sri Lanka's competitors in the high-end market, namely India and Indonesia. Since Sri Lanka's pepper contains more flavorful volatile oil than Indonesian pepper, Sri Lanka's pepper exports to the high-end market will increase substantially as grading systems and facilities are developed.

Although pepper production in Sri Lanka is much smaller than in India and Indonesia as of 1998, the potential to increase pepper production is great. As Sri Lanka's Department of Export Agriculture is promoting pepper cultivation as a minor crop in coffee gardens, pepper production in Sri Lanka is expected to increase through the expansion of the area under pepper cultivation (CARE Sri Lanka, 1996). In addition to the production expansion, the prospect of the domestic

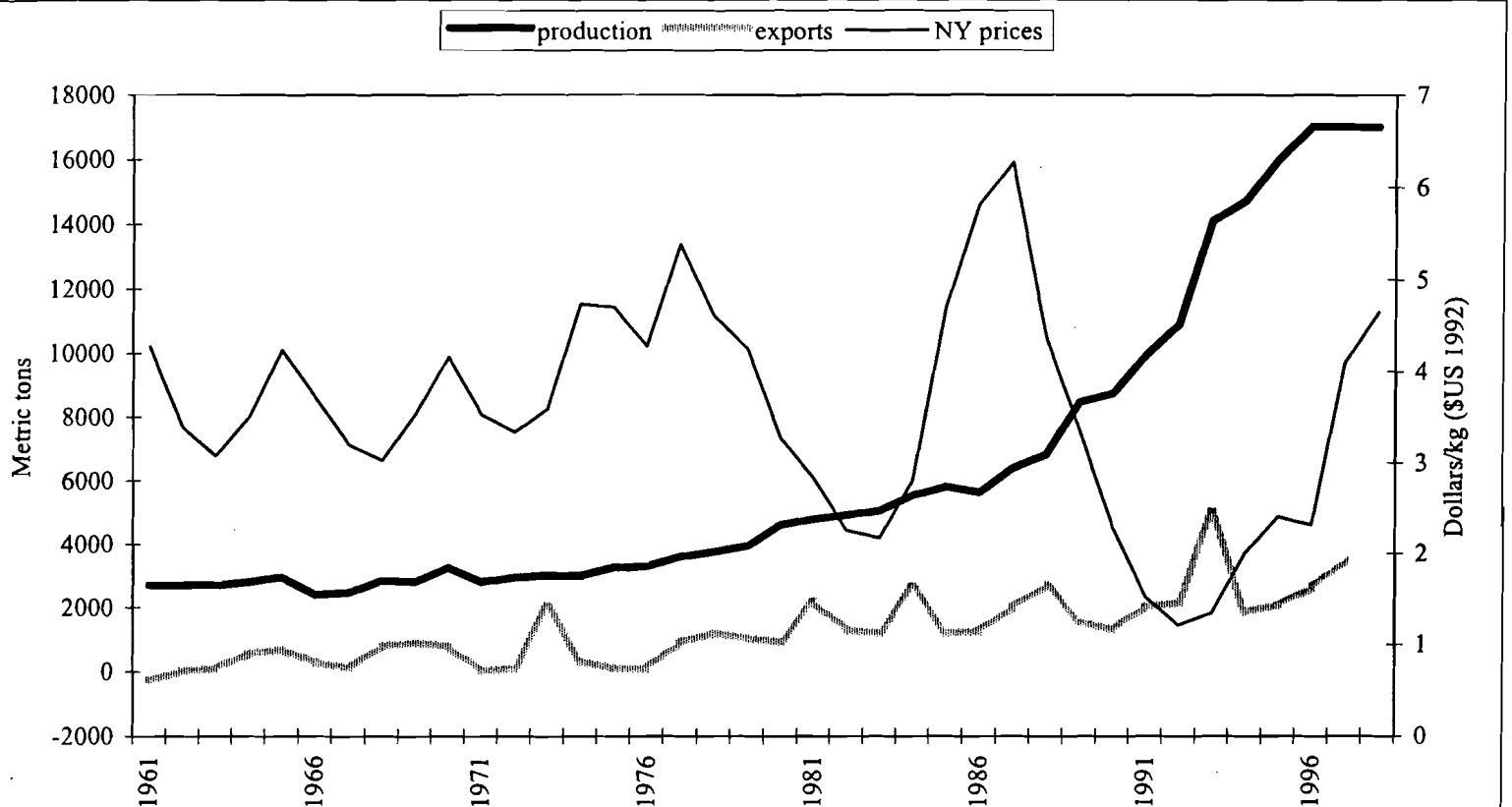


Figure 17. Sri Lanka: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

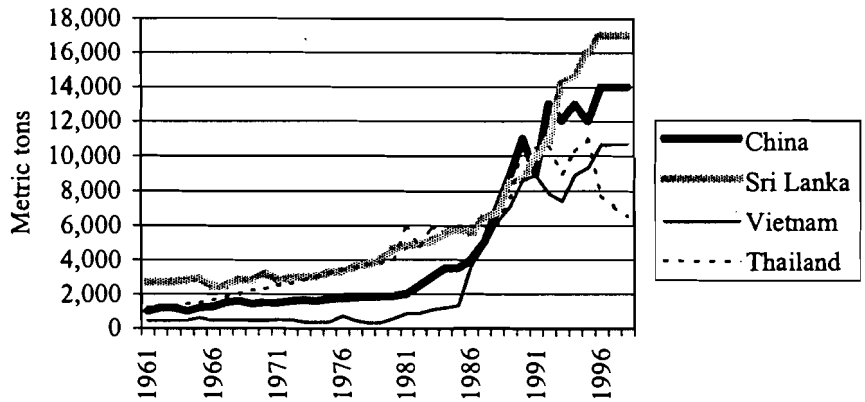


Figure 18-a. Minor Producers' Production, 1961-1998

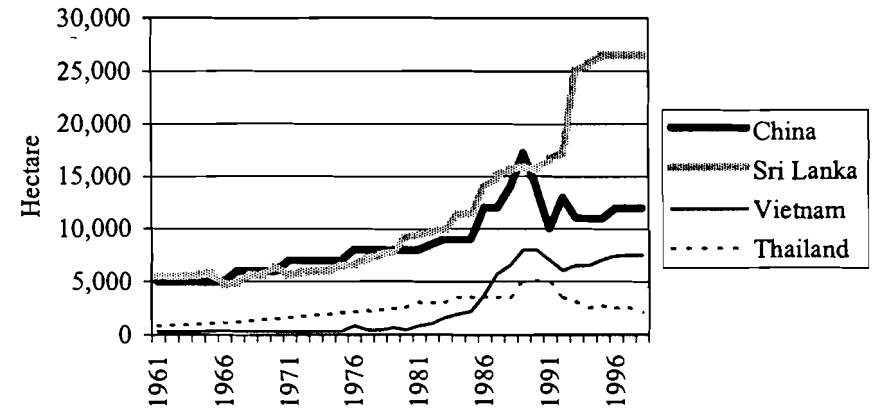


Figure 18-b. Minor Producers' Area Under Pepper Cultivation, 1961-1998

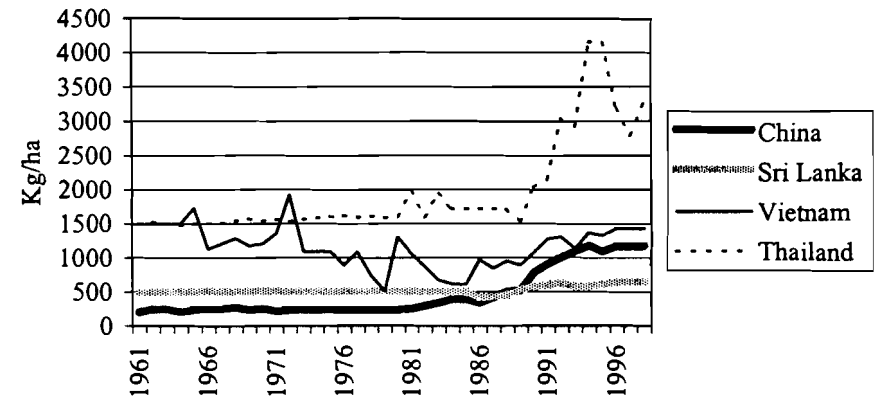


Figure 18-c. Minor Producers' Yield Per Hectare, 1961-1998

Sources: FAOSTAT,http://apps.fao.org/

market expansion is limited; thus there will be more pepper available for exports. Sri Lanka has a great potential to become a major player in the high-end pepper market by 2020.

China

Most Chinese pepper farms are on the island of Hainan, and cultivation is intensive. China produces only white pepper, and imports black pepper. Chinese pepper production started to increase rapidly during the high pepper price period in the late 1980s (Figure 19). During this period, both area expansion and yield improvement contributed to the production growth (Figure 18). After the high price period was over, despite the fact that the area under pepper declined, Chinese pepper production kept increasing with further improvement of yield. Production reached 14,000 MT in 1996, and China became the world's fifth largest pepper producer.

Exports from China, however, are very limited. In 1997, Chinese net export of pepper was about 1,000 MT with 4,000 MT white pepper exports and 3,000 MT black pepper imports. China's per capita GNP (PPP) in 1997 was US$3,070. Considering the relatively lower pepper consumption in the Northeast Asian countries, China's per capita pepper consumption at this level of income is expected to be only about 4-6g. With a population of 1.2 billion, the Chinese domestic pepper market should be 5,000-7,000 MT. Thus, China's net exports should be 7,000-9,000 MT instead of 1,000 MT. Accumulated stocks will come into the market when the pepper prices, especially for white pepper, become high.

China doesn't seem to have much potential to expand pepper production, since pepper cultivation is barely possible only on the Hainan island. Even on the Hainan island, pepper vines cannot receive an adequate amount of rainfall. In addition to the limited prospect of production expansion, the Chinese domestic market will grow much larger from 5,000-7,000 MT in 1997 to 18,000-30,000 MT by 2020. Therefore, China is not likely to pose a threat to India as a major competitor.

Vietnam

Most pepper farms in Vietnam are located in the south and central region of the country, and the intensive cultivation method is commonly practiced. As with other emerging pepper producers, Vietnamese pepper production also started to increase during the high price period in the late 1980s (Figure 20). Both area expansion and yield improvement contributed to the production growth (Figure 18). In 1996, Vietnamese pepper production reached 10,000 MT.

Vietnam's per capita income (PPP GNP) in 1997 was US$1,590. Considering the generous use of black pepper in Southeast Asian cuisine, per capita pepper consumption at this income level will be 40-45g. With a population of 74 million, Vietnam's domestic pepper market should be 3,000-3,300 MT. Therefore, Vietnam should be able to export around 7,000 MT of black pepper. Figure 20, however, does not show Vietnam's net exports of pepper, since detailed pepper trade figures of this country are not available at this point.

Vietnam possesses a good potential to expand pepper production further. Even though most pepper farms in Vietnam employ the intensive cultivation method, yields are still under 1,500 kg/ha, which can be improved to 2,500-3,500 kg/ha. The expansion of area under pepper cultivation is also promising in the southern part of the country, while the forested area in the middle to the northern part of the country is often dangerous to clear due to unexploded objects

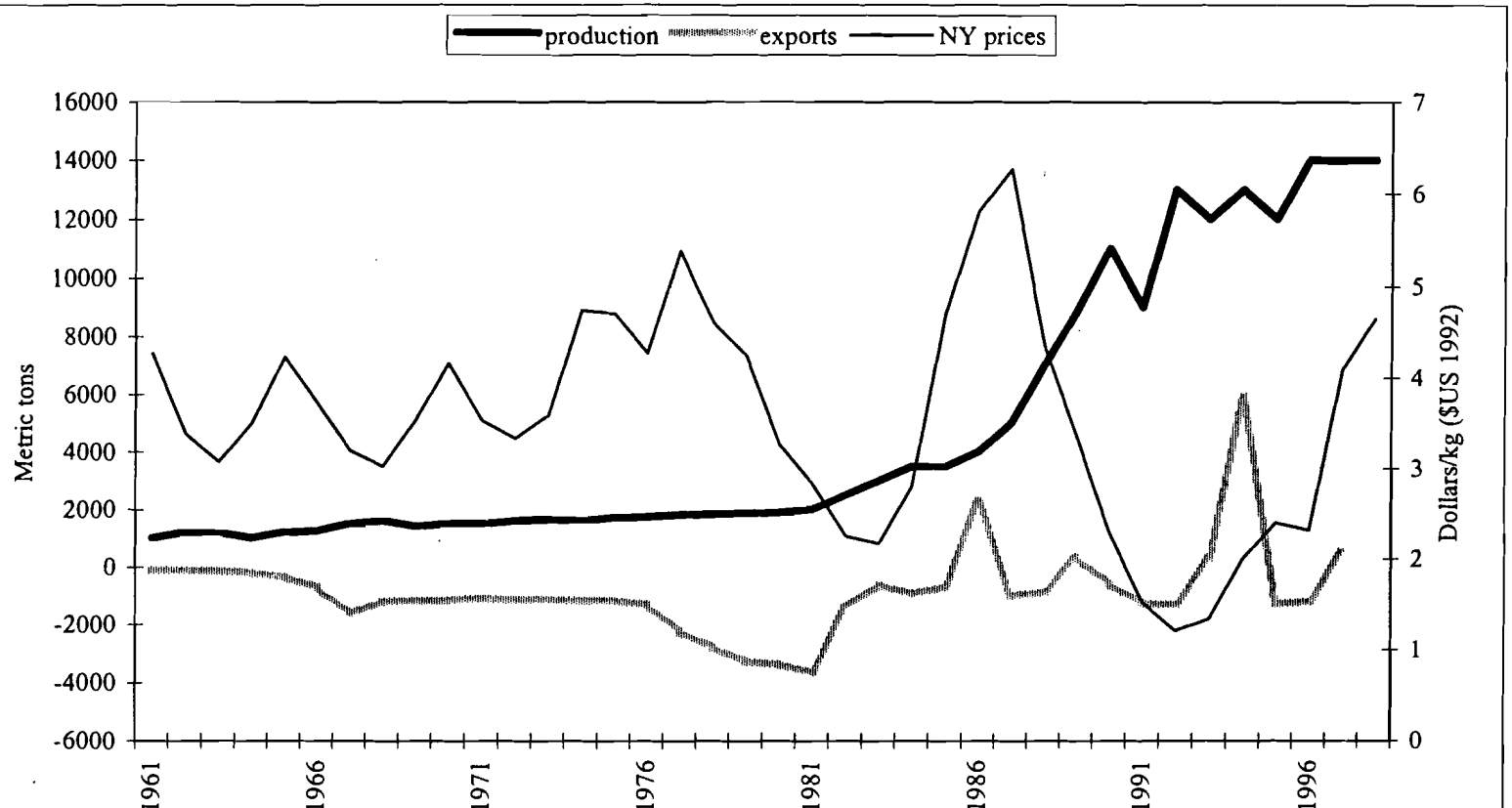


Figure 19. China: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

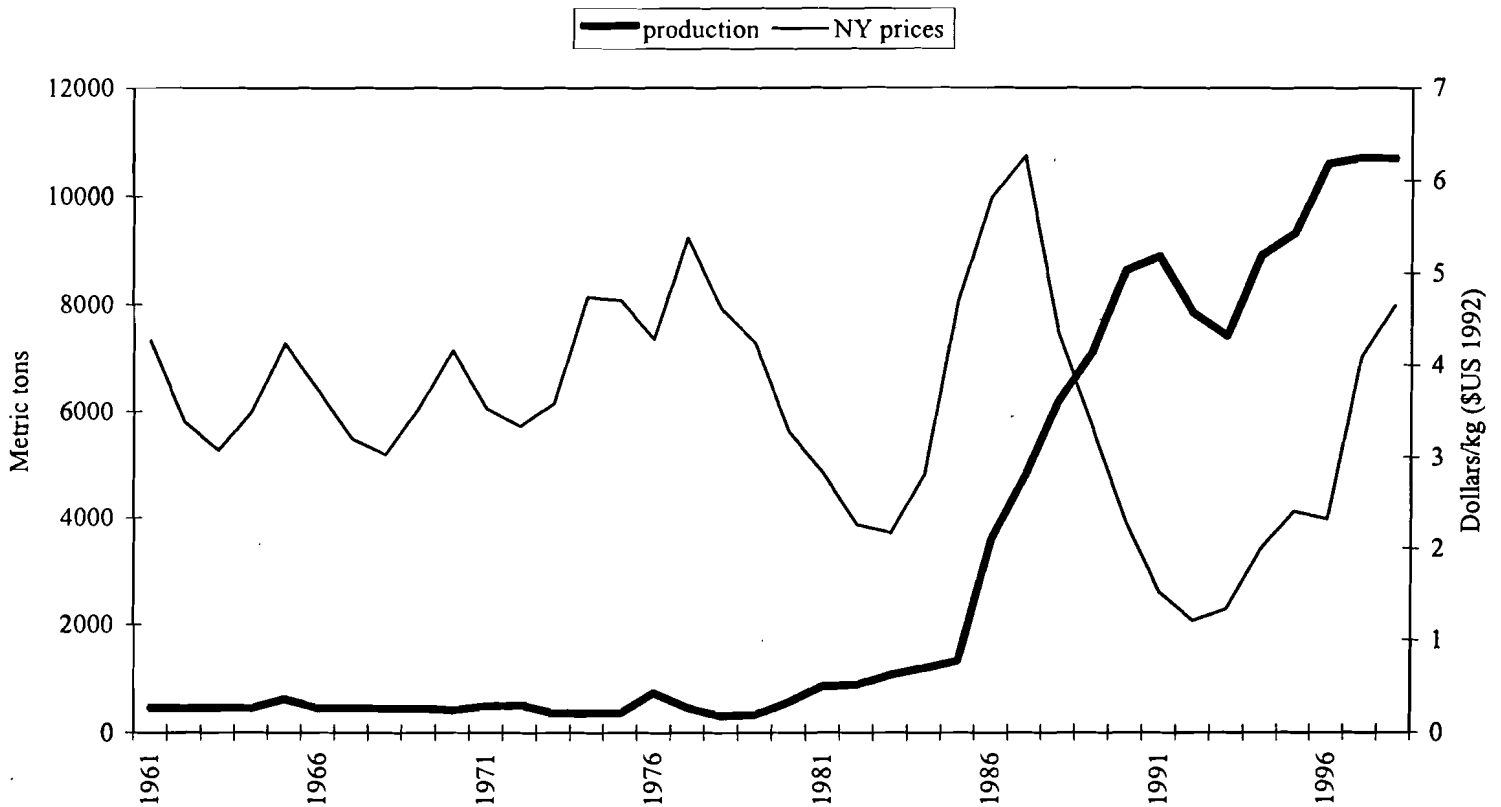


Figure 20. Vietnam: Production and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

which remain from the Vietnam War in the 1960s-70s. In addition to the strong prospects of production increase, the amount of pepper available for export will also be substantial because the domestic market is likely to increase from 3,000 MT in 1997 to only 8,000 MT by 2020. Vietnam is likely to be a major player in the low-end pepper market by 2020.

Thailand

Most pepper farmers in Thailand are descendants of Chinese immigrants. Their cultivation method is intensive mono cropping. Pepper production had gradually increased since the early 1960s (Figure 21). Thai pepper production reached 10,000MT in 1990, and started falling in 1996. Until 1989, only area expansion was responsible for the production growth (Figure 18). When yields started to increase in 1990, the area under pepper cultivation began declining. As the area under pepper cultivation kept declining and yields continued to climb, production stagnated. Since 1996 both the area under pepper cultivation and yield have been declining.

Thailand's per capita income (PPP GNP) in 1997 was US$6,490. At this level of income and taking into account the characteristics of Southeast Asian cuisine, per capita pepper consumption in Thailand is expected to be 90-100g. With a population of 58 million, Thailand's domestic pepper market should be 5,200-6,000MT. Therefore, pepper exports from Thailand were just 300MT in 1997 when declining production hit 7,000MT.

Since yields are already quite high in Thailand, significant improvement cannot be expected in this aspect. The expansion of area under pepper cultivation may be possible to some extent. Substantial production increases, however, are not likely due to a labor shortage. High labor charges will increase production costs and make Thai pepper less competitive. In addition, the Thai domestic market will expand to around 11,000 MT by 2020 from 5,200-6,000 MT in 1997. With limited production prospects and an expanding domestic market, Thailand may even become a net importer of pepper by 2020.

Overall, production and exports of high quality pepper in Indonesia and Sri Lanka are expected to increase significantly toward 2020. On the other hand, in the low-end market, a substantial increase of production and exports is not likely except in Vietnam.

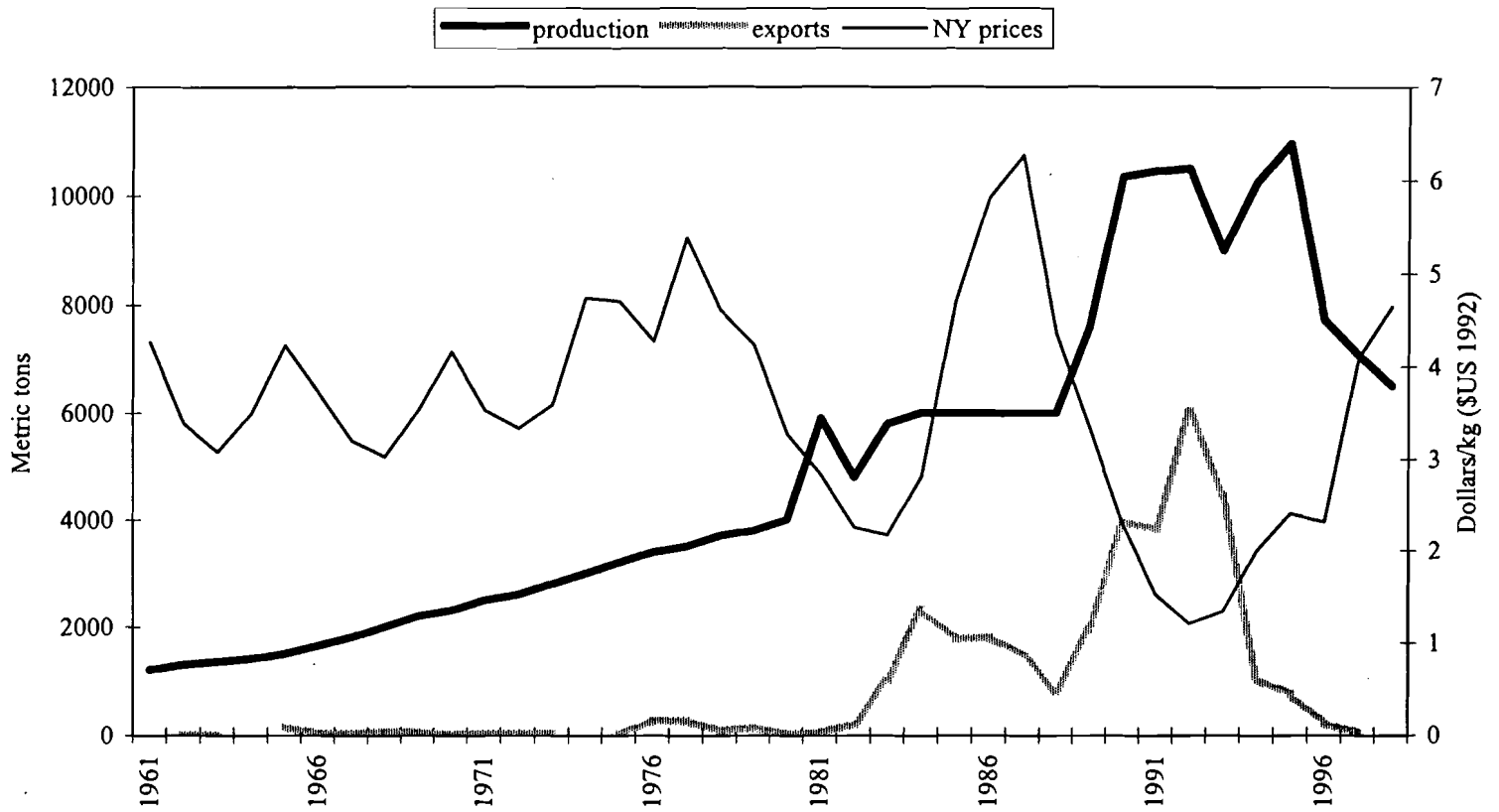


Figure 21. Thailand: Production, Exports, and Real Price of Pepper, 1961-1998

Source: FAOSTAT, http://apps.fao.org/; Commodity Research Bureau, Commodity Yearbook, various issues
US Dept. Commerce, Bureau of Economic Analysis, http://www.bea.doc.gov/

CHAPTER THREE
DEMAND SIDE OF THE WORLD PEPPER ECONOMY

This chapter shows what today's pepper consumption characteristics are, who the major importers are, and what lies ahead for pepper demand around the world. This chapter has four sections. Section A reveals that the expansion of the food-processing industry is driving the world pepper demand. Section B describes characteristics of each regional import market. Section C estimates pepper demand from each region market in 2020. Demand for high and low quality pepper is also estimated. Section D summarizes the demand and supply prospects in both high-end and low-end markets in 2020, and examines India's export potential in those markets.

Section A: The engine of demand growth

World demand for pepper has been increasing by two to three percent a year. Although the world population is also increasing at roughly the same rate, population growth is not the only factor underlying increased demand; dietary changes in the industrialized countries also play an important role.

The industrialized countries consume about half the pepper produced in the world today, and the vast population of developing countries, including all pepper- producing countries, consumes the other half. This implies that, as with many other commodities, per capita pepper consumption is generally much higher in the industrialized countries than in the developing countries (Table 1). Income level alone, however, does not explain the level of pepper consumption in a given country. Per capita pepper consumption varies even among countries with same income levels due to the great differences of local foods. The level of pepper consumption has increased as income has risen in the Western industrialized countries, but among countries the differences in pepper consumption levels have also widened (Figure 22).

Therefore, diet, as well as income level, plays an important role in determining the future demand for pepper. The effects of regional cooking on the level of pepper consumption will be discussed in detail in a subsequent section.

As the people in the Western industrialized countries have become more prosperous, have they begun to use more pepper when they cook? Yes; but that is only a fraction of the whole picture. People in the industrialized countries eat processed and pre-cooked foods more and more every year; and it is this phenomenon that is making the significant difference in pepper consumption. In fact, the average American's expenditure in constant dollars for frozen prepared foods almost doubled from 1980 to 1988 (Economic Research Services (ERS), 1988). The amount of pepper used in the food-processing industry accounts for more than half of total consumption in the industrialized countries (Buzzanell, Dull, and Gray, 1994; Purseglove et al., 1981). Figure 23 shows idealized flows of imported pepper in an industrialized country from the spice's origin to the plate of the consumer. Spice companies clean, grind, pack, and distribute imported pepper to domestic users. A considerable portion of pepper is consumed as a hidden ingredient in frozen foods and other food products.

A major processed food item containing pepper is processed meat such as ham, sausage, frankfurters, salami, and so forth (Gotoh, 1983; Purseglove et al., 1981). As per capita income rises, consumption of meat per capita increases to a certain level and then plateaus. Since the

Table 1. Per Capita Net Imports of Pepper by Country, 1988-92 Average

Industrialized Countries	Grams/year	Developing Countries	Grams/year
Germany	208.0	Gabon	40.9
Netherlands	170.2	Urguay	35.3
Denmark	167.7	Ivory Coast	12.2
USA	150.6	Venezela	11.2
France	139.5	Colombia	8.9
Canada	120.9	Sudan	5.6
UK	77.4	Zambia	2.2

Source: FAOSTAT, http://apps.fao.org/

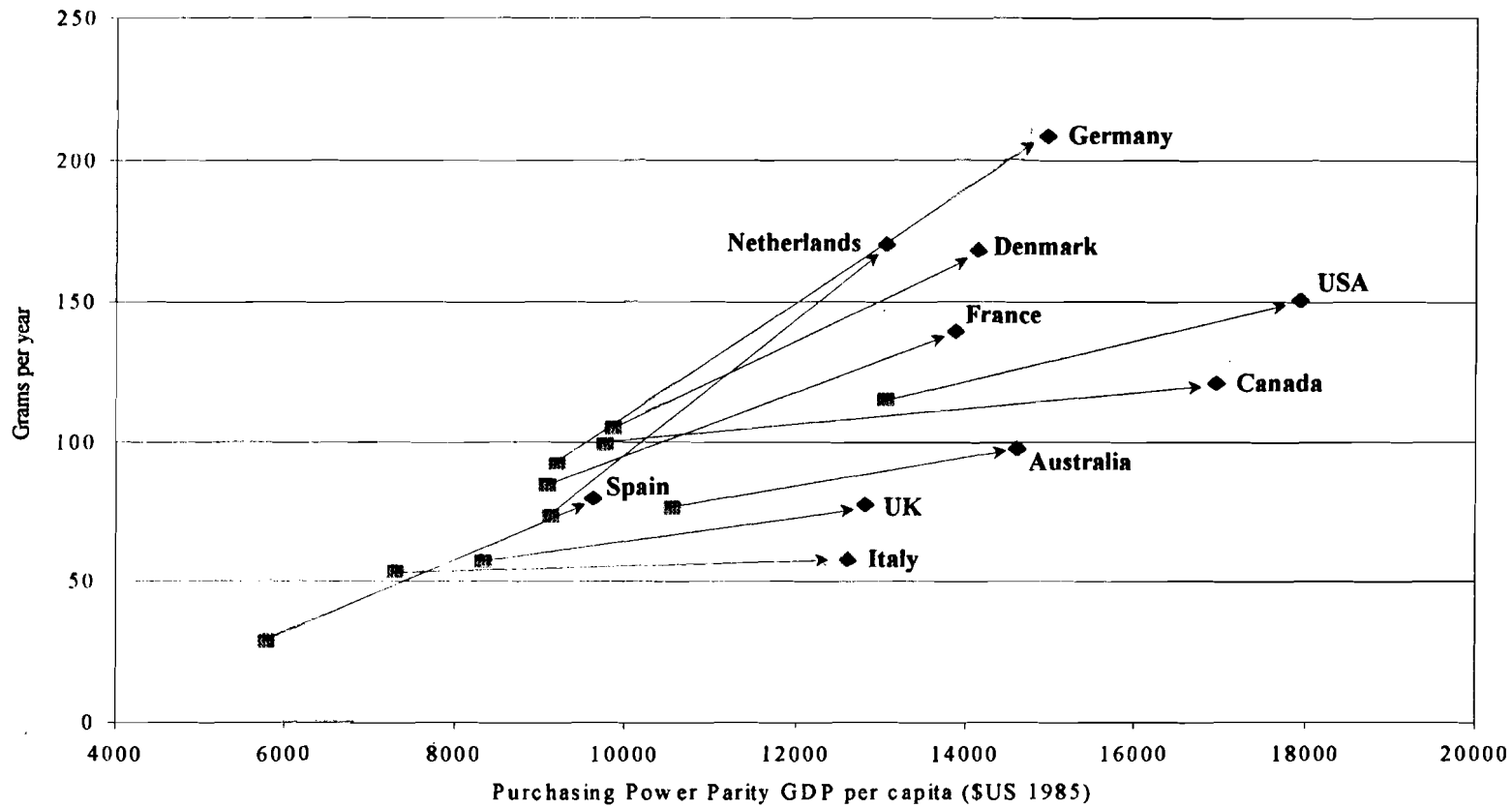


Figure 22. Increasing Per Capita Net Imports of Pepper in the Industrialized Countries from 1968-72 Average to 1988-92 Average

Sources: FAOSTAT, http://apps.fao.org/; Penn World Tables 5.6, http://www.nber.org

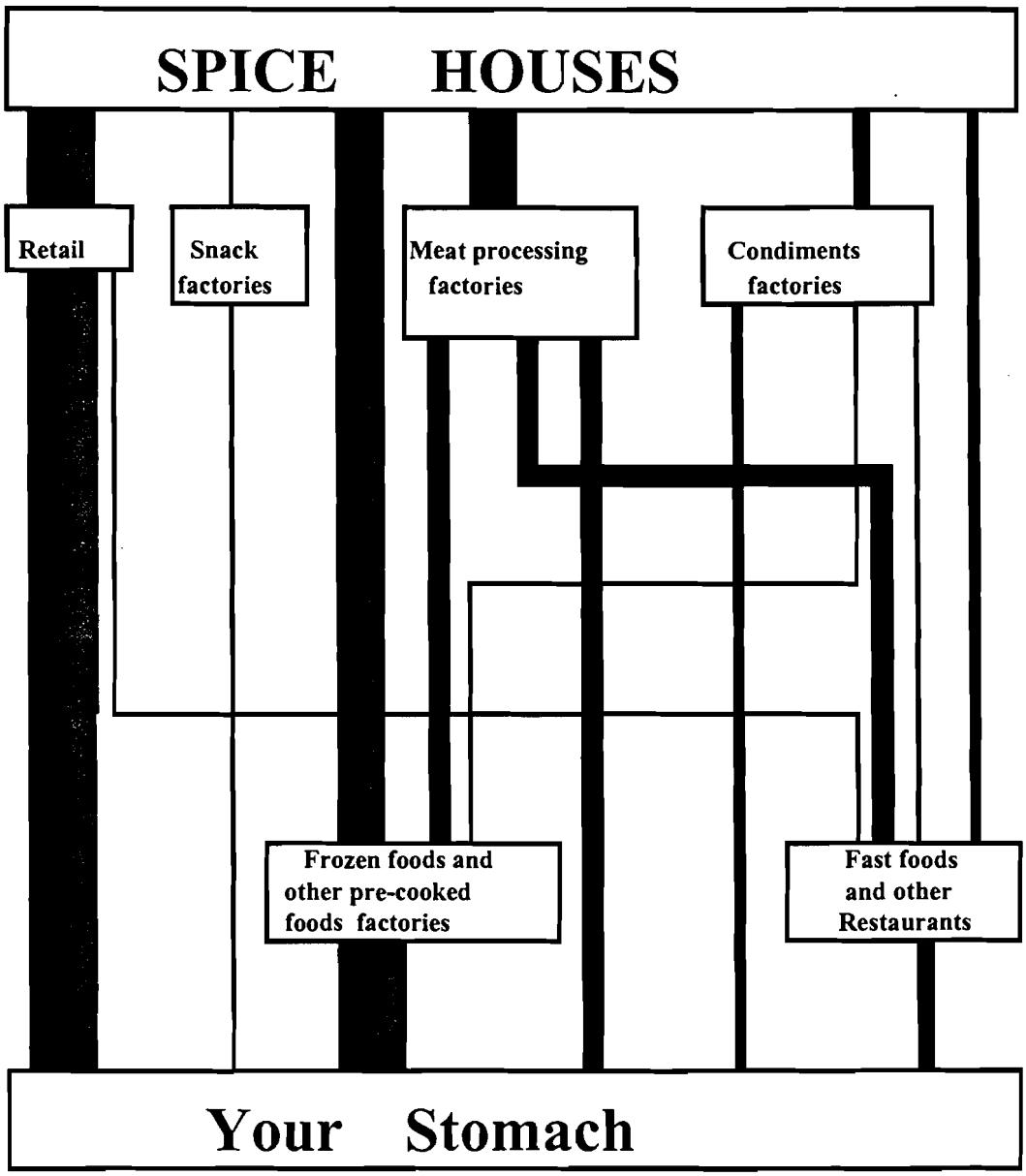


Figure 23. Idealized Flow Diagram of Pepper Utilization

Note: Spice Houses include: importers, grinders, and packers
Width of line is intended to be suggestive of relative magnitudes and are the author's estimates (ASTA, International pepper news bulletin)

level of meat consumption is already quite high in the industrialized countries, growth of per capita meat consumption is slow, but the proportion of processed meat to total meat consumption has been getting larger. For instance, the share of processed meat in the total expenditure for meat in the United States increased from 26.5 percent in 1980 to 30.9 percent in 1988 (ERS, 1988). The National Hot-Dog and Sausage Council, a group of American meat packers and processors, estimates that consumption of hot-dogs in the United States in 1999 would increase about 5 percent from 1998; this stimulates the consumption of pepper, which is needed in the production of frankfurters. Also, when a hot dog is eaten, ketchup and mustard are often used; pepper is essential ingredient of both of these condiments (Gotoh, 1983).

So-called convenience foods including frozen foods, canned soups, seasoning packets, and instant noodles are now consumed in greater quantities and also use a lot of pepper (Buzzanell, Dull, and Gray, 1994). For instance, soup consumption in the United States increased about two percent a year from 1980 to 1988 (ERS, 1988). As more women join the work force, the demand for convenience foods increases. The popularization of the microwave oven has contributed to the further development of the frozen foods markets.

The fast-food industry has also stimulated pepper consumption (Buzzanell, Dull, and Gray, 1994). Pepper is necessary for the production of meat patties for McDonald's, and the popularity of French fries has increased the consumption of ketchup. The worldwide expansion of Kentucky Fried Chicken has also increased the use of pepper and other spices, while the success of the sandwich chain, Subway, has boosted consumption of ham and salami. One of the latest booms in the fast food industry is pizza, which has stimulated the consumption of pepperoni, ham, and Italian sausage. Consumption of snacks such as potato chips increased 36 percent in the United States from 1980 to 1988 (ERS, 1988). Development of potato chip derivatives, such as Doritos' tortilla chips, has also opened a new market for pepper.

People in the industrialized countries have also come to enjoy dining out more frequently. In 1961, expenditure on food away from home accounted for 27 percent of the total food spending in the United States, and it rose to 46 percent in 1996 (ERS, 1996). Ethnic food restaurants are certainly becoming popular, in part due to the increasing number of Asian and other immigrants in the Western world. As a result, there are more opportunities for Westerners to try unknown ethnic foods, and spicy Asian foods are now widely and enthusiastically accepted. In 1982, the expenditure on "oriental foods" accounted for 3.6 percent of the total expenditure on food away from home in the United States, expanding to 4.8 percent in just seven years (ERS, 1989). Thai and other Southeast Asian foods are increasing their presence in major cities around the world, while Szechwan and Hunan dishes have become the preferred Chinese take-out options. Pepper, as well as chillies, is a major seasoning in these dishes.

It should also be noted that health concerns in the industrialized countries have created a movement toward a low sodium diet; one aspect of this diet is an increase in the use of herbs and spices to compensate for the flavor loss. Hot spices like pepper make dull starchy staples more palatable.

As we have seen, the food processing industry is getting more and more important for pepper producers. The demand from the food processing industry will keep going up, and similar dietary changes in the developing countries are likely as income levels rise. On the other hand, the prospect of increased pepper use in households in industrialized countries seems less promising. Therefore, when the pepper demand in the future is estimated, it should be noted that the pepper

used in the food-processing industry is mostly ground pepper rather than whole peppercorns, and ground pepper can be produced from low quality pepper.

A recent trend in food- processing industries also deserves special attention: the factories are beginning to prefer a liquid form of pepper, pepper oleoresin, to ground pepper for several reasons. First, since pepper oleoresin is liquid, it's easier to mix with other ingredients. Second, oleoresin is clean and free from microorganism contamination. Third, oleoresin is easier for workers to handle; it won't cause sneezing. Finally, compared to ground pepper, oleoresin can be stored longer without deterioration of quality. Imports of black pepper oleoresin to the United States have almost tripled since 1980 (Buzzanell, Dull, and Gray, 1994). This trend toward oleoresin use offers an opportunity for the pepper-producing countries to earn more foreign exchange. Since pepper oleoresin is more value-added product than ground pepper, pepper-producing countries can earn greater profits if they produce oleoresin by themselves. Like ground pepper, pepper oleoresin can also be produced from low quality pepper.

In addition to the demand for low quality pepper from the industrial sector, increasing population and rising income levels in the developing countries will also expand the demand for low quality pepper. Therefore, the demand for cheap low quality pepper is likely to be the fastest-growing segment of pepper demand in the future. However, whether India should consider the low-end market as its primary market depends on how much demand growth in the high-end market can be expected in the future. The expansion may be slow in the high-end market, but it may be more advantageous for India to capture the high priced, high-end market.

Section B: Characteristics of import markets

As the industrial use of pepper has increased, price has become the primary factor for importing countries when they decide how much pepper to import from where. The industrialized countries' efforts to obtain the cheapest pepper available have increased direct shipments from producing countries and diminished the role of Singapore as an entrepot. In the early 1960s, as much as one-third of pepper traded in the world was channeled through Singapore, while these days, only one-fifth is traded via Singapore.

Although price is the most important factor for decisions about importing, certain preferences still exist for particular origins and types of pepper. These preferences influence the trade pattern, and in some regions, the market share of Indian pepper is small due to such preferences. In order to increase exports to such regions, it is essential for India to examine regional preferences and, if possible, accommodate exports and production strategies to target markets that currently lack demand for Indian pepper.

North America

The North American market accounts for one-third of the world pepper trade (Figure 24). The presence of Indian pepper in the North American market is strong, in fact, Indian pepper share is close to half (Figure 25). The amount of pepper India exports to this region is so phenomenal that Indian pepper exports face great volatility. If the United States were to enforce trade sanctions on Indian pepper for any reason, the possible damage to the Indian pepper industry would be catastrophic. In order to avoid the risks associated with this kind of dependence on one market, India should increase exports to other regions and spread exports more evenly around the world.

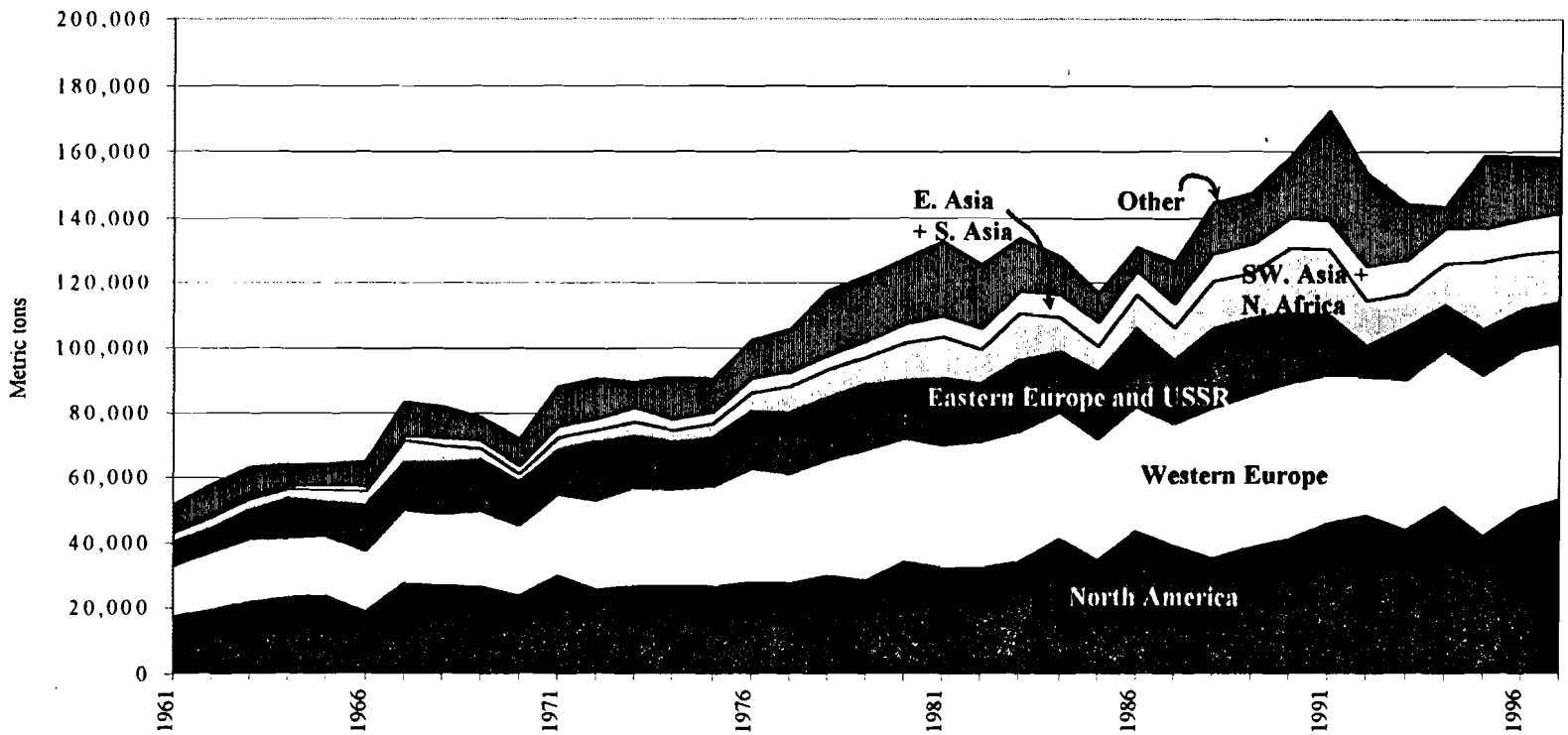


Figure 24. World Pepper Imports by Region, 1961-1997

Source: FAOSTAT, http://apps.fao.org

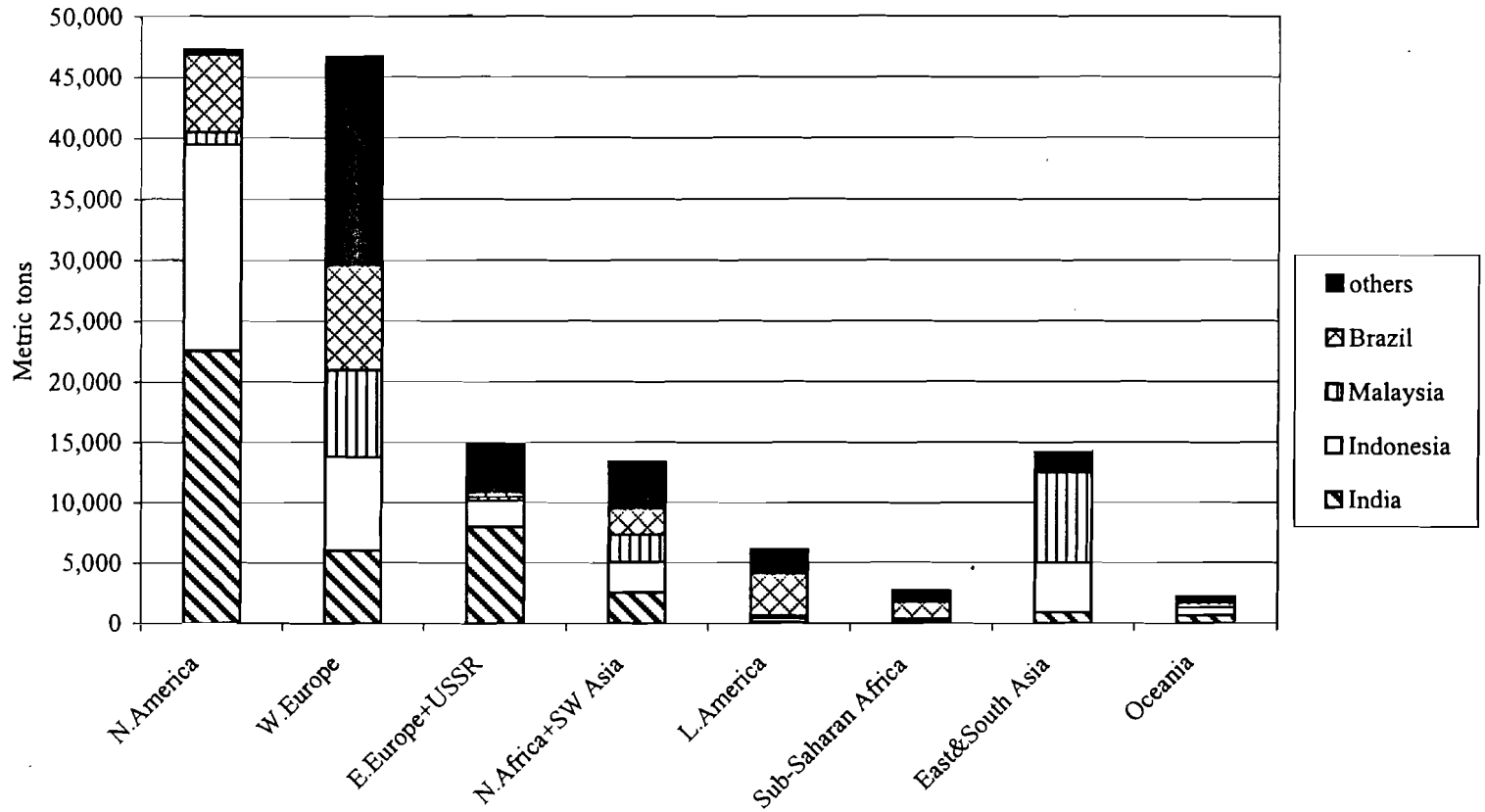


Figure 25. Origins of Pepper in Major Importing Regions, 1993-95 Average

Source: International Pepper Community, Pepper Statistical Yearbook 1995/1996

A part of the reason why the United States imports heavily from India and Indonesia is that the export standards of India and Indonesia meet the very strict US import specifications, known as the American Spice Trade Association standard (ASTA standard). Some specifications are shown in Table 2. Lower-quality pepper from other countries has to be refined by traders to meet the ASTA standard before it is shipped to the United States. The number of spice traders in the United States, however, has declined by half over the past ten years due to vertical integration movement in the spice industry. Currently, retailers like McCormick also engage in trading, and they avoid sources that require refinement.

In the North American market, black pepper is highly preferred to white pepper, which accounts for only about one-seventh of total pepper imports. The rate of demand growth, however, is much faster in white pepper. For the past twenty years, imports of white pepper in the United States have increased twice as fast as those of black pepper.

Western Europe

The Western European market is an equivalent size to the North American market, but it imports more evenly around the world; hence, the Indian share in this market is smaller than in the North American market. In fact, the Indian share in this market is disproportionately small when India's production level is considered. A possible explanation for India's failure to capture the Western European market is that this market consumes a considerable amount of white pepper, of which India does not produce much. The Western European market imports twice as much white pepper as the North American market does. The Western European market imports about one-third of its total pepper from Singapore, including both black pepper and white pepper; one-third of the total white pepper traded in the world today is still channeled through Singapore. Relations between Singapore spice merchants and pepper exporters in Southeast Asian countries will be discussed in detail in the next chapter.

Western European countries have less strict import specifications than the ASTA standard. Most countries use the Fair Average Quality standard (F.A.Q. standard) of Indonesia or Malaysia. Unlike in the United States, the presence of large spice-trading firms, such as Rotterdam's Man Producten, is still strong in the Western European market, and they refine imported pepper before distributing it to retailers and manufacturers.

Eastern Europe and former USSR

The Eastern European market, including the former Soviet Union, was the world's third largest market and the major destination for Indian pepper until the collapse of the Soviet Union. Indian exports to the USSR and other communist countries of Eastern Europe increased significantly in the 1960s as a result of bilateral government purchase agreements, while exports to Western Europe and North America declined. By the late 1970s, almost three-quarters of Indian exports were directed to the East European market, and the Indian share reached almost 100 percent. The demand for white pepper is very limited in this region, which helped Indian domination in the market. After the meltdown of the former Soviet bloc, economic hardship in the region cut the total market size to less than two-thirds. The East European market shrank 8,600 MT from 23,400 MT in 1988-1990 to 14,800 MT in 1993-1995. To make matters worse, Eastern European countries cancelled bilateral governmental purchase agreements with India and started to import from cheaper sources. The Indian share declined from about 90 percent in 1988-1990 to half in 1993-1995. Indian exports to this region shrank 12,600 MT from 20,600 MT in 1988-

Table 2. Export and Import Standard Specifications of Pepper Around The World

	Extraneous matter %	Light berries %	Moisture %
USA			
ASTA standard			
ASTA Black	1	2	12.0
ASTA White	1	2	12.0
India			
MG-1 (black)	0.5	2	11.0
MG-2 (black)	0.5	5	11.0
Indonesia			
Indonesian black ASTA	1	2	12.0
Indonesian black FAQ	3	3	13.5
Indonesian white ASTA	1	2	12.0
Indonesian white FAQ	2	3	13.5
Malaysia			
Sarawak black special	1.5	4	13.5
Sarawak black FAQ	3	8	15.0
Sarawak black field	4	10	16.0
Sarawak white special	0.25	0.5	14.0
Sarawak white FAQ	0.5	1	16.0
Sarawak white field	1	1.5	16.0
Brazil			
Brazilian black 1	0	3	10.0
Brazilian black 2	1	6	10.0
Brazilian white 1	0	3	10.0
Brazilian white 2	10	3	10.0

Sources: Gotoh. 1998. Koshou. Tokyo; Purseglove, Brown, Green and Robbins. 1981. Spices volume 1. London

1990 to only 8,000 MT in 1993-1995. Recovery of this market doesn't seem likely in the near future, and even if the market size recovers to its pre-crisis level, there would not be any more bilateral government purchase agreements to protect India's place in the market.

East and South Asia

The East and South Asian import market is about one-third the size of the North American market, and Japan is the largest importer in the region, accounting for more than 50 percent of the total. Many countries in this region produce pepper, and as a result the import market is not substantial. India exports a limited amount of pepper to neighboring countries such as Pakistan and Nepal, but the Indian share in the East and South Asian market is small. On the other hand, exports from Malaysia account for as much as 50 percent of the market share by dominating the Japanese and South Korean markets. Unlike other industrialized countries, Japan imports a substantial amount of ground pepper, as much as 15 percent of total pepper imports; most ground pepper comes from Malaysian manufacturers, many of which are part of joint ventures between Malaysian and Japanese firms. White pepper also accounts for about one-fifth of total imports to Japan, and Indonesia is the dominant white pepper supplier.

Japan doesn't have its own standard for pepper imports. In the past, most Japanese traders imported pepper from Singapore, where reliable grading systems assured quality. In 1975, however, the Malaysian government established export standards, and most Japanese traders now import directly from Malaysia, using Malaysian standards, such as Sarawak special and Sarawak F.A.Q., to ensure the quality of shipments. As a result of this development, the re-exports from Singapore to Japan have diminished.

North Africa and Southwestern Asia

The North African and Southwestern Asian market is about one-third that of the North American market in trade size. More than half of imports to this market passes through Singapore, but the actual origins of pepper are well balanced. Indian pepper accounts for one-fifth of the total imports, which are primarily black pepper.

Latin America

The Latin American import market is small, because many countries in this region produce and even export pepper in small quantities, and Brazil, of course, is one of the major world's producers. Most import demands in this region are satisfied by Brazilian exports, so Indian exports to this region are insignificant. Most pepper consumed in this region is black pepper, and the demand for white pepper is limited.

Sub-Saharan Africa

The Sub-Saharan African market is very limited in size due to the low levels of income. The pepper consumed in this region is almost exclusively black pepper. Cheap Brazilian pepper takes more than half of the market share, and the more expensive Indian exports are very limited.

Oceania

The Oceania market is also very small due to the small population of the region. Although there are many small countries in Pacific Ocean, Australia and New Zealand alone represent almost the entire market. The origins of imports are well balanced, and India has a fair market share, despite the fact that about one-fifth of this small market is for white pepper.

Section C: Prospects of pepper demand

To determine the prospect of pepper demand in a particular region, three factors have to be taken into account. First, population growth, ceteris paribus, increases pepper demand. Second, an increase of income levels also has a positive impact on pepper demand. Degrees of impact, however, vary country to country depending on the level of income and the traditional cuisine in the region, which is the third factor influencing pepper demand. This chapter will first discuss population prospects, and then the effects of an income increase on pepper demand. Particularities of regional cuisine and their effects on prospects for pepper demand will be discussed for each regional market, and the prospect of pepper demand toward 2020 will also be estimated. Particularly, the demand prospect for Indian pepper in each regional market will be examined.

Population growth

Estimating future population is a difficult task, and many organizations have their own projections. Projections vary greatly from organization to organization, and prospects are continually being revised. Based on past performance, the best projection appears to be the one from the Population Division of the United Nations. The UN's population estimate has high, medium, and low variant projections, and the medium variant projection is most likely to be the closest prediction of future population. The 1998 Revision of the World Population Prospects from the UN shows that, based on the medium projection, the world population in 2050 will be 8.9 billion (POPIN, 1999). This is about half a billion less than the medium variant projection in the 1996 Revision (UN Population Division, 1997). The 1998 Revision also shows that the gap between the high and low variant projections of estimated population in 2050 is as much as 3.4 billion. Since detailed figures of the 1998 Revision are not yet available, for the use of this paper, I have incorporated the available 1998 Revision's figures in order to modify the figures from the 1996 Revision. Figure 26 shows population growth from 1950 to 1990 and the projections through 2050 with three variants.

About one to two billion more people will be added to the world population between 1997 to 2020. Most of this increase will take place in the developing countries, especially in South Asia and Sub Saharan Africa (Figure 27). The population of the industrialized regions will not increase much except in North America, where 30 to 70 million more people will be added. Therefore, in addition to the food-processing sector in industrialized countries, the significant part of the increase of pepper demand will also take place in the developing countries.

Income level growth

As income level increases, most people shift their primary concern about food from quantity to quality. As people grow richer, they seek tastier food. Therefore, as income level increases, people tend to consume fewer starchy staples and more animal products, fat and oil, fruits and vegetables, and flavoring ingredients like spices (Poleman and Thomas, 1994). When

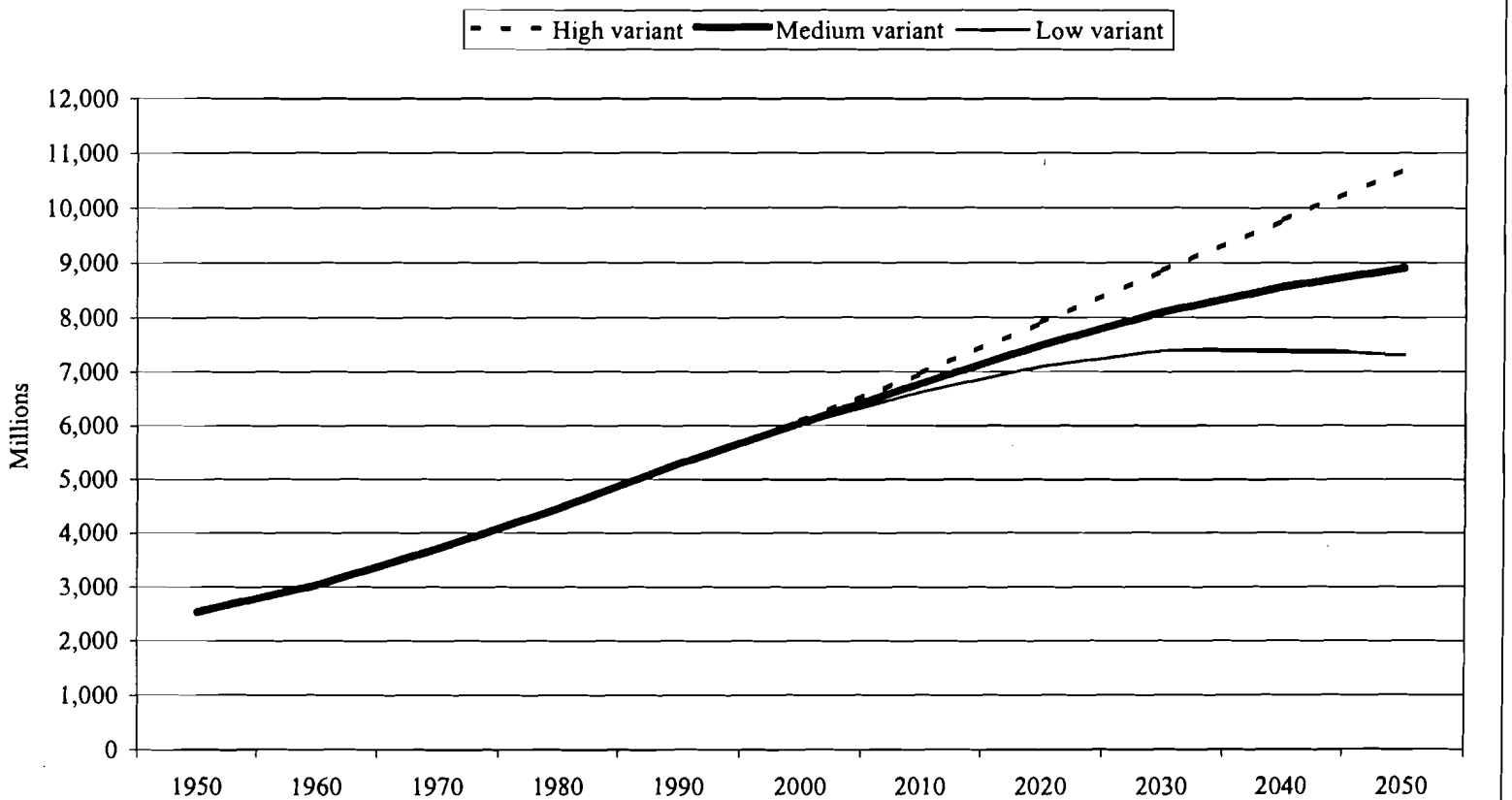


Figure 26. World population since 1950 and world population prospects to 2050

Sources: Population Division, UN Secretariat, World Population Prospects: the 1996 Revision
Population Division, UN Secretariat, World Population Prospects: the 1998 Revision, http://www.popin.org/pop1998/1.htm

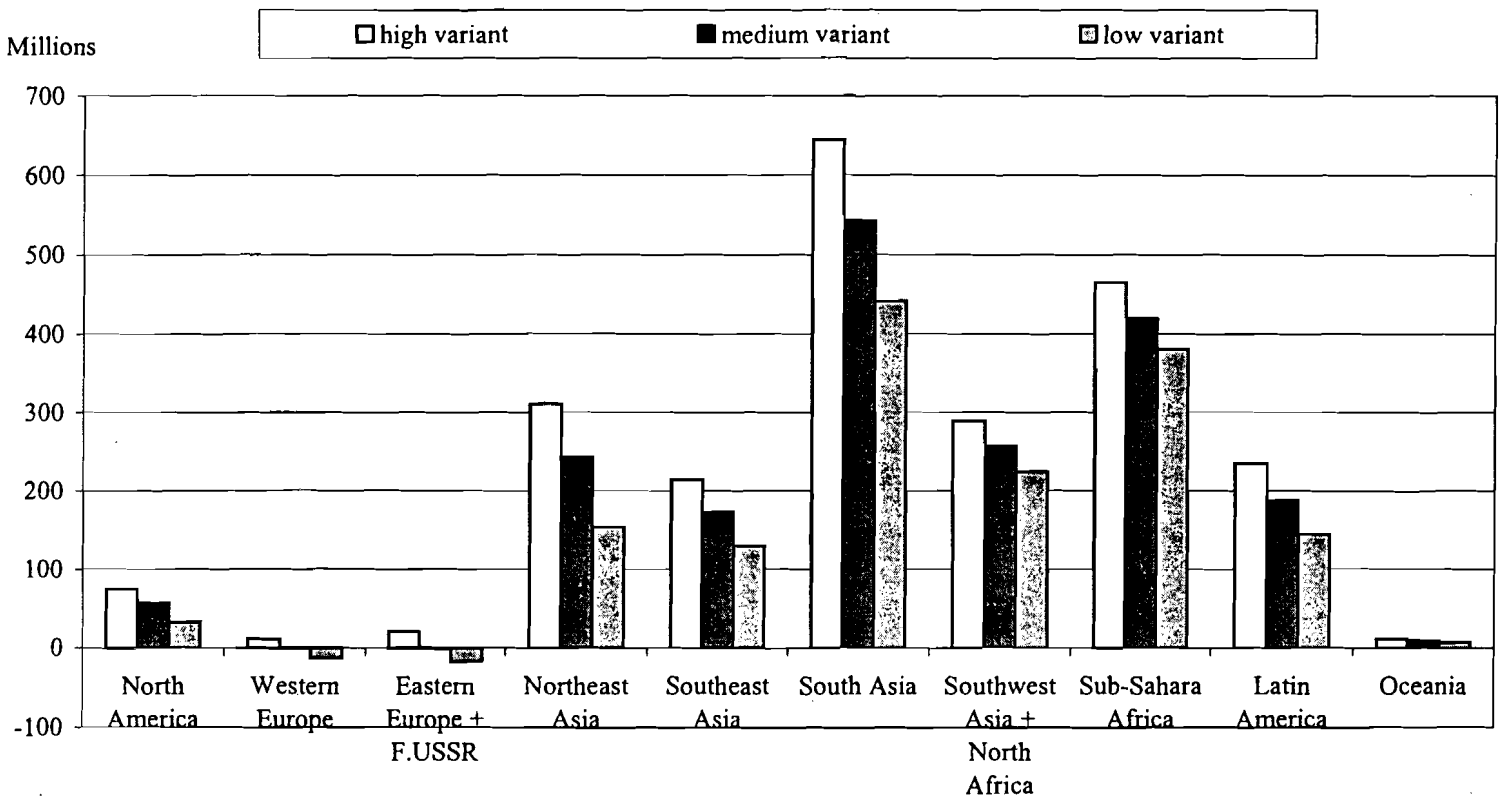


Figure 27. Projected popluation increase by region from 1995 to 2020

Note: Projections are estimated by author based on the following sources.

Sources: Population Division, UN Secretariat, World Population Prospects: the 1996 Revision

Population Division, UN Secretariat, World Population Prospects: the 1998 Revision, http://www.popin.org/pop1998/l.htm

per capita pepper consumption of each regional market is plotted against per capita income of the respective market, it is clear that the level of pepper consumption per capita is positively related to per capita income level (Figure 28). Therefore, pepper demand will increase, as income levels in developing countries become higher.

Pepper, chillies, or soy sauce?

Although income growth will increase pepper demand, the magnitude of the income growth on pepper demand will vary considerably from region to region due to the peculiarities of local food. People in North America, Western Europe, Eastern Europe (including Russia), and Oceania (excluding the Pacific islands) eat so-called "Western foods," which are basically similar. Thus, per capita pepper consumption can be predicted fairly well by income level alone, and these markets are located close to the regression line.

For the non-western regions, characteristics of different local dishes cause the coordination of income level and pepper consumption level to deviate from the regression line. For example, Southeast Asia is located above the regression line, showing that they use more pepper at the given level of income than western countries. In fact, Thai cuisine heavily uses black pepper. On the other hand, Latin America is located below the line, indicating that they use less pepper at the given income level than western countries. Latin American cuisine is also hot and spicy, but they use chillies more often than pepper. Thus, when pepper demand is estimated, characteristics of local foods have to be considered.

North America

North America is the world's most prosperous market and the level of per capita pepper consumption is the highest of all regions. An average person in this region consumes about 160 grams of pepper a year. This is equivalent to 70 teaspoonfuls, or 1400 pinches. Despite the high level of consumption, market saturation is not yet in sight. In fact, the rate of increase in per capita pepper consumption is speeding up. Per capita pepper consumption of the 1985-1990 average was up 8.7 percent from the 1980-1985 average, while the 1990-1995 average was up 14.6 percent from the 1985-1990 average (ASTA, 1995).

Of course, such growth of per capita consumption has to be backed up by the continuous growth of income levels. Per capita purchasing-power-parity Gross National Products (PPP GNP) of this market is the highest in the world (Table 3), and I assume that it will grow at a 1.5-2.5 percent average annual rate toward the year 2020, based on the economic performance of this region from 1990-1997. If income levels grow at this rate, per capita pepper consumption will increase to 222-289g according to the regression line. The North American population is also expected to grow at 0.42-0.9 percent a year, and will host another 33-74 million people by the year 2020. Population growth will increase pepper demand of the region as long as it doesn't decrease per capita income levels. Taking all aspects discussed above into account, I estimate that the pepper demand in this region will reach somewhere between 73,300 to 107,200 MT by 2020, up from 47,500 MT in 1995-97. Income growth will contribute 74-76 percent of the total demand increase, and population growth will be responsible for another 24-26 percent. The pepper demand in this region will grow at an average of 1.9-3.6 percent per year.

Per capita pepper consumption in North America was 160g in 1995-97, and about a half of this consumption was connected to the food processing sector (Buzzanell, Dull, and Gray,

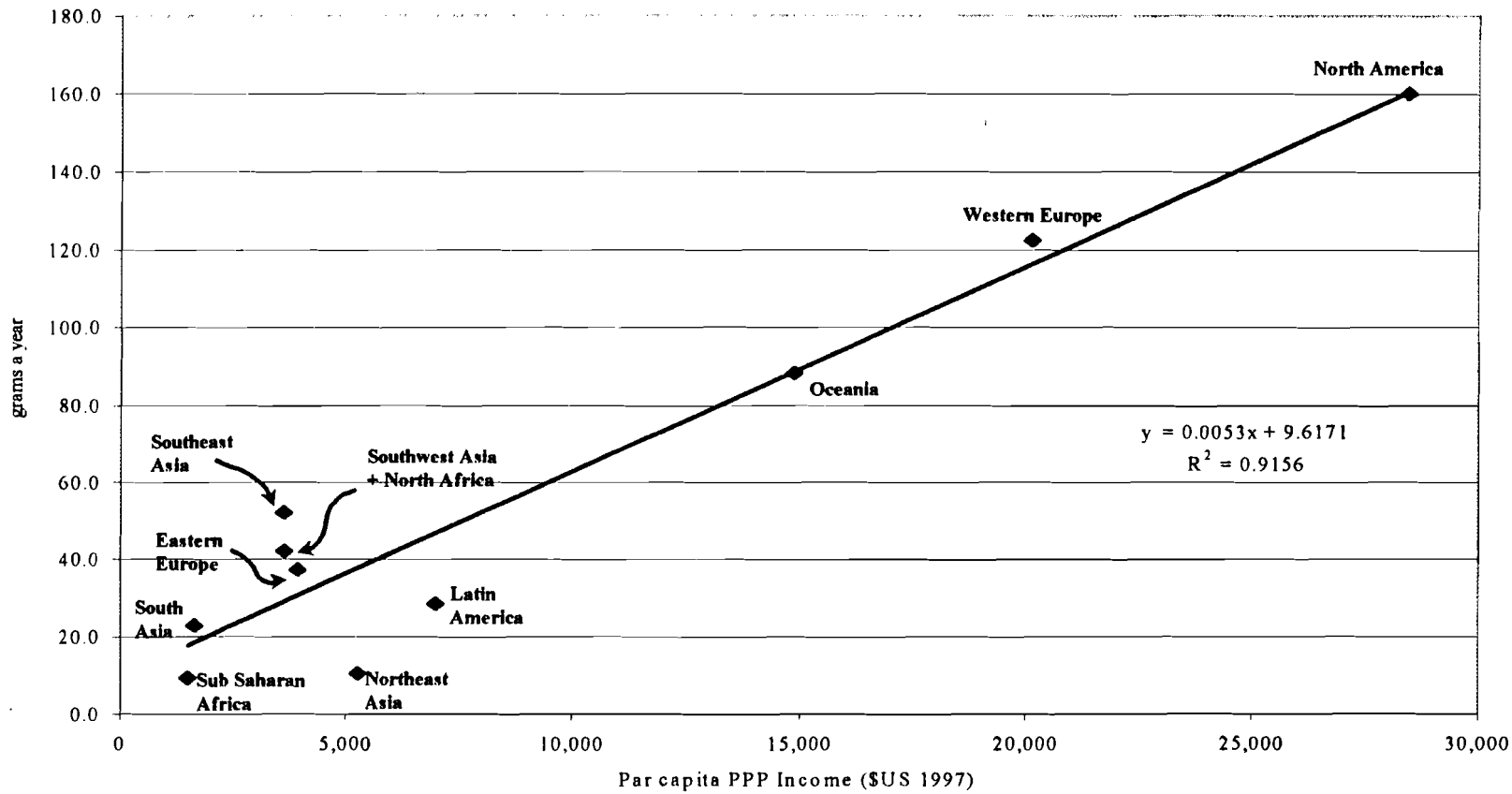


Figure 28. Relation Between Regional Average Per Capita Pepper Consumption and Purchasing-Power-Parity Income, 1995-1997

Sources: International Pepper Community, Pepper Statistical Yearbook 1995/1996: FAOSTAT, http://apps.fao.org/: World Bank, Size of the economy, http://www.worldbank.org/

Table 3. Prospects of Population, Purchasing Power Parity GNP Per Capita, And Pepper Consumption Per Capita Toward Year 2020

	Population			PPP GNP per capita			per capita pepper consumption			Pepper Demand		
	1997 Popula-tion	estimated annual growth	estimated population in 2020	in 1997	estimated annual growth	estimated PPP GNP per capita in 2020	per capita consump-tion 1995-97	Diet Factor	estimated level of per capita consumption in 2020	pepper demand in 1995-97	estimated annual demand growth	estimated pepper demand in 2020
	millions	%	millions	1997's $	%	1997's $	grams		grams	metric tons	%	metric tons
North America	297	0.42 ~ 0.9	330 ~371	28,458	1.5 ~ 2.5	40,080 ~ 52,760	160	++	222 ~ 289	47,500	1.90 ~ 3.60	73,260 ~ 107,219
Western Europe	388	-0.13 ~ 0.11	375 ~ 399	20,151	1.5 ~ 2.5	28,380 ~ 35,559	123	++	157 ~ 195	47,500	0.94 ~ 2.17	58,875 ~ 77,805
Eastern Europe	406	-0.16 ~ 0.2	389 ~ 426	3,911	1.0 ~2.0	4,917 ~ 6,167	37	++	42 ~ 50	15,000	0.37 ~1.54	16,338 ~ 21,300
Northeast Asia	1,421	0.41 ~ 0.79	1,575 ~ 1,732	5,254	2.5 ~ 3.5	9,271 ~ 11,591	11	+	21 ~ 26	15,000	3.50 ~ 4.90	33,075 ~ 45,032
Southeast Asia	482	0.96 ~ 1.48	611 ~ 696	3,615	3.5 ~ 4.5	7,975 ~ 9,949	52	+++	88 ~ 100	25,000	3.39 ~ 4.56	53,768 ~ 69,600
South Asia	1,245	1.22 ~ 1.68	1,686 ~ 1,889	1,634	1.5 ~ 2.5	2,301 ~ 2,883	23	++	28 ~ 30	28,500	1.89 ~ 3.03	43,836 ~ 56,670
SW. Asia + N. Africa	356	1.97 ~ 2.41	580 ~ 646	3,632	2.0 ~ 3.0	5,727 ~ 7,188	42	+++	60 ~ 70	15,000	3.73 ~ 4.91	34,800 ~ 45,220
Sub Saharan Africa	588	2.02 ~ 2.36	969 ~ 1054	1,518	0.5 ~ 1.5	1,703 ~ 2,138	9	+++	10 ~ 12	5,500	2.50 ~ 3.69	9,690 ~ 12,648
Latin America	477	1.06 ~ 1.61	621 ~ 711	6,976	2.5 ~ 3.5	12,310 ~ 15,390	28	++	40 ~ 50	13,500	2.69 ~ 4.30	24,840 ~ 35,550
Oceania	28	0.93 ~ 1.34	36 ~ 39	14,874	1.5 ~ 2.5	20,948 ~ 26,247	88	++	115 ~ 140	2,500	2.22 ~ 3.45	4,140 ~ 5,460
World total	5,687	0.93 ~ 1.36	7,172 ~7,962							215,000	2.17 ~ 3.52	352,622 ~ 476,504

Note: Population growth rate is calculated by the author from World population prospects: the 1996 Revision, and the 1998 Revision, published by Population devision, United Nations Secretariat; Growth rate of per capita PPP GNP and Pepper demand growth rate are also estimated by the author
Diet factor: one + for general spice use, one + for hot cuisine, one + for no taboo on meat consumption

Sources: World Bank, Size of the economy, http://www.worldbank.org/; UN Secretariat, Population division, World population prospects: the 1996 Revision; and the 1998 Revision, http://www.popin.org/:
International Pepper Community, Pepper Statistical Yearbook 1995/1996; FAOSTAT, http://apps.fao.org/

1994). On the other hand, in South Asia, where per capita pepper consumption was 23g in 1995-97, most pepper was consumed through the retail sector. Therefore, pepper usage in the food processing sector apparently starts developing when per capita pepper consumption reaches about 20g, and reaches 50 percent of the total when per capita pepper consumption reaches about 160g. After that, pepper usage in the processing sector keeps gaining the share. Therefore, the simple linear relation between per capita pepper consumption (X) and amount consumed through the retail sector (Y) is Y=0.4286X+11.42. This estimate is used throughout this study. Then, of an estimated 222-289g per capita consumption in 2020, 107-135g will be consumed through the retail channels, and 115-154g will be from the food-processing sector.

As of 1998, most Indian pepper flowed to retail channels. This is because Indian pepper is preferred by retailers due to its superior taste and aroma, while the industrial sector prefers cheaper pepper due to cost effectiveness. The demand from the retail sector in 2020 should be 35,200-50,200 MT. Therefore, new demand for high quality pepper should be 11,400-26,400 MT, while the demand for low quality pepper should expand by 14,400-33,300 MT.

Western Europe

Western Europe's pepper consumption level will approach the level of North America as income level rises. I assume that per capita PPP GNP in Western Europe will increase at the same rate as that of the North American region, an annual average of 1.5-2.5 percent toward the year 2020. Population, however, won't increase much; in the low variant case, it could even decrease. In addition to static population prospects, an aging population will reduce its consumption of meat, which will probably slow the rise of per capita pepper consumption. Therefore, the rate of increase in per capita pepper consumption of this market will be slower than that of the North American market. Taking projected income levels into account, I estimate that per capita pepper consumption will reach 157-195g. At this rate, pepper demand in this region will become 58,900-77,800 MT by 2020, up from 47,500 MT in 1995-97. The average annual increase rate will be 0.94-2.17 percent. Income growth will contribute 95-111 percent of new demand, and population growth will be responsible for –11 to 5 percent.

Among the 157-195g per capita pepper consumption in this region in 2020, 79-95g should be consumed in the retail sector. The pepper demand from the retail sector should be 29,500-37,900 MT; thus, new demand for high-quality pepper should be 4,700-13,100 MT.

Eastern Europe and former USSR

The economic turmoil that started in 1989 in this region reduced income levels and pepper consumption. This means that in the case of economic recovery, the pepper consumption level will certainly recover to the pre-crisis level. Except in some Eastern European countries, however, it is hard to see signs of economic recovery as of 1999. I assume that income levels will grow at an annual average rate of one to two percent toward 2020. Population is unlikely to grow. Population growth in Eastern Europe had already become negative in the 1990-95 period, and the former Soviet Union's Central Asian countries, which show positive population growth, are only sparsely populated. The only hope for pepper demand in this region is that income levels increased more than 5 percent in Hungary and Poland in 1997 (World Bank, 1999), and Polish and Hungarian cuisine use a lot of spices, including pepper. Based on the prospects of income growth, I estimate that per capita pepper consumption will climb back to 42-50g by 2020. The pepper demand of this market will increase to 16,300-21,300 MT by 2020, from 15,000 MT in 1995-97.

The average annual growth rate will be between 0.37-1.54 percent. Income growth will contribute 86-155 percent of new demand, and –55 to 14 percent will come from population growth.

Among the 42-50g per capita pepper consumption in this region in 2020, 29-33g should come from the retail sector. Thus, this region's demand for pepper from the retail sector should be 11,400-14,000 MT, adding 400-2,900 MT of new demand. The income levels of this region in 2020, however, will still be too low to allow consumers to spend extra money on high quality pepper.

Northeast Asia

Per capita pepper consumption of this market is much lower than that of the Western market at the given level of income due to the general unfamiliarity of pepper usage in the regional cuisine. For instance, PPP GNP per capita in Japan and Hong Kong in 1997 was more than $24,000, but per capita pepper consumption was only about 50g and 40g, respectively. In this region, the most popular seasonings are still traditional soy sauces and soybean pastes, even though western foods are now strongly influencing dietary patterns in this region, especially among the younger generations.

Although the marginal propensity to use pepper is lower, pepper demand is expected to grow because of the strong economic prospects in this region. Income levels should increase at an average of 2.5-3.5 percent toward 2020. Population is also expected to grow further, adding another 154-311 million people, mostly in China. One bright sign for pepper growers is that cuisine along the Yangtze River uses black pepper heavily, probably because pepper was abundant along the river, brought by ships from Shanghai, a major port for the China-Southeast Asian trade since the tenth century. Thus, the weak marginal propensity to use pepper in other parts of this market will be compensated for by strong economic prospects, population growth, and the demand from the Yangtze area. Based on strong economic prospects, I estimate that per capita pepper consumption will reach 21-26g. The pepper demand in this region in 2020 will be 33,100-45,000 MT, up from 15,000 MT in 1995-97. The rate of the demand growth will be 3.5-4.9 percent per year. Income growth will generate 74-83 percent of new demand, and 17-26 percent will come from the population growth.

New demand will come mostly from China, since the Japanese market will grow very slowly because of a static population. Most of this new demand will arise from the retail sector. The pepper demand from the retail sector in 2020 should be 32,200-39,100 MT, while the demand from the industrial sector should be only 900-5,900 MT. The retail sector should generate 16,500-23,500 MT of new demand by 2020, but the projected income levels in 2020 will be too low to expect a preference for high quality pepper. Therefore, Indian pepper will have little chance for success in this market.

Southeast Asia

Southeast Asian cuisine is spicy, and uses both chillies and pepper in great quantities. The average income level of this market is about the same as that of the Eastern European and the former USSR market, while per capita pepper consumption in the Southeast Asian market is roughly 40 percent higher. Thus, it is expected that pepper demand will increase faster than in western markets. Although most Southeast Asian countries are still struggling to recover from the

economic crisis that hit in December 1997, I assume optimistically that income levels will increase at an annual average of 3.5-4.5 percent toward 2020. The average income level of this region has already reached $3,500, so any further increase in purchasing power will result in people changing their dietary patterns, and consuming tastier foods: more animal products, vegetables, and spices. Per capita pepper consumption will reach somewhere between 88-100g by 2020. Furthermore, the population prospect is also strong and expected to grow at an annual average rate of 0.96-1.48 percent. The pepper demand in this region in 2020 will be 53,800-69,600 MT, up from 25,000 MT in 1995-97. The rate of the demand growth will be 3.39-4.56 percent per year. The rise of income level will create 56-64 percent of the new demand, and 36-44 percent will come from population growth.

The pepper demand from the retail sector in 2020 should be 30,000-37,800 MT, and the demand from the industrial sector should be 23,700-31,800 MT. The new demand from the retail sector should be 13,800-21,600 MT. However, most countries of this region produce pepper; thus, the new demand will be filled up by domestic production. There will not be much room for Indian pepper in this market.

South Asia

When people think of South Asian cuisine, they may imagine curry, and might assume that pepper is used often in the preparation of such spicy dishes. However, per capita pepper consumption in this region is only one-seventh of that in North America. Of course, South Asian cuisine uses a lot of pepper, as well as chillies, to cook the chicken or lamb if that is prepared in the wealthy Maharaja's house. However, most people in this region are so poor that most of them can eat only monotonous starchy staples with a small cup of curry. The income level in this region is *still* slightly above $1,600, and an increase in income level will simply bring an increased quantity of starchy staples, not meat. Hindu vegetarianism is also strong in rural areas and among poor people. However, based on my observation of what rich Hindus eat, I suspect that vegetarianism will decline as the Hindus become richer. Probably, by 2020, quite a few prosperous Hindus will still refuse to eat sacred cows, but will gladly eat chicken and mutton. Per capita pepper consumption will increase dramatically along with meat consumption, only if the income level increases much faster, and this is unlikely to happen soon. Population is expected to increase at an annual average rate of 1.22-1.68 percent, holding per capita income growth at probably 1.5-2.5 percent per year. Therefore, income levels in 2020 will still be somewhere between $2,300 to $2,900. At this level, per capita pepper consumption will be just 26-30g. The pepper demand of this market in 2020 will be 43,800-56,700 MT, up from 28,500 MT in 1995-97. The rate of expansion will be 1.89-3.03 percent per year. Population growth will be responsible for 68-75 percent of new demand, and 25-32 percent will result from income growth.

Most demand in South Asia will continue to come from the domestic Indian retail market. The pepper demand from the retail sector in 2020 should be 38,100-45,900 MT, while the demand from the industrial sector should be 5,800-10,800 MT. The new demand from the retail sector should be 11,600-19,400 MT, and will be filled by domestic Indian pepper.

Southwest Asia and North Africa

Per capita pepper consumption of this market is slightly higher than in Southeast Asia, although income levels are about the same. Meat dishes of this region generally use a lot of black pepper; for instance, grilled mutton on a stick, Kebab, is seasoned by rubbing the meat with salt

and coarsely ground black pepper, and Gyro, or Turkish sausage, also requires a large amount of black pepper for flavoring. Since income levels in this region are high enough to bring about dietary change, income growth will increase meat consumption, and therefore pepper consumption.

Since the economic prospects of this region depend heavily on petroleum exports, the world petroleum market must be examined briefly. In 1996's US dollar terms, the real prices of petroleum were stable at around $15 per barrel during 1950s, and gradually declined to $12/bl through the 1960s. Then in 1974, the first oil shock pushed oil prices to $20/bl, and the Iranian revolution in 1979 and the Iran-Iraq war beginning in 1980 kept pushing the oil prices higher. The real price of petroleum finally reached $54/bl in 1981, and fell as OPEC cut prices. By 1986, the oil prices returned to the range of $15-20/bl, and the Gulf War in 1990 pushed the oil prices up once again to $24/bl. During the 1990s, oil prices were on the down turn as Russia and the former Soviet Union's Central Asian countries, seeking hard currency, aggressively sold petroleum to the world market. The Asian economic crisis that started in December 1997 also contributed to the deterioration of petroleum prices, and in 1998 oil prices fell to around $12/bl. Oil prices recovered slightly after the April 1999 OPEC meeting, and by the time that the effects of this meeting start to erode, The East Asian countries will be recovering from their economic crisis and will keep oil prices high.

As strong economic growth toward 2020 is expected in East Asia and other developing countries, the Energy Information Administration (EIA) of the United States Department of Energy has estimated that world petroleum demand will grow at about two percent per year (EIA, 1999). The EIA estimates that the petroleum price in 2020 will be between $14/bl to $28/bl in 1996's dollar, but I estimate that it will be lower because petroleum production seems to be increasing faster than demand. Since the new pipelines of the Central Asian countries are expected to be completed by the early 2000s, petroleum exports from Central Asia will increase significantly by 2020 (Western Technology Research Group, 1998). On the demand side, in order to reduce the emission of greenhouse effect gas, diversification of energy sources will continue to replace petroleum with solar power, atomic energy, and so forth.

Neither very high petroleum prices, such as above $30/bl, nor very low prices, such as below $10/bl, would be sustainable. If the prices go very high, more money will be invested in the petroleum industry, which will enhance the development of new technologies for finding and extracting petroleum cheaply. Furthermore, consumers will shift to alternative sources of energy.

If the oil prices go very low, extracting petroleum from oil reserves outside the Persian Gulf will become unprofitable, and investment in alternative energy sources will decrease. Therefore, in the long run, the world petroleum prices through 2020 should be somewhere between $10/bl to $20/bl in 1996's dollar.

Considering the estimates of future petroleum prices and the economic performance of this region during the late 1980s, I assume that income levels of this region will grow at two to three percent per year. Thus, income levels in 2020 will be $5,700-7,200 and per capita pepper consumption will reach 60-70g. The population will increase at 1.97-2.41 percent per year, adding another 224-290 million people by 2020. Hence, the pepper demand in this region in 2020 will be 34,800-45,200 MT, up from 15,000 MT in 1995-97. The growth rate of the demand will be the fastest in the world: 3.73-4.91 percent per year. Income growth will contribute 34-35 percent of the new demand, and 65-66 percent will come from the population increase.

The pepper demand from the retail sector in 2020 should be 21,500-26,800 MT, while the demand from the industrial sector should be 13,300-18,500 MT. The new demand from the retail sector should be 11,100-16,300 MT, but this demand will not be for high quality pepper because the projected income levels of this region in 2020 is too low to expect consumers to have a preference for high quality pepper.

Sub-Saharan Africa

Since the income levels in this region are so low, per capita pepper consumption is also very limited. It may be that beyond the year 2020, this market will emerge as a significant pepper market. Apparently, there are no taboos regarding meat consumption, and local food is generally hot and spicy. In addition, a number of countries in both East and West Africa started producing pepper in the middle of 1980s, so pepper will soon become a more familiar seasoning. Therefore, this region has a good potential to become a significant market, but it will remain quiet for a while.

The population of this region is growing so fast that per capita income is actually declining in some countries. For instance, out of eight countries that recorded negative per capita income growth in this region during 1996-97, six countries had a positive economic growth at the national level (World Bank, 1999). Despite the heavy toll of AIDS in the region, the population is expected to continue to increase at 2.02-2.36 percent per year. I assume with hope that per capita income will not decline further, and will eventually reach an average 0.5-1.5 percent annual growth rate by 2020. If the debt cancellation scheme, which has been discussed among the industrialized Group of 7 with an aim to reach an agreement, is signed and actually implemented by the year 2000, the income levels of this region will grow even faster. I estimate that per capita pepper consumption will increase slightly to 10-12g by 2020. Since population growth is rapid, this small increase in per capita consumption leads to an annual average 2.5-3.69 percent expansion of pepper demand. The pepper demand in 2020 will be 9,700-12,600 MT, up from 5,500 MT in 1995-97. Population growth will contribute 78-91 percent of the new demand, and only 9-22 percent will come from income growth. The 4,200-7,100 MT of new demand will be entirely consumed in the retail sector. The income levels of this market in 2020 should remain below $2,000, and there will be no demand for high quality pepper.

Latin America

Per capita income of this region is as high as $7,000, but the level of pepper consumption is relatively low. This is because chillies are the predominant spice in Latin American cuisine, but this is likely to change to some extent as American fast food becomes popular among the younger generations. Now, many young Latin Americans prefer hamburgers to tacos, and their taste preference will be further westernized as their income level rises. I assume that income levels will grow at 2.5-3.5 percent per year, and income levels in 2020 will reach $12,300-$15,400. At such income levels, per capita pepper consumption in this region will be 40-50g. The pepper demand in 2020, therefore, will be 24,800-35,600 MT, up from 13,500 MT in 1995-97. The rate of the demand growth will be 2.69-4.3 percent per year. Income growth will contribute 49-50 percent of new demand, and 50-51 percent will come from the population expansion.

The pepper demand from the retail sector in 2020 should be 17,700-23,400 MT, while the demand from the industrial sector should be 7,100-12,200 MT. The new demand from the retail sector should be 6,500-12,100 MT, but it is doubtful that consumers of this market, who prefer

chillies as seasoning, will spend extra money for high quality pepper when they can buy cheap pepper from Brazil.

Oceania

Three-quarters of the population of this market live in either Australia or New Zealand, where both per capita income and pepper consumption are high. I assume that the income levels in this region will increase at 1.5-2.5 percent as in other developed countries. Per capita pepper consumption will be 115-140g if consumers in this region behave like those in other western countries. Population is expected to increase at 0.93-1.34 percent per year. The pepper demand in this region in 2020 will be 4,100-5,500 MT, up from 2,500 MT in 1995-97. The average annual growth rate of the demand will be 2.22-3.45 percent. Income growth will contribute 56-65 percent of the new demand, and 35-44 percent will come from the population increase.

The pepper demand from the retail sector in 2020 should be 2,200-2,800 MT, while the demand from the industrial sector should be 1,900-2,700 MT. The new demand from the retail sector should be only 800-1,400 MT. Since most of this region is prosperous, this new demand will include a place for high quality pepper.

Section D: High-end or Low-end market: which is more advantageous for India?

Pepper demand in 2020 as a whole should be 352,600-476,500 MT, up from 215,000 MT in 1995-97. Income growth should contribute 61-62 percent of the new demand, and 38-39 percent should result from population growth. Pepper demand should increase at an annual average 2.17-3.52 percent, which is about the same as or even faster than the growth rate from 1980-98. The difference is that about half of demand expansion took place in industrialized countries between 1980-1998, while roughly three-quarters of new demand by 2020 is expected to come from the developing countries.

Among the 352,600-476,500 MT of pepper in the world pepper market in 2020, more than half, 227,600-290,400 MT, should come from the retail sector. Most of demand will come from the developing countries where the income levels will not have reached the level at which consumers seek high quality pepper. Demand for high quality pepper in 2020 will come only from the retail sector in the North American, Western European, and Oceania markets, and will be 66,900-90,900 MT, up 17,000-41,000 MT from 49,900 MT in 1997.

On the other hand, the industrial sector and the retail sector in developing countries will increase the demand for low quality pepper. Demand for low quality pepper in 2020 will be 247,100-335,700 MT, up 107,000-195,600 MT from 140,100 MT in 1997 (excluding India). In addition, the demand from the Indian domestic market will expand to 38,600-49,900 MT, up 13,600-24,900 MT from 25,000 MT in 1997.

If India keeps producing high quality pepper and stays in the high-end market, the market potential for Indian pepper in 2020 will be 105,500-140,800 MT (high-end market 66,900-90,900 MT plus Indian domestic market 38,600-49,900 MT), up 30,600-65,900 MT from 74,900 MT in 1997. In the high-end market, India will face increasing competition from Sri Lanka and Indonesia. If the newly generated 17,000-41,000 MT demand for high-quality pepper is evenly divided among India, Indonesia, and Sri Lanka, India will gain 5,700-13,700 MT. With current

exports at 35,000 MT, and 38,600-49,900 MT of estimated demand from the domestic market in 2020, the market potential for Indian pepper toward 2020 is 79,300-98,600 MT.

On the other hand, if India starts producing low quality pepper and shifts to the low-end market, the market potential for Indian pepper in 2020 will be 285,700-385,600 MT (low-end market 247,100-335,700 MT plus Indian domestic market 38,600-49,900 MT), up 125,600-225,500 MT from 160,100 MT in 1997. If India switches from the high-end market to the low-end market, India will face competition from Vietnam. Brazil and Malaysia will keep their share of the current export markets, but they will not be able to capture the newly created segment of the low-end market in 2020, since production expansion in Brazil and Malaysia will be limited. If the newly generated 107,000-195,600 MT demand for low-quality pepper is evenly divided among India and Vietnam, India will gain 53,500-97,800 MT. Since 35,000 MT of Indian exports are currently directed to the high-end market, if India starts producing low quality pepper, India will lose 35,000 MT in the export market. With the newly captured 53,500-97,800 MT demand in the low-end market, and 38,600-49,900 MT of estimated demand from the domestic market in 2020, the market potential for Indian pepper toward 2020 is 92,100-147,700 MT.

This is 16-50 percent larger than the potential market share for Indian pepper in the high-end market. Although prices for low quality pepper are about ten percent lower than those for high quality pepper, the earning potential is still greater in the low-end market. However, the trade-off associated with changing the pepper production systems must be carefully analyzed before determining whether India should switch the primary target of its pepper exports to the low-end market from the high-end market.

CHAPTER FOUR
PEPPER CULTIVATION IN INDIA: HIGH PRICE OR HIGH YIELD

This chapter examine what changes must be made if India switches its primary target of pepper exports from the present high-end market to the low-end market, and analyzes what consequences would result from such changes. The traditional extensive system and the alternative intensive system are compared. There are three sections in this chapter. Section A investigates the rationale of the traditional extensive system. Section B analyzes the alternative intensive system. Possible consequences of replacing Murik with wooden stakes are discussed in the final section.

Section A: The Traditional Extensive Cultivation System

First, this section briefly discusses the nature of the 1998 Kerala Pepper Survey, the field survey carried out during the summer 1998 for this study. Second, the practice of mixed cropping and the use of live trees as support stands are revealed to be the reasons for India's low pepper yields. Finally, the reasons for mixed cropping are investigated.

The 1998 Kerala Pepper Survey

In order to collect detailed field data on pepper cultivation in India, I carried out the 1998 Kerala Pepper Survey in the Idukki district of Kerala from July to August 1998 (Figure 29). Idukki is the major pepper-producing district in Kerala, and Nedumkandam is a typical pepper-producing village in the district. Nedumkandam is located in the Cardamom Hills, a mountainous area with an elevation of 5,000 feet. As its name indicates, this is also a major cardamom production region. With high altitude and continuous rain, the temperature was in the upper teens in centigrade in the morning and evening, and in the lower 20s during the day. In the dry season, the daytime temperatures range in the upper 20s to mid 30s. Nedumkandam consists of several sub-districts scatted among surrounding mountains. Public jeeps run between sub-districts, and the commercial center is concentrated in one muddy street. Most houses have access to clean water and electricity, although power failure is an everyday phenomenon. Most adults of both sexes can read and write their language, Malayalam. The majority of the villagers are Christians. Agriculture is the major industry and most farmers cultivate pepper, coffee, and cardamom. The majority of farmers own less than a hectare as the result of land parcels having been split and passed down from one generation to the next.

I hired a young English teacher as an interpreter and research assistant. He is a pepper cultivator himself and thus helped me to improve the questionnaire. We interviewed a total of 120 pepper farmers. We walked through the village and knocked on the door of any house that had a pepper garden. Since we visited both relatively wealthy houses near the wide main street and less wealthy houses in remote areas, the samples of the survey should represent the typical pepper farm in Nedumkandam. Mono-cropped farms were, however, very rare in the area. We asked the local office of the Spices Board where we could find monocropped farms and went to these areas; in fact, we did find monocropped farms, but could obtain only five samples of this type of farm.

Most interviewed farmers welcomed us and were willing to talk to a rarely-seen Japanese; we were often offered a cup of coffee or tea, and even lunch. After being introduced to the farmer, I started asking the questions on the questionnaire. Most questions were intended to gather numerical data, but some questions were open-ended and qualitative. I was surprised to find that

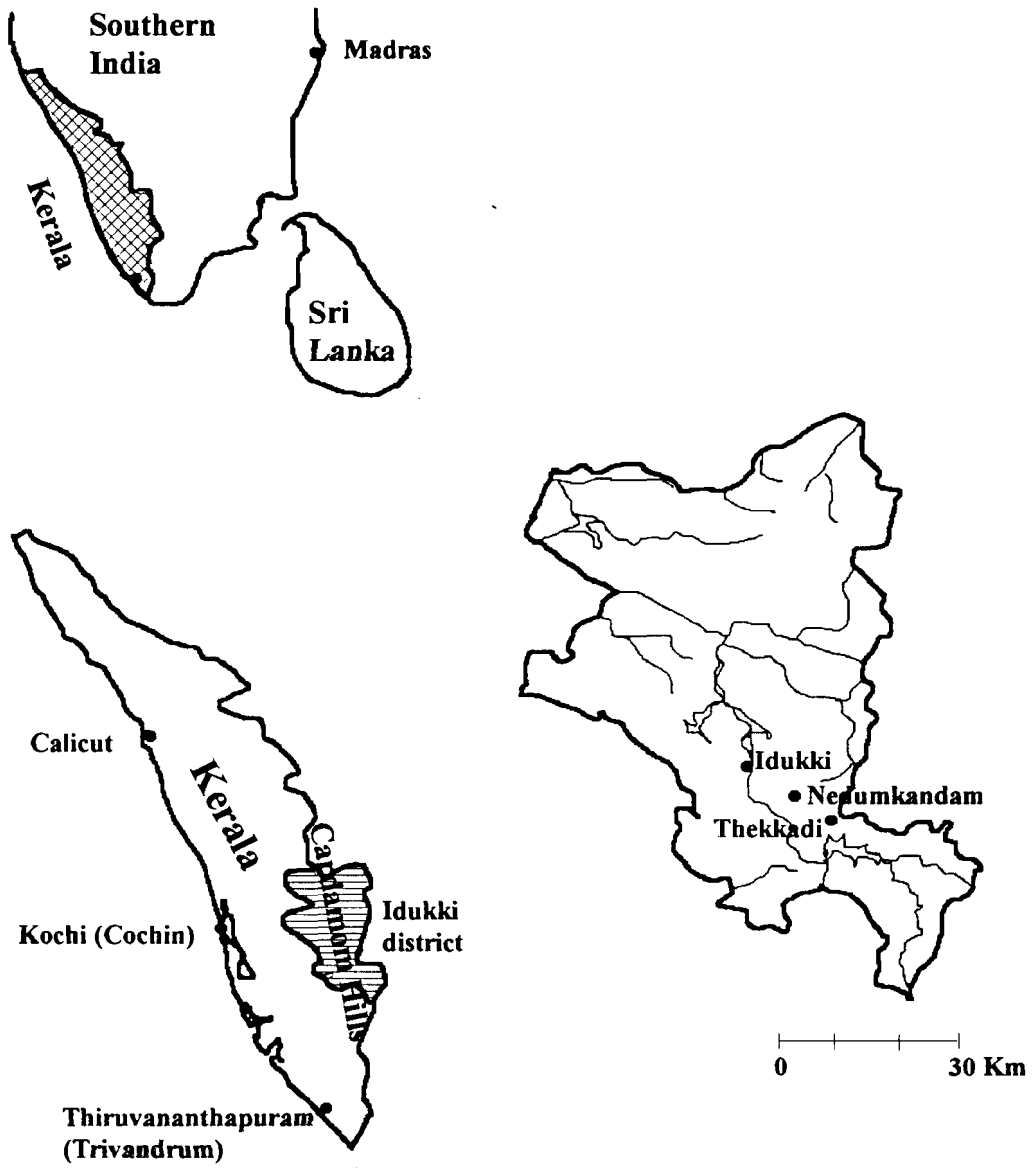


Figure 29. Map of Idukki District, Kerala, INDIA

most farmers know the size of their land and the number of plants in the field. Of course, the number was more precise for big plants like coconut trees than for smaller plants like pepper.

A possible weakness of the survey results is that farmers gave estimates when they were asked how many days were needed for certain kinds of work for each crop. Since many types of works are done simultaneously in mixed-cropped fields, farmers didn't know, for instance, exactly how much manure was applied for pepper and how much for coffee. Their estimates are, however, based on many years of experience on their own farms; therefore the survey results should be reasonably reliable.

A summary of collected data and the questionnaire of the 1998 Kerala Pepper Survey are provided in the Appendix.

Reasons for low yield

There are two main reasons for Indian pepper's low yield: mixed cropping and the use of live trees as support stands. Mixed cropping, which is the dominant form of pepper cultivation in India, can host fewer pepper vines per unit of land than mono cropping. Based on the results of the 1998 Kerala Pepper Survey, a typical mixed-cropped pepper farm has 1,227 various plants in one hectare, including 610 pepper plants.

In contrast, the other three major pepper producing countries grow pepper in monocropped fields. There are 1,100-2,500 pepper plants in one hectare of a monocropped field, depending on the spacing scales. For instance, some Brazilian pepper farmers plant pepper vines with very close spacing, 2m X 2m, and therefore around 2,500 pepper plants exist in one hectare (Toniolo and Uhl, 1995). In Indonesia, a typical spacing is 2.25m X 2.25m or 2.25m X 2.5m; thus one hectare of a monocropped field hosts 2,000-1,800 pepper plants (Harper, 1974). Therefore, the number of pepper plants in a mixed-cropped field is only one-third or even one-quarter of that in a monocropped farm.

In addition to the smaller number of pepper plants in a unit of land, the yield per pepper plant is also low in India. The 1998 Kerala Pepper Survey revealed that the Indian pepper yield per plant averages 506g in mixed-cropped farms. On the other hand, Malaysian pepper yield per plant was reported to be as high as 3,436g (Wong, 1985). This substantial gap comes from the amount of fertilizer applied and, more importantly, from the types of support stands used.

Non-living materials such as wooden stakes or concrete poles are used for support stands in Malaysia, Brazil, and parts of Indonesia, while live trees are used in India. The most commonly used tree is Murik (Erythrina Indica); other tall tree crops such as coconut and arecanut are also used as support stands for pepper. A number of experiments were conducted in Kerala to compare the yield of pepper grown on non-living stands and Murik, and it was found that yield is two to four times higher on non-living stands than Murik. For example, Menon, Nair, and Sharma (1982) carried out an experiment in Kerala to determine pepper yield differences that resulted when different types of support stands were used, and concluded that the yield of pepper on Murik was 439g per plant while the yield of pepper on a teak pole was 1,419g per plant. It was pointed out that when two or more crops share the same space, the suppression of yield was likely to be observed for one or all crops (Willey, 1979). Since the support tree itself needs soil moisture and nutrients for growth and survival, there must be competition between the support tree and the

pepper plant. Moreover, the development of pepper's root systems can be hampered because the pepper vine is planted only after Murik has firmly developed its roots.

Reasons for Murik use

Despite the fact that Murik competes with the pepper plant for soil moisture and nutrients and reduces the yield of pepper, more than 85 percent of support stands for pepper plants in India are Murik (the 1998 Kerala Pepper Survey). Murik grows well during the region's rainy season, but sheds leaves during the dry season; hence, it does not provide shade to the pepper vine when it is most needed (Menon, Nair, and Sharma, 1982). In addition, Murik has little timber value; it is simply burnt down after the pepper plant dies, and the ash is returned to the soil. It is difficult to consider Murik to be an important source of fuel wood since it cannot be harvested while the pepper plant is alive, which is about 20-25 years. Why, then, has this seemingly useless tree become the most commonly used pepper support stand in India?

The most commonly heard answer to this question during the 1998 Kerala Pepper Survey was the availability and ease of propagation. Murik can be propagated quite easily by cutting a straight branch and simply sticking it into the ground. Since most pepper farmers already have Murik trees in their farms, it does not cost anything.

Although no one pointed this fact out during the survey, Murik is a leguminous plant capable of fixing atmospheric nitrogen (Gotoh, 1998; Cheeran et al., 1992). This makes pepper cultivation in India sustainable without the application of fertilizer. Much of the nitrogen in the farm soil around the pepper plant circulates through Murik. Nitrogen is taken by Murik to build its trunk, branches, roots, and leaves. The leaves return to the soil every year, and the tree is also burnt down to return to the soil when the pepper plant dies. The amount of nitrogen removed from the soil in the form of black pepper is then added back by Murik's nitrogen fixation. The ability to maintain soil fertility with little inputs is certainly appealing for subsistence farmers. It seems that Indian pepper farmers have selected the most suitable tree for their pepper support stand through a series of experiments over the centuries.

These are all positive reasons for using Murik as a pepper support stand, but a passive reason also exists; that is, the tremendous setup costs associated with using wooden stakes. The support stands must be durable enough to survive decay for at least 15 years in a severe wet tropical environment. The most widely used ironwoods in Malaysia are Kulim (Siorodocarpus bomeesls), Tempenis (Strebus elongatus), and Chengal (Balanocarpus heimii); and in Brazil, Acapu (Unoa capousamericana). These trees are very heavy, durable, and relatively hard to find; thus, they are expensive. Therefore, the costs of wooden stakes constitute a considerable part of the initial setup costs, and significantly increase them. This barrier has prohibited poor Indian pepper farmers from using wooden stakes. In fact, during the 1998 Kerala Pepper Survey, I met a number of Kerala pepper farmers who had learned through their own experimentation that using wooden stakes as support stands improves pepper yield, but they said that the costs of wooden stakes made it prohibitive to pursue such an option. The details of the setup costs will be discussed in section C.

Reasons for mixed cropping

In Kerala, pepper is cultivated almost exclusively in mixed-cropped fields. A few pepper monocropped farms can be found, but they are mostly new farms in the beginning stage of

development. Once enough capital is accumulated from pepper cultivation, other crops will be added to the field in order to establish more complex mixed copping systems. The most commonly co-planted crops are coffee, coconut, arecanut, cardamom, and banana.

Output Maximization

There are two main approaches to explain the rationale behind mixed cropping; they are the profit maximization theory and the risk minimization theory. The profit maximization theory considers mixed cropping as a means for generating maximum profit from a limited set of resources. In this approach, it is believed that farmers intuitively allocate their limited resources, such as land, fertilizer, and labor, efficiently among the crops, and choose a set of crops that maximizes net returns (Ellis, 1993; Hopper, 1966). This hypothesis is not tested here, but it seems to be rather difficult for mixed-cropped pepper farmers to change the input allocation pattern and the ratio of crops in accordance with prices of crops and inputs in the market every year, since crops in the mixed-cropped farms are mostly perennial. In addition, changing the ratio of crops is unlikely because large initial investments are required for perennial crops. Moreover, Indian pepper farms are extensive; thus, fertilizers and plant protection chemicals are not applied regardless of the market prices. In fact, the field survey conducted by George, Nair, and Pushpangadan (1989) indicates that about 72 percent of pepper farmers in Kerala were not aware of pepper price changes. This indicates that Indian pepper farmers are not likely to change their cultivation pattern on the basis of price changes. The profit maximization theory appears to be untenable in Indian pepper mixed-cropped farms.

Risk Minimization

On the other hand, the risk minimization theory sees mixed cropping as a farming practice designed to increase food security rather than to maximize profit (Ellis, 1993; Lipton, 1968). A subsistence farmer diversifies his sources of income through mixed cropping in order to avoid severe swings of net returns and especially a fatal shortage of income. A bad year or two won't ruin the life of a farmer in a wealthy country, but it can easily destroy the life of a subsistence farmer in a poor country. Income shortage is so threatening to a poor farmer that he chooses a subsistent but stable mixed cropping system over a more profitable but volatile mono cropping system.

Since Indian pepper farmers are poor and face the income volatility associated with many types of uncertainty, this claim appears to be tenable. Natural hazards such as outbreaks of disease or pests, droughts, and cyclones hit often without warning, and destroy harvests. Fluctuations in supply, accompanied by fluctuations in demand, create price uncertainty. In fact, various statistics in Kerala indicate that prices of most crops in mixed-cropped farms were volatile from 1984 to 1998. For example, real coffee prices in 1986 were 65 percent higher than the average of 1984-1998, and 57 percent lower in 1992; real arecanut prices were 18.6 percent higher in 1992, and 33.9 percent lower in 1989 (Figure 30).

Yields of many crops in the mixed-cropped fields were also volatile during the same period. Since available yield figures for Kerala agriculture cover the entire state, large-scale plantations, as well as small-scale mixed-cropped farms, are included; thus, they are not comparable with figures from the 1998 Kerala Pepper Survey, which excludes large-scale plantations. In order to estimate yield figures in mixed cropping farms for the period of 1984-1997, yield figures for each crop for the whole state of Kerala were first indexed as ratios to the

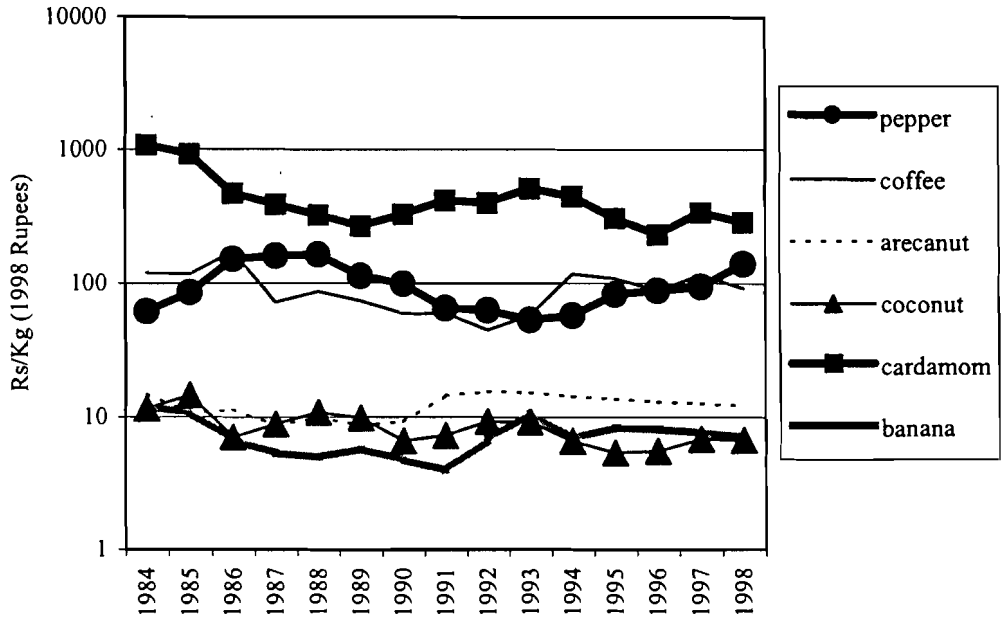


Figure 30-a. Real Price Changes Of Crops Grown In The Mixed Cropping Farms In Kerala, 1984-1998 (Logarithmic Vertical Scale)

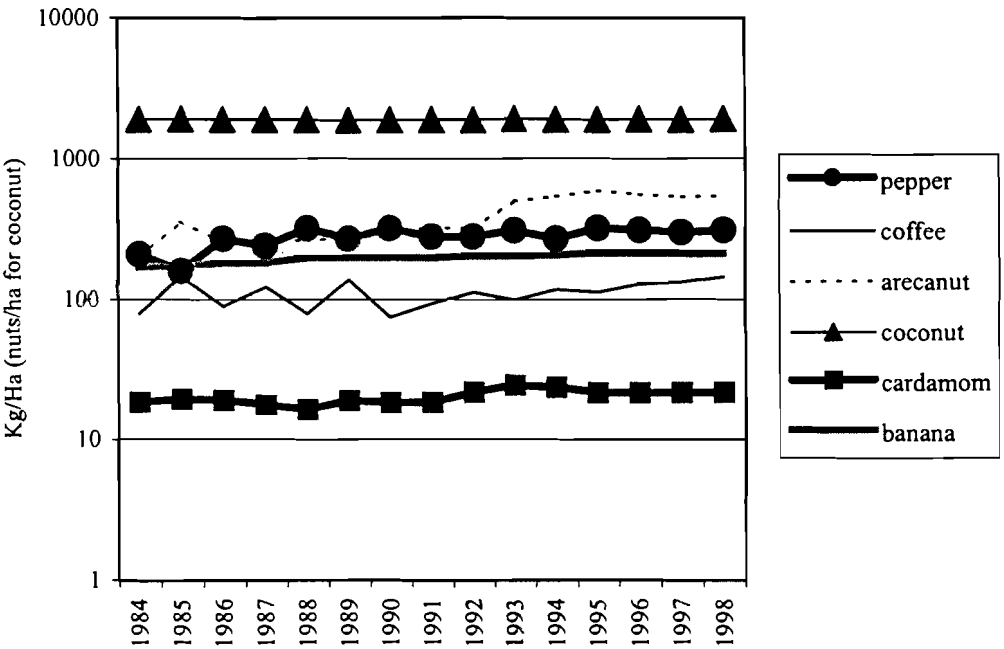


Figure 30-b. Yield changes Of Crops Grown In The Mixed Cropping Farms In Kerala, 1984-1998 (Logarithmic Vartical Scale)

Sources: Appendix Table 1 and 2

figures for 1998. Then, yield figures in mixed-cropped farms during 1984-1997 were derived from actual yield figures for 1998 from the 1998 Kerala Pepper Survey. Since weather conditions influence crop yield in large-scale plantations and small-scale mixed-cropped farms equally, estimated yield figures for mixed cropping farms should be within a reasonable range. The yield of coffee in 1985 was 30.4 percent higher than the average of 1984-1998, and 32.9 percent lower in 1990; the yield of arecanut was 51.4 percent higher in 1995, and 48.3 percent lower in 1984.

Also, since the 1998 Kerala Pepper Survey indicates that pepper yield per plant in mono cropping in 1998 was 23 percent higher than that in mixed cropping, this rate was incorporated when the yield figures for mono cropping for 1984-1998 were calculated. The reason for a higher yield per plant in mono cropping is related to the spacing. There are, on average, 1,160 pepper plants in one hectare of a monocropped farm in Kerala, while a mixed-cropped farm of the same size has 1,227 plants of all kinds of crops, including 38 coconut trees, one of which occupies a space four times larger than that occupied by a pepper plant. The competition among crops for light, soil moisture, and nutrients must therefore be more severe in a mixed-cropped farm than in a monocropped farm.

In order to see how incomes in pepper monocropped and mixed-cropped farms have changed during the 15-year-long period from 1984 to 1998, the production cost of each crop in mixed-cropped fields is calculated from the 1998 Kerala Pepper Survey (Table 4). Based on the figures in Table 4, production cost per hectare of mono- and mixed-cropped farm is derived (Table 5). The gross revenues from one hectare of mono- and mixed-cropped fields were also computed from the yield and price figures used in Figure 30. The detailed calculations of the gross revenues were provided in Appendix Table 3 and 4. Then, net returns from one hectare of mono- and mixed-cropped farms were derived by subtracting annual production cost from the gross revenue (Table 6). Figure 31 shows how net returns from mono- and mixed-cropped pepper farms have changed from 1984 to 1998. Figure 31 clearly shows that mixed cropping provides a more stable flow of income than mono cropping. Standard deviations of net return from mono cropping and mixed cropping are Rs. 28,105 and Rs. 11,231, respectively. Furthermore, Indian pepper farmers have selected crops, the prices of which are not likely to fall together with other crops. For example, according to the real price data from Appendix Table 1, real prices of pepper and coffee are only weakly related, and the correlation coefficient is 0.217. Real prices of other crops in the mixed-cropped farms are in fact negatively related to real prices of pepper; this indicates that prices of co-planted crops are likely to move upward when pepper prices fall. Correlation coefficients between real prices of pepper and other crops, namely arecanut, coconut, cardamom, and banana, are -0.768, -0.001, -0.345, and -0.463, respectively.

When both price and yield of a particular crop hit the bottom at the same time, and a farmer is dependent on only one type of crop, the possibility of suffering from a fatal income shortage is quite high. For instance, price and yield of pepper were lowest in 1993 and 1985, respectively, but if both events had happened in the same year, the net return from one hectare of a pepper monocropped farm would have been negative Rs. 4,729. On the other hand, if the combination of the lowest price and the lowest yield had happened in all crops in a mixed cropping farm, the net return would have still been positive Rs. 1,845. Moreover, the chance that such a worst-case scenario would occur is much smaller in a mixed-cropped farm than in a monocropped farm. Therefore, mixed cropping is superior to mono cropping in terms of disaster avoidance.

It is often pointed out that there is a trade-off between stability and profitability in mixed cropping. However, the average of the imputed net return from 1984 to 1998 is higher in mixed

Table 4. The 1998 Kerala Pepper Survey: Cultivation Cost Per Plant in Kerala in 1998 Rupees, Selected Crops

	Pepper (Murik)	Coffee	Arecanut	Coconut	Cardamom	Banana
Initial cost						
support stand	2.96	0	0	0	0	0
planting stand	4	0	0	0	0	0
seedling	3.14	2.05	14.2	17.82	3	0
planting seedling	2.65	7.85	18.27	32.31	8.17	11.27
total initial cost	12.75	9.9	32.47	50.13	11.17	11.27
economic lifetime (years)	20	20	60	60	15	1
Amortized initial cost	0.64	0.50	0.54	0.84	0.74	11.27
Operational cost						
cow dung	2.37	2.35	4.86	4.9	2.33	0
fetilizer	0.05	0.08	0.11	4.69	1.39	0.08
protection chemicals	0.09	0.11	3.19	0.65	1.44	0
appliyting cow dung	1.88	1.86	3.33	6.75	1.72	0
applying fertilizer	0.02	0.03	0.22	2.76	1.53	0.06
sprying chemicals	0.02	0.09	1.74	0.56	1.45	0
pruning stand	2.97	0	0	0	0	0
pruning crop	1.8	4.27	0	0	4.21	0
harvesting/processing	8.79	7.38	7.74	9.51	8.12	3.12
miscellaneous	2.56	2.31	2.73	5.39	2.39	1.19
Total operational cost	20.55	18.48	23.92	35.21	24.58	4.45
Annual cost	21.19	18.98	24.46	36.05	25.32	15.72

Note: Annual cost = Amortized initial cost + Operational cost

Source: the 1998 Kerala Pepper Survey

Table 5. The 1998 Kerala Pepper Survey: Annual Cost Per Hectare of Mono- and Mixed-Cropped Farm Using Murik

	Mono cropping	Mixed cropping						
	Pepper (mono)	Total	Pepper (mixed)	Coffee	Arecanut	Coconut	Cardamom	Banana
Number of plants per hectare	1,160	1,227	610	320	108	38	90	61
Initial cost per hectare	14,790	18,050	7,778	3,168	3,507	1,905	1,005	687
Operational cost per hectare	23,838	24,854	12,536	5,914	2,583	1,338	2,212	271
Annual cost per hectare	24,578	26,246	12,924	6,072	2,642	1,370	2,279	959

Sources: The 1998 Kerala Pepper Survey, and Table 4

Table 6. The 1998 Kerala Pepper Survey: Imputed Net Return Per Hectare of Mono- and Mixed-Cropped Farm Using Murik

	Mono cropping			Mixed cropping		
	revenue Rs/ha	annual cost Rs/ha	net return Rs/ha	revenue Rs/ha	annual cost Rs/ha	net return Rs/ha
1984	30,053	24,578	5,475	69,099	26,246	42,853
1985	31,795	24,578	7,217	81,786	26,246	55,540
1986	95,083	24,578	70,506	82,089	26,246	55,843
1987	89,123	24,578	64,545	73,739	26,246	47,493
1988	121,504	24,578	96,927	87,999	26,246	61,753
1989	71,130	24,578	46,552	67,529	26,246	41,283
1990	74,265	24,578	49,687	58,296	26,246	32,050
1991	42,572	24,578	17,995	50,464	26,246	24,218
1992	40,975	24,578	16,398	54,826	26,246	28,580
1993	38,465	24,578	13,887	61,820	26,246	35,574
1994	35,980	24,578	11,402	60,979	26,246	34,733
1995	61,238	24,578	36,661	64,706	26,246	38,460
1996	63,531	24,578	38,954	62,768	26,246	36,522
1997	66,123	24,578	41,546	72,020	26,246	45,774
1998	101,013	24,578	76,435	83,320	26,246	57,074
Average	64,190	24,578	39,612	68,763	26,246	42,517

Sources: Table 5, Appendix Table 3, and Appendix Table 4

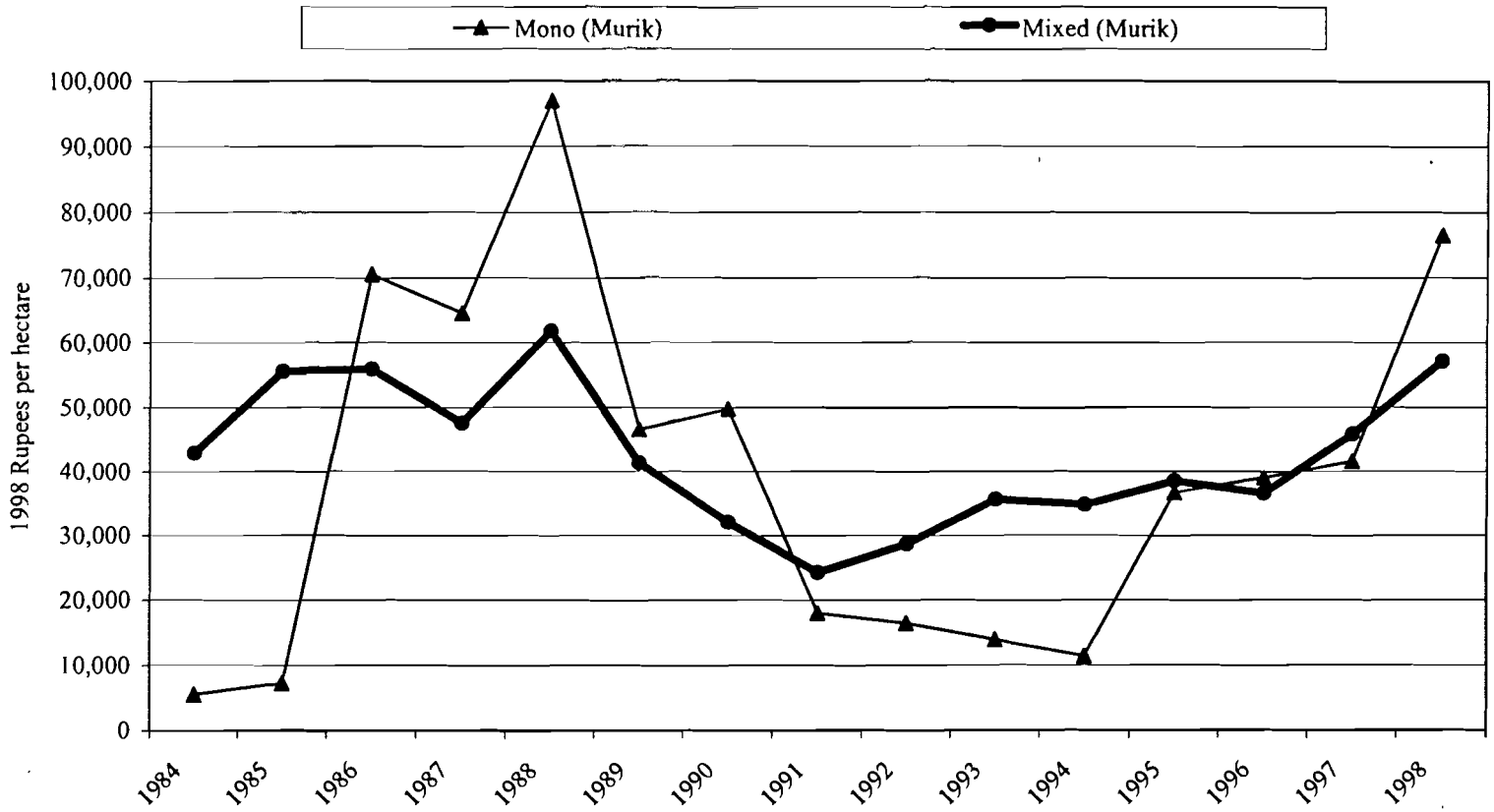


Figure 31. 1998 Kerala Pepper Survey: Imputed Net Return Per Hectare Of Mono And Mixed Cropped Pepper Farms, Adjusted To Inflation (1998 Rupees)

Sources: Table 6

cropping than in mono cropping (Figure 32). The average net return of mono cropping is Rs. 39,612, while that of mixed cropping is Rs. 42,517, or 7.3 percent higher than mono cropping. The data provides statistically sufficient evidence to support the conclusion that the average net return in mixed cropping is higher than mono cropping at a 95 percent confidence level. Therefore, pepper mixed cropping simultaneously brings a more stable flow of income and a higher average net return than pepper mono cropping. No wonder pepper mono cropping does not exist in Kerala!

Section B: The Alternative Intensive Cultivation System

Over the centuries, Indian pepper farmers have developed the most stable and profitable combination of crops in mixed-cropped fields. If Indian pepper farmers employ mixed cropping to minimize risk as well as to maximize profit, then why is mono cropping dominant in other major pepper producing countries? This section investigates the alternative intensive cultivation system.

Profitability difference related to the types of support stand

Because Indian pepper yield per plant is low, pepper is not particularly more profitable than any other crop in a mixed-cropped field. Indian pepper yields per plant, however, could be increased by two to four times if live trees were replaced by non-living material, such as wooden stakes. Therefore, if wooden stakes were used as support stands, it is possible that pepper would become so profitable that mono cropping of pepper would generate a higher profit than any combination of crops in mixed cropping.

Although estimates of how much yield per plant increases by using wooden stakes vary from experiment to experiment, most results are in the range of a 2-4 fold increase (Cheeran et al., 1992; Menon et al., 1982). Therefore, for the purpose of comparing average net returns, I take the middle figure and assume that per plant yields increase three times when Murik are replaced by wooden stakes. Since it is impossible to replace the support stand during a pepper plant's lifetime, the wooden stake must be very durable in a humid and warm environment, and must last for at least 15 years. Wooden stakes used in Malaysia and Brazil are made from so-called "ironwood", which is heavier and harder than teak and very durable. Since using wooden stakes as pepper support stands is not a common practice in Kerala, it is difficult to determine how much such wooden stakes would cost there. Interviews with lumber makers in the Idukki district suggested that one hardwood stake, 3.5m long and 5cm in diameter, would cost between Rs. 50 to Rs. 70. Thus, taking the median figure, I assume that one wooden stake would cost Rs. 60 in Kerala (Table 7). In addition, since planting a wooden stake requires digging a large hole, an additional labor charge must be taken into account. In Malaysia, it takes eight hours for a man to plant about 14 stakes (Wong, 1985). Since eight hours of labor is valued at about Rs. 100 in Kerala, I estimate that the labor charge for planting one stake would be roughly Rs.7 (Table 7).

In extensive pepper cultivation, a pepper plant can be harvested for as long as 25 years and more. The economic lifetime of pepper plant, however, is considered to be about 20 years because yield declines significantly thereafter. Meanwhile, in intensive pepper cultivation, pepper's productive lifetime is shorter and to be around 15 years due to a high level of stress to the plant (Pruthi, 1993; Gotoh, 1983; Purseglove et al, 1981). Therefore, I assume that pepper's productive life ends in the fifteenth year after planting if a wooden stake is used as a support stand (Table 7).

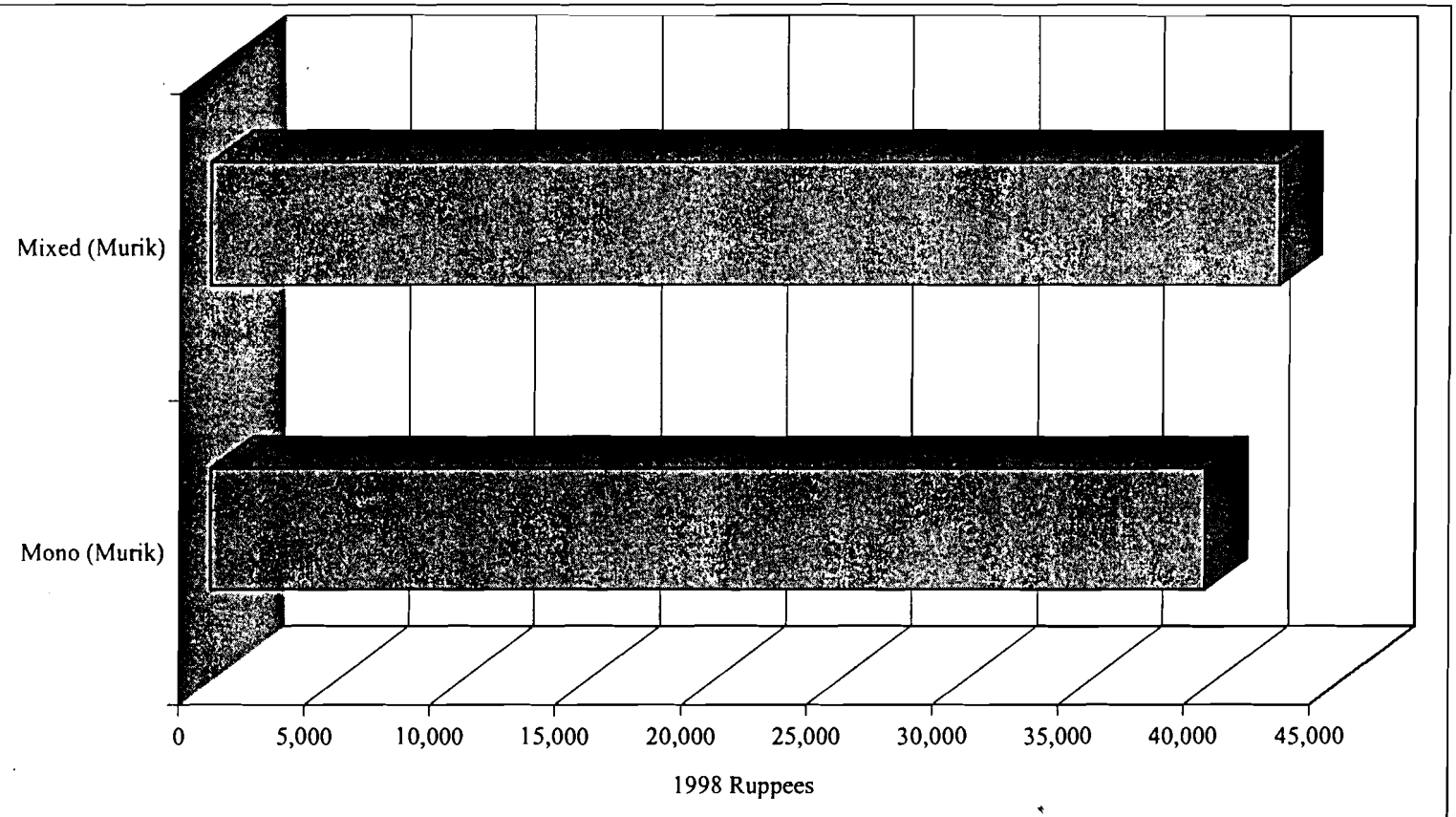


Figure 32. 1998 Kerala Pepper Survey, Imputed Net Return Per Hectare of Mono And Mixed Cropped Pepper Field, The Average for 1984-1998

Sources: Table 6

Table 7. Changes In Costs Per Pepper Plant If Murik Is Replaced With A Wooden Stake

	Pepper (Murik)	Pepper (Stake)
Initial cost		
support stand	2.96	60.00
pepper cutting	3.14	3.14
planting stand	4.00	7.00
planting pepper	2.65	2.65
Total Initial costs	12.75	72.79
economic lifetime (years)	20.00	15.00
Amortized initial costs	0.64	4.85
Operational cost		
cow dung	2.37	0.00
fertilizer	0.05	13.00
protection chemicals	0.09	0.09
applying cow dung	1.88	0.00
applying fertilizer	0.02	2.50
sprying chemicals	0.02	0.02
pruning stand	2.97	0.00
pruning pepper	1.80	1.80
harvesting/processing	8.79	25.00
miscellaneous	2.56	2.56
Total operational costs	20.55	44.97
Annual cost	21.19	49.82

Note: Annual cost = Amortized Initial cost + Operational cost

Assumptions: If wooden stakes are used,

The yield of pepper increases three times per plant
Economic lifespan is shortened to 15 years
One wooden stake costs Rs. 60.
Planting 14 stakes takes one man-day (Rs. 100): Rs. 7 per stake
Farmers will switch from cow dung to fertilizer
Fertilizer costs Rs. 6.5 per kilogram
One pepper plant needs 2 kg of fertilizer
Applying fertilizer to 40 pepper plants takes one man-day: Rs. 2.5 per plant
Pruning Murik branches becomes unnecessary
Harvesting/processing peppercorns from 4 stands takes
one man-day: Rs. 25 per plant

Source: Table 4

Moreover, as the next section will discuss in detail, the operational cost per pepper plant increases when wooden stakes are used as support stands due to an increased dosage of fertilizer. In intensive pepper monocropped farms in Malaysia, 2 kg of fertilizer is applied for each pepper plant (Gotoh, 1983). If Indian farmers follow this practice, Rs. 13 per plant must be added to the operational cost, since fertilizer costs about Rs. 6.5 per kilogram in Kerala (Table 7). In addition to the fertilizer itself, the labor charge for applying fertilizer must be also taken into account. In Malaysia, one man-day is required to apply fertilizer to 40 pepper plants; hence, if the same labor time is required in Kerala, applying fertilizer would cost Rs. 2.5 per plant (Table 7).

Furthermore, since the use of wooden stakes increases yield three times, harvesting and processing would take more time. It would not, however, take three times longer. Since Indian farmers allow Murik and pepper to grow much taller than a man's height, they need a ladder when they harvest; it takes time to move this ladder between pepper plants. On the other hand, Malaysian farmers limit the height of stakes so that they can harvest without using a ladder. Harvesting pepper is very labor-intensive work; in Malaysia, harvesting and processing 800 pepper vines takes 200 man-days, or 0.25 man-day per plant. Therefore, I assume that harvesting and processing would cost Rs. 25 per plant in India if wooden stakes were used (Table 7).

Not every cost would increase if Murik were replaced by wooden stakes. Pruning support trees would become unnecessary. Indian farmers presently spend 2.97 man-days per 100 stands to prune the branches of Murik; thus, Rs. 2.97 should be subtracted from operational costs (Table 7). In addition, the cost of applying cow dung would disappear. A pepper plant on a wooden stake requires 2kg of chemical fertilizer, which contains 13 percent or 260g nitrogen. If this amount of nitrogen is obtained from cow dung, which contains nitrogen in the proportion of only 0.5 percent of weight, as much as 52kg of cow dung is needed per plant (Surendran and Krishnan, 1982). Since applying such a large quantity of cow dung requires too much labor, Indian farmers would have to switch from cow dung to chemical fertilizer. Currently only 835.6g of cow dung, or about 4g of nitrogen, is applied per pepper plant in Kerala. Cow dung costs Rs. 2.84 per kilogram and application takes about nine minutes, or Rs. 1.88 per plant. Therefore, when wooden stakes are used, Rs. 4.72 (Rs. 2.84 plus Rs. 1.88) has to be subtracted from the operational cost per pepper plant on Murik (Table 7).

In order to see how incomes in pepper mono- and mixed-cropped farms in Kerala could have changed during the 15-year-long period from 1984 to 1998 if wooden stakes had been used as support stands, the above assumptions are applied to the production cost of pepper in Table 4, and the production cost per hectare of mono- and mixed-cropped farms using wooden stakes are calculated (Table 8). Since pepper grown on wooden stakes is less pungent and less flavorful, this low quality pepper is cheaper than pepper grown on Murik. Therefore, if India starts producing pepper on wooden stakes, Indian pepper would command lower prices. To incorporate this fact in to the analysis, the yearly average prices of Malaysian and Brazilian pepper from 1984 to 1998 are used as the price figures instead of Indian pepper prices. Then, the gross revenues from one hectare of mono- and mixed-cropped farms using wooden stakes are imputed under the assumption of three times higher pepper yield per plant (Table 9). The detailed calculations are provided in Appendix Table 5 and 6. The net returns from mono- and mixed-cropped farms are imputed by subtracting the production costs per hectare from the gross revenues, and the changes of the net returns from 1984 to 1998 are shown in Figure 33. It is now obvious that both mono and mixed cropping using wooden stakes generate higher net returns than mixed cropping using Murik.

Table 8. Imputed Annual Cost Per Hectare of Mono- and Mixed-Cropped Farm Using Wooden Stakes

	Mono cropping Pepper (mono)	Mixed cropping Total	Pepper (mixed)	Coffee	Arecanut	Coconut	Cardamom	Banana
Number of plants per hectare	1,160	1,227	610	320	108	38	90	61
Initial cost per hectare	84,436	54,674	44,402	3,168	3,507	1,905	1,005	687
Operational cost per hectare	52,165	39,750	27,432	5,914	2,583	1,338	2,212	271
Annual cost per hectare	57,794	43,714	30,392	6,072	2,642	1,370	2,279	959

Sources: The 1998 Kerala Pepper Survey, Table 4 and 7

Table 9. Imputed Net Return Per Hectare of Mono- and Mixed-Cropped Farm Using Wooden Stakes

	Mono cropping			Mixed cropping		
	revenue	annual cost	net return	revenue	annual cost	net return
	Rs/ha	Rs/ha	Rs/ha	Rs/ha	Rs/ha	Rs/ha
1984	89,419	57,794	31,625	94,496	43,714	50,782
1985	79,513	57,794	21,719	102,199	43,714	58,486
1986	310,865	57,794	253,071	174,398	43,714	130,685
1987	259,588	57,794	201,794	146,663	43,714	102,949
1988	294,891	57,794	237,096	162,172	43,714	118,459
1989	169,281	57,794	111,487	109,518	43,714	65,804
1990	165,692	57,794	107,898	97,408	43,714	53,694
1991	87,077	57,794	29,283	69,503	43,714	25,789
1992	98,341	57,794	40,546	79,367	43,714	35,653
1993	114,391	57,794	56,597	94,300	43,714	50,587
1994	100,492	57,794	42,698	88,577	43,714	44,863
1995	171,387	57,794	113,593	111,827	43,714	68,113
1996	178,776	57,794	120,982	112,069	43,714	68,355
1997	180,139	57,794	122,345	120,795	43,714	77,082
1998	237,855	57,794	180,061	141,860	43,714	98,146
Average	169,180	57,794	111,386	113,677	43,714	69,963

Assumption: Pepper yield increases three times when Murik is replaced with a wooden stake
Source: Table 8, Appendix table 5, and Appendix Table 6

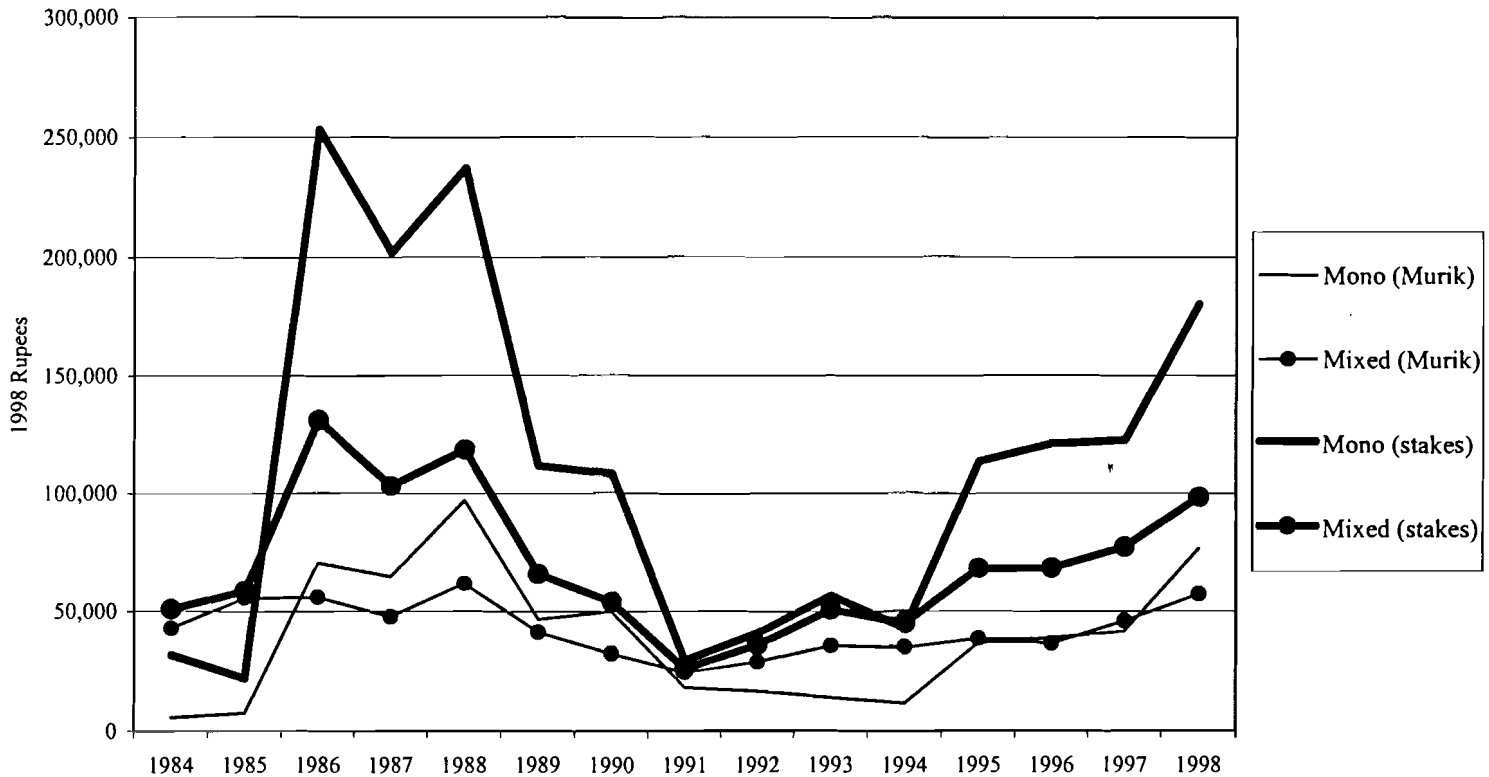


Figure 33. 1998 Kerala Pepper Survey: Imputed Net Return Per Hectare Of Mono And Mixed Cropped Pepper Farms If Wooden Stakes Were Used As Support Stands

Sources: Table 6 and 9

Figure 34 shows the differences of average net returns per hectare of mono- and mixed-cropped pepper fields when wooden stakes are used. It also shows average net returns when Murik is used. When Murik is used as the support stand, mixed cropping has a higher average net return than mono cropping, while when wooden stakes are used, mono cropping outperforms mixed cropping by about 60 percent. Since a monocropped field has more pepper plants than a mixed-cropped field, an improvement of profitability per pepper plant influences mono cropping with greater magnitude. The average of the imputed net return per hectare of a mixed-cropped farm is Rs. 69,963, while that of a monocropped farm is Rs. 111,386.

Standard deviations of net returns from pepper mono and mixed cropping are Rs. 76,940, and Rs. 30,347, respectively. This implies that a trade-off between stability and profitability, which does not exist when Murik is used, does exist when wooden stakes are used. If Indian pepper farmers were to use wooden stakes instead of Murik, should they employ the riskier but more profitable mono cropping or the less profitable but more stable mixed cropping? In order to determine which cultivation method is more suitable for Indian pepper farmers, the worst-case scenario must be examined.

Between 1984 and 1998, pepper yields in Kerala were lowest in 1985, and prices for low quality pepper were at their lowest point in 1991. What if these two events had happened at the same time? In the previous section, the net return per hectare of a pepper monocropped farm using Murik in such a worst-case scenario was calculated to be negative Rs. 4,729; the net return of mono cropping using wooden stakes in the worst-case scenario turns out to be negative Rs. 8,079. According to the 1998 Kerala Pepper Survey, the average size of a pepper farm in Kerala is 0.77 hectare; thus, the net return from a typical size pepper monocropped field using wooden stakes in the worst case scenario is negative Rs. 6,221. However, the likelihood of the worst-case scenario actually occurring is very small, and the average expected net return is quite high if wooden stakes are used; thus, even small pepper monocropped farms could save and survive the worst-case scenario. As the size of the farm becomes larger, the profit (or loss) becomes larger proportionately, but family consumption is likely to increase at the slower pace. Therefore, the threat of the worst-case scenario is less severe for the larger farms. The average size of a pepper farm in the other major pepper producing countries is much larger than in India, and thus, pepper farmers in other major pepper producing countries can take the risk and enjoy the higher net returns. For instance, the average size of a Brazilian pepper farm is 3.5-5.0 hectare (Toniolo and Uhl, 1995). As long as the risk of severe income shortage exists in the worst-case scenario, small-scale Indian pepper farmers will never and indeed should not shift from mixed cropping to mono cropping.

Since Indonesian pepper farmers use Murik (called Dadap in Indonesia) as support stands, the cultivation method that generates higher net returns should be mixed cropping. However, both mono and mixed cropping exist in Indonesia. Most pepper monocropped farms are relatively large, and most small farms employ mixed cropping. This indicates that smaller farms are seeking security rather than profitability, while larger farms are taking risks and seeking higher profits. The reason why the trade-off between security and profit exists in Indonesia but does not in India is that some crops in Indian mixed-cropped farms cannot be grown or are less profitable in Indonesia. In fact, Indonesian pepper producing areas cannot produce cardamom, which is widely co-planted with pepper in Kerala. Moreover, the average coconut price from 1993-1995 was about 17 percent of the average pepper prices in India, while in Indonesia, the average price of coconut was only 7 percent of the average pepper price.

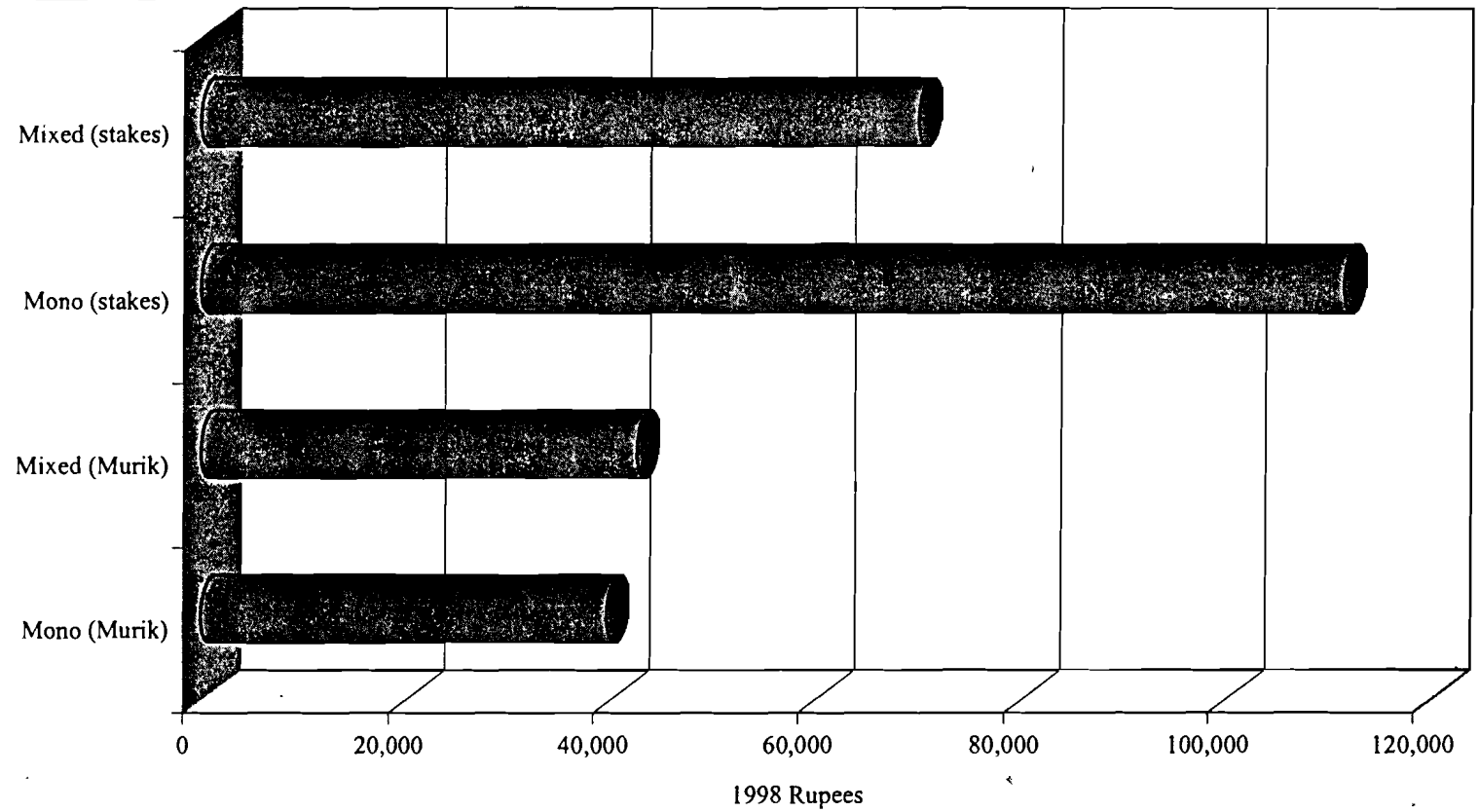


Figure 34. 1998 Kerala Pepper Survey: The Average of Imputed Net Return Per Hectare of Mono and Mixed Cropped Pepper Farms If Stakes Were Used As Support Stands

Sources: Table 6 and 9

Section C: Possible consequences of replacing Murik with wooden stakes

The possible consequences of replacing Murik with wooden stakes should be analyzed before determining whether such change is worthwhile. Since the wooden stake does not enhance pepper's pungency, it should be noted that Indian pepper will lose its reputation as the world's highest quality pepper if pepper plants are grown using wooden support stands. Indian exports to the retail sector may decrease due to flavor deterioration, but the price premium on Indian pepper will vanish, and Indian exports to the much more promising food processing sector could expand.

Per plant production cost would also be reduced significantly if wooden stakes were used. In India, the annual production cost of pepper is Rs. 42 per kilogram in a mixed-cropped farm using Murik; it would be reduced to Rs. 27 per kilogram if pepper is grown in monocropping using wooden stakes.

Since there is a risk of income shortage under monocropping, some sort of safety-net must be provided for the small-scale farmers. Crop insurance is a way to prevent a severe income shortage, but crop insurance for pepper does not exist in Kerala. The government of India started an experimental crop insurance scheme in 1972, and the latest version, the comprehensive scheme, was implemented in 1985. The Indian crop insurance scheme covers only five crops: rice, wheat, millet, pulses, and oil-seeds. This crop insurance plan covers yield fluctuations caused by unfavorable weather and the outbreak of pests and disease, but does not cover price fluctuation (FAO, 1988). Pepper prices fluctuate significantly, thus, if the prices are at a peak, a small harvest does not necessary lead to an income shortage. Therefore, if the Indian government establishes crop insurance for pepper, a combination of both yield and price should be used to determine the cut-off line at which indemnity is paid. If crop insurance becomes available to small-scale pepper farmers, this insurance can also provide additional collateral for bank loans.

The setup cost of a monocropped pepper farm using wooden stakes is tremendous. Figure 35 shows the imputed initial costs to setup one hectare of mono- and mixed-cropped pepper farms using wooden stakes in India. Initial investments required to set up one hectare of mono- and mixed-cropped pepper farms using wooden stakes are Rs. 86,908, and Rs. 57,146, respectively. These are roughly four and three times larger than the initial investments required to set up a mixed-cropped farm using Murik.

Indeed, set-up costs are high if wooden stakes are used; however, if spread throughout the pepper plant's economic life, the annual cost should be affordable. Since usage of wooden stakes as support stands increases yields significantly, a small increase in annual costs should not be a major problem. However, in the rural areas of Kerala, it is difficult for poor farmers to borrow a considerable sum of money for an extended period.

Table 10, based on the 1998 Kerala Pepper Survey, shows the pepper farmers' borrowing situations in Kerala. Fewer than ten percent of pepper farmers have taken out long-term loans in the past ten years. The average amount borrowed per hectare is about Rs. 30,000. All long-term loans are made by either commercial banks or the land and mortgage bank, and land ownership is required as collateral in all cases. Since the traditional mixed-cropped farm produces only Rs. 43,000 annually, banks may not be willing to accept such property as collateral for a long-term loan of the Rs. 87,000 required to establish a one-hectare monocropped field using wooden stakes. If such a loan were made, however, the same one hectare of land could produce Rs. 111,000 annually. Despite this huge potential, if private commercial banks are not willing to lend, public

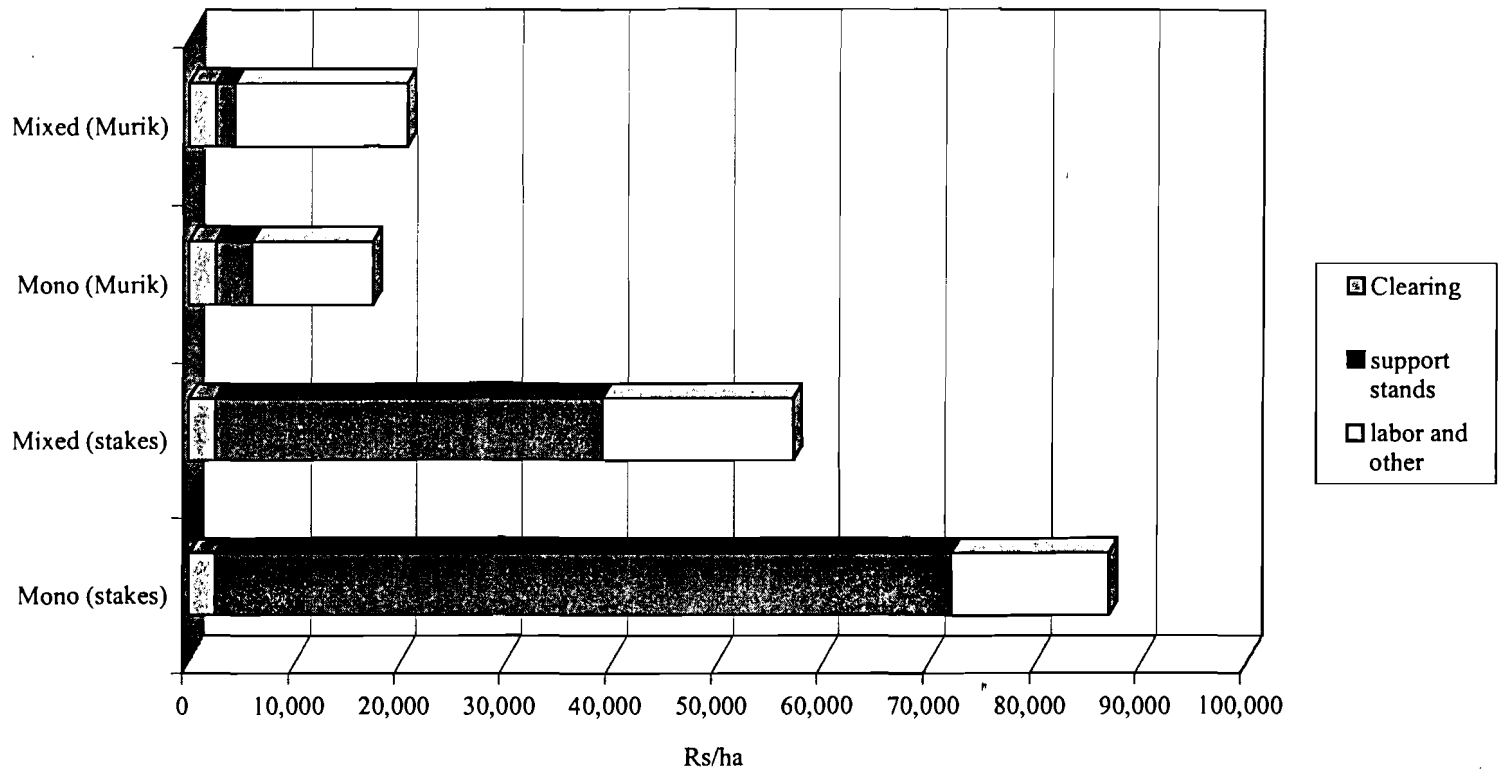


Figure 35: 1998 Kerala Pepper Survey: Imputed Initial Costs To Setup One Hectare Of Mono And Mixed Pepper Farm Using Wooden Stakes

Note: Price of one wooden stake is assumed to be Rs. 60, and labor charge for planting one stake is estimated to be Rs. 7.
"labor and other" in mixed cropping includes setup costs of co-planted crops
Source: Appendix Table 10

Table 10. The 1998 Kerala Pepper Survey: Credit Market For Pepper Farmers In Rural Kerala

Long-term loan		Short-term loan	
Number of long-term loans	9	Number of short-term loans	28
% of total farmer (N=107)	8.4	% of total farmer (N=107)	26.2
% of total loan (N=37)	24.3	% of total loan (N=37)	75.7
Average land size (hectare)	1.03	Average land size (hectare)	0.88
Purpose		Purpose	
Replanting (%)	33.3	Replanting (%)	32.1
Irrigation (%)	44.4	Irrigation (%)	3.6
Crop Loan (%)	22.3	Crop Loan (%)	64.3
source		source	
Bank (%)	100	Bank (%)	25
Cooperative (%)	0	Cooperative (%)	75
Average amount borrowed (Rs)	29,556	Average amount borrowed (Rs)	17,357
per hectare (Rs)	28,664	per hectare (Rs)	19,628
amount outstanding (Rs)	19,444	amount outstanding (Rs)	15,839
% outstanding	65.8	% outstanding	91.3
average annual interest rate (%)	14.8	average annual interest rate (%)	12.8
average terms (year)	10.1	average terms (year)	1
requirements		requirements	
land (%)	100	land (%)	10.7
References (%)	0	References (%)	89.3

Source: *the 1998 Kerala Pepper Survey*

lending organizations should intervene to correct the credit market failure. Without long-term loans, it is impossible for Indian pepper farmers to start pepper monocropping using wooden stakes.

Murik can fix nitrogen while a wooden stake cannot. Thus, if use of wooden stakes as support stands increases pepper yield three times, then three times more nitrogen is removed from the farm soil every year in the form of harvested pepper. Thus, to maintain the fertility of the soil, fertilizer must be applied in great quantities every year. If, as in Malaysia, Indian pepper farmers apply 2 kg of fertilizer per pepper plant, fertilizer alone would cost about Rs. 15,000 per one hectare of monocropped farm. The annual operational cost is Rs. 25,000 for a traditional mixed-cropped farm, in contrast to Rs. 52,000 for a monocropped farm using wooden stakes. Table 10 shows that even without using wooden stakes, more than a quarter of Indian pepper farmers took out short-term loans, and more than 60 percent of short-term borrowers needed crop loans to pay their operational costs. Since pepper mixed cropping using Murik is not very profitable, capital accumulation takes a long time, and thus, some pepper farmers need to borrow to finance their operational costs.

In contrast, although establishing and maintaining a monocropped pepper farm using wooden stakes requires substantial operational capital, once the pepper plants start yielding, capital will accumulate rapidly and operational costs will become less burdensome. In Kerala, three-quarters of short-term loans are made through cooperative lending societies, and most crop loans are renewable every year by payment of interest. Cooperative lending societies require three personal references before making a loan, but don't require collateral of land ownership. The average amount borrowed as a short-term loan is about Rs. 20,000 per hectare. Larger loans granted with similar conditions would provide the necessary support for farmers who start monocropped pepper farms using wooden stakes. However, many cooperative societies would not be willing to lend as much as Rs. 52,000 without requiring collateral. In addition, when a poor farmer wants to borrow an amount of money that exceeds his annual income, it may be very difficult for him to find acquaintances willing to be his references. In such cases, government intervention may be necessary. Otherwise, even if wooden stakes are implemented, pepper yield in poor farmers' fields will drop quickly due to an insufficient application of fertilizer.

Another concern is soil erosion. Most Indian pepper farms are located on hillsides with 16-35 degree slopes in order to avoid foot-rot disease. If coconut trees, arecanut trees, and Murik are removed from mixed-cropped fields and pepper monocropping using wooden stakes is employed, intense rainfall during monsoons and cyclones may cause serious soil erosion. An erosion study by Moench (1991) in Nedumkandam shows that soil erosion in natural forest, pepper monocropping using Murik, and typical mixed cropping averaged 0.65, 3.5, and 1.45 tons per hectare, respectively, in the 1988 monsoon season. If forest-like mixed-cropped farms on hillsides are cleared to set up monocropped farms using wooden stakes, hillside slopes should be terraced. Furthermore, having cover crops grow on the ground will reduce soil erosion. Leguminous cover crops, such as Centrosema and Pueraria, are commonly planted in oil palm plantations in Malaysia to protect the soil surface and also to fertilize soil through the cover crops' nitrogen fixation. Leguminous cover crops can add as much as 150 Kg of nitrogen per hectare per year to the farm system through atmospheric nitrogen fixation. Cover crops, however, absorb 149 kg of nitrogen from the soil and return 123 kg through litter fall; thus, a net 26 kg of nitrogen is removed from the soil. A total 176 kg of nitrogen (150 kg plus 26 kg) is stored in cover crops, but it cannot be utilized until the cover crops die and decompose (Agamuthu and Broughton, 1984). In addition, weeding cover crops to utilize the stored nitrogen would not be desirable in the pepper farms

because one of the leading causes of foot-rot disease is infection from cuts on the pepper's root system inflicted during weeding. Unlike in oil palm plantations, where growing oil palms block light and eventually kill cover crops, it is more difficult to utilize the stored nitrogen in cover crops in pepper monocropped farms. Terraces should be used in pepper monocropped farms to reduce soil erosion, but further experiments on cover crops are needed to determine how they would influence the yield of pepper.

Since Kerala, unlike the situation in Southeast Asia, has a four-month-long severe dry season from December to March, drought might be a problem in some parts of Kerala in an especially dry year (Figure 36). Such risks, however, could be negligible since most pepper plants in mixed-cropped fields survived the dry seasons when they were still in monocropped fields. If the threat of drought is serious in the dry lowland, such as Trivandrum district, several coconut trees could be co-planted with pepper as shading trees.

In addition, because the severe heat of the long dry season decomposes organic matters in the soil and reduces soil fertility very quickly, the soil surface must be protected from direct sun exposure (Gotoh, 1983). This problem could be eliminated by placing banana or coconut leaves on the ground between the pepper plants. These leaves would protect the soil from direct sun exposure, keeping the temperature of the soil cool and reducing the rate of decomposition.

If monocropping were employed, the high density of the pepper plants might make the farms more susceptible to the outbreak of pests and disease. However, since pests are a relatively insignificant problem in pepper cultivation, pesticide would be unnecessary. For disease prevention, no effective chemical exists so far. Thus, no additional cost is necessary. Scientific research for the cure and prevention of foot-rot disease should be encouraged at the national and international level.

Overall, if pepper monocropping using wooden stakes were introduced in Kerala, several minor problems might occur as a consequence, but the problems would not be insurmountable. If India decides to promote pepper monocropping using wooden stakes among Indian pepper farmers, who are mostly small-scale subsistence farmers, three important preconditions have to be met: the implementation of safety-net measures in case of severe income shortage, the availability of short-term loans to finance the farmers' huge operational costs, and the availability of long-term loans to finance the huge initial setup costs. If India wants to popularize pepper monocropping using wooden stakes among small-scale farmers as well as large-scale farmers, the credit market in rural areas must be carefully re-organized and accessibility of credit to small-scale farmers must be improved. If the above three preconditions are met, even small-scale pepper farmers would have the opportunity to improve their standard of living through a more profit-oriented cultivation method: pepper monocropping using wooden stakes.

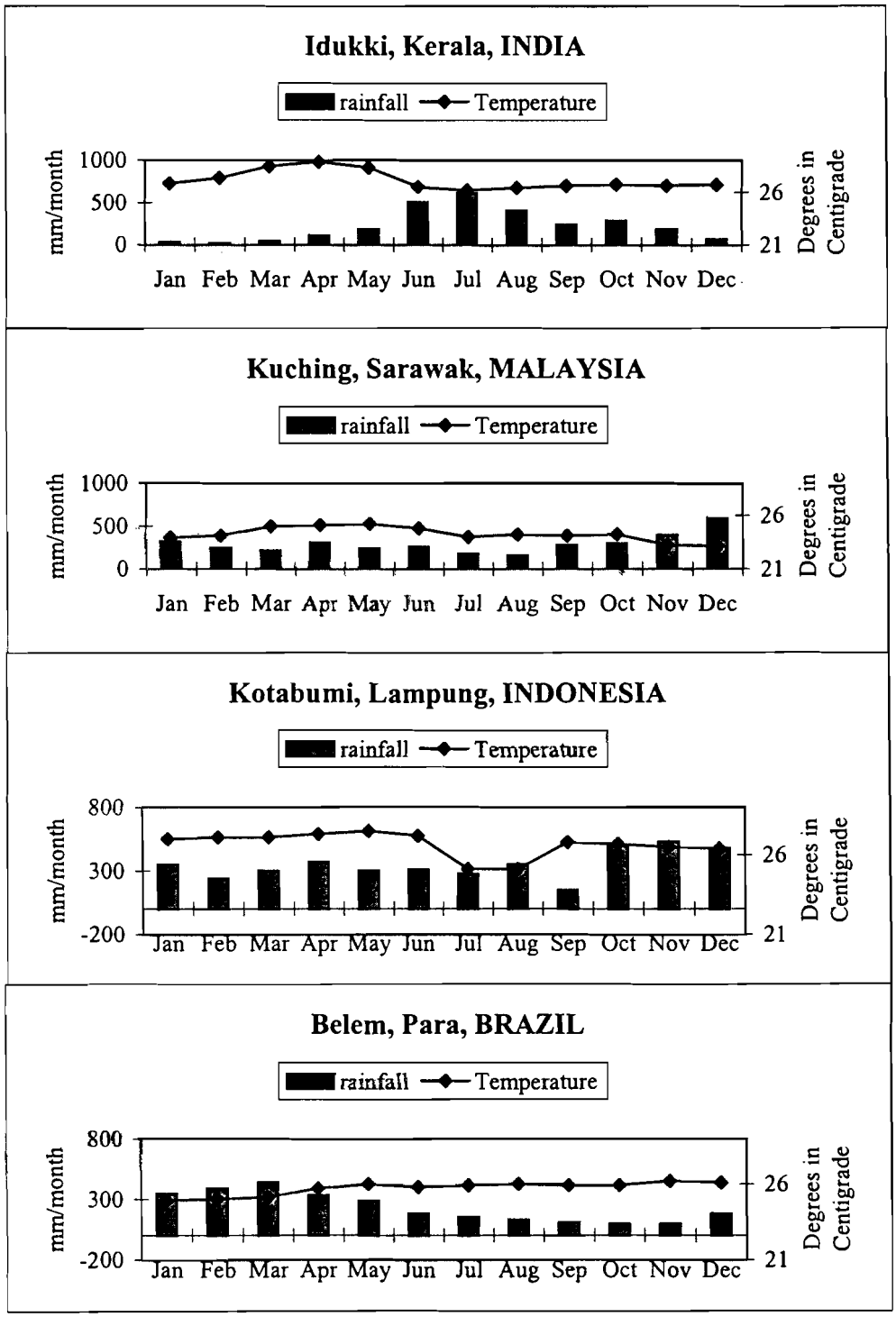


Figure 36. Monthly Average Temperature And Rainfall In The Major Pepper Producing Areas

Sources: Ramachandran, A. K, and Nair, M. A. B. L., 1986, Kerala State Gazetteer; Y. Tsuboi, 1987, Nettai no Nougyoukishou.

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APPENDIX A: The 1998 Kerala Pepper Survey

Section A: Questionnaire of the 1998 Kerala Pepper Survey

No.
Date.

1. Identification of Sample Household
   a) Name
   b) Address
   c) Details of Members (including persons staying in the household and unmarried children staying outside household)

	Relation to Head	Sex	Age	Job 1	Job 2	Job 3	Job 4
1							
2							
3							
4							
5							
6							
7							
8							

Relation to Head: code
1 Head
2 Father
3 Mother
4 Wife
5 Son
6 Daughter
7 In-law
8 Grand child
9 Other

Occupation code:
1 Cultivator
2 Agricultural Laborer
3 Non-Agri. Laborer
4 Cattle keeper
5 Trade & Commerce
6 Transportation
7 Student
8 Domestic work
9 Public Services
10 Other

d) Income structure of the household

	Income			
	Job 1	Job 2	Job 3	Job 4

2. Land Holdings and Utilization
   a) Details of Land Holdings as of July 1998

	Area	Irrigation facilities		Year of possession	Ownership
	(acre)	area	source	(years ago)	code
1					
2					
3					
4					

Irrigation source: code
1. Check dam
2. Pond / Well
3. Stream
4. Tube Well
5. Other

Ownership: code
1. Kuthakappattom
2. Pucca ownership with Patta
3. Holding without Patta
4. Lease
5. Other

b) Why do you employ mixed cropping? What is the advantage?

c) What is the disadvantage of mono cropping?

3. Crop Production and Damage rate

a) Details of Production

	Pepper	Coffee	Coconut	Arecanut	Cardamom	Banana		
No. of Plants								
Average Age								
Production								
Domestic Use								
Unit Price								

b) Type of Pepper Varieties

Variety	Neelamundi	Karimunda	Vellamundi	Geelamundi	Panniyur	Other
Percentage						

c) Number of plants lost

	Pepper	Coffee	Coconut	Arecanut	Cardamom	Banana		
Drought								
Disease								
Pests								
Other								

4. Cost of Cultivation

	Pepper		Coffee		Coconut		Arecanut		Cardamom		Banana					
	Labor	Material	L	M	L	M	L	M	L	M	L	M	L	M	L	M
Clearing																
Digging pits																
Nursery																
Planting Support Stands																
Planting																
Manure																
Fertilizer																
Plant Protection																
Transportation (shopping)																
Irrigation																
Weeding																
Pruning																
Harvesting																
Drying and packing																
Marketing																

5. Borrowing

   a) Have you made any borrowing during the last 15 years for agricultural purpose? If so, please give the following details

Year	Purpose	Source	Amount	Outstanding	Rate	Term	Pre-requirements

6. Extension Services
   a) Have you ever been visited or given extension/advisory services by the Spices Board or Department of Agriculture?

   b) Have you ever received the agricultural supplies (fertilizer, pesticide, etc) from the Spices Board or Department of Agriculture?

   c) Have you ever attended any seminar given by the Spices Board or Department of Agriculture?

7. Cultivation Practice
   a) Have you heard of Panniyur?

   b) Do you have Panniyur in your pepper garden?

   c) If the answer for b) is yes, how are they doing?

   d) If the answer for b) is no, why?

   e) Do you apply fertilizer? Why?

   f) Do you apply pesticide/fungicide to pepper? Why?

   g) In Malaysia, they use the wooden stakes for support stands. Why do you use Murik?

8. Marketing

a) How did you sell your pepper last year?

	Standing	Green	Black	White
Amount Sold (Kg)				
Unit Price (Rs/Kg)				
Sales Channel				

Sales Channel: code

1. Local Market
2. Local Trader
3. Wholesaler in Cochin or Kottayam
4. Exporter
5. Factory

Section B: Detailed summary of the field data

1. Pepper cultivation comparison between mono cropping and mixed cropping

	Mono Cropping (5 farms)	Mixed Cropping (102 farms)
Average size of land (hectare)	0.45	0.77
Number of pepper plants per hectare	1160	610
Pepper yield per hectare (Kg/ha)	722	309
Pepper yield per plant (Kg/plant)	0.622	0.506

2. Yields and costs of each crop in mixed cropping farms

	Pepper	Coffee	Coconut	Arecanut	Cardamom	Banana
Number of plants per hectare	610	320	38	108	90	61
Yield per hectare (Kg/ha)	309	144	1898 nuts	542	21.6	211
Yield per plant (Kg/ha)	0.506	0.45	49.96 nuts	5.02	0.24	3.46
Setup labor cost per plant (Rs)	6.65	7.85	32.31	18.27	8.17	11.27
Setup material cost per plant (Rs)	6.1	2.05	17.82	14.2	3.0	0
Operational labor cost per plant (Rs)	18.04	15.94	24.97	15.76	19.42	4.37
Operational material cost per plant (Rs)	2.51	2.54	10.24	8.16	5.16	0.08
*Annual cost per plant (Rs)	21.2	19.0	36.0	24.5	25.3	15.7

* Annual cost = operational cost + amortized setup cost for each crop's economic life

3. Average rate of plants destroyed by drought and disease

	Pepper	Coffee	Coconut	Arecanut	Cardamom	Banana
Drought (%)	7.15	5.49	0.00	0.00	32.19	0.00
Disease (%)	5.00	3.30	0.00	1.82	1.83	0.00

4. Pepper varieties in mono cropping farms and mixed cropping farms

	Neelamundi	Karimunda	Vellamundi	Geelamundi	Panniyur
Mono cropping	61.0	34.6	4.4	0.0	0.0
Mixed cropping	66.3	20.7	11.6	1.4	0.4

APPENDIX B: Data Tables for Chapter Four

Appendix Table 1. Real Prices for Selected Crops in Kerala, in Rs. 1998

Year	Pepper Rs/kg	Coffee Rs/kg	Arecanut Rs/kg	Coconut Rs/nut*	Cardamom Rs/kg	Banana Rs/kg
1984	61.5	120.3	14.9	11.6	1081.6	11.8
1985	85.4	117.4	10.6	14.6	923.6	10.8
1986	151.3	172.1	11.4	7.0	468.9	6.7
1987	159.5	71.9	8.7	8.9	388.4	5.3
1988	163.1	86.5	9.8	10.9	323.0	5.0
1989	113.2	73.7	8.6	9.8	267.8	5.7
1990	99.7	59.1	9.2	6.6	327.3	4.8
1991	65.3	60.3	14.4	7.3	415.7	3.9
1992	62.9	44.9	15.5	9.3	397.9	6.7
1993	53.3	57.6	15.2	9.2	508.4	10.6
1994	57.3	117.0	14.2	6.6	443.9	6.9
1995	82.2	108.1	13.6	5.4	307.4	8.3
1996	88.1	88.1	12.9	5.5	231.8	8.1
1997	94.7	116.1	12.6	6.8	338.6	7.6
1998	140.0	92.0	12.0	6.7	286.5	7.0
Average	98.5	92.3	12.2	8.4	447.4	7.3

Note: * Price for 0.19 kg of Copra, which is made from one coconut (Banzon, J. A. et al. 1990. Coconut as food)

Sources: Spices Board, Spice statistics, 1986-1998, India.
Indian Coffee Board, Annual Report, 1986-1998, India.
State Planing Board of Kerala, Statistical abstract, 1986-1998, India.
Coconut Development Board, Coconut Statistical Yearbook, 1986-1998, India.
Centre for Monitoring Indian Economy, India's Agricultural Sector, 1994-98, India.
Koizumi, S., *1998 Kerala Pepper Survey*

Appendix Table 2. Yield of Selected Crops in Kerala, 1984-1998, (kg/ha)

Year	Pepper (Mono) Kg/ha	Pepper (Mixed) Kg/ha	Coffee Kg/ha	Arecanut Kg/ha	Coconut Nuts/ha	Cardamom Kg/ha	Banana Kg/ha
1984	488.8	209.1	78.8	199.3	1887.1	18.5	168.3
1985	372.4	159.3	144.8	356.8	1898.0	19.3	172.3
1986	628.4	268.8	88.6	250.2	1876.2	19.0	180.8
1987	558.6	239.0	122.6	264.1	1876.2	17.7	181.3
1988	744.8	318.6	78.7	259.5	1872.5	16.4	197.0
1989	628.4	268.8	137.2	273.4	1872.5	19.0	197.0
1990	744.8	318.6	74.3	301.2	1876.2	18.4	195.9
1991	651.7	278.8	92.7	319.7	1876.2	18.4	196.5
1992	651.7	278.8	112.5	319.7	1868.9	21.7	203.4
1993	721.5	308.7	99.3	495.8	1908.9	24.4	202.8
1994	628.4	268.8	117.5	532.9	1879.8	23.6	205.8
1995	744.8	318.6	111.9	583.9	1879.8	21.6	211.6
1996	721.5	308.7	127.7	551.4	1898.0	21.6	211.3
1997	698.2	298.7	131.6	532.9	1879.8	21.6	209.7
1998	721.5	308.7	144.0	542.2	1898.0	21.6	211.1
Average	647.0	276.8	110.8	385.5	1883.2	20.2	196.3

Sources: Spices Board, Spice statistics, 1986-1998, India.
Indian Coffee Board, Annual Report, 1986-1998, India.
State Planing Board of Kerala, Statistical abstract, 1986-1998, India.
Coconut Development Board, Coconut Statistical Yearbook, 1986-1998, India.
Centre for Monitoring Indian Economy, India's Agricultural Sector, 1994-98, India.
Koizumi, S., *1998 Kerala Pepper Survey*

Appendix Table 3. Imputed Net Return Per Hectare of Mono-Cropping Pepper Farm Using Murik

Year	Yield kg/ha	Price Rs/kg	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha
1984	488.8	61.5	30,053	24,578	5,475
1985	372.4	85.4	31,795	24,578	7,217
1986	628.4	151.3	95,083	24,578	70,506
1987	558.6	159.5	89,123	24,578	64,545
1988	744.8	163.1	121,504	24,578	96,927
1989	628.4	113.2	71,130	24,578	46,552
1990	744.8	99.7	74,265	24,578	49,687
1991	651.7	65.3	42,572	24,578	17,995
1992	651.7	62.9	40,975	24,578	16,398
1993	721.5	53.3	38,465	24,578	13,887
1994	628.4	57.3	35,980	24,578	11,402
1995	744.8	82.2	61,238	24,578	36,661
1996	721.5	88.1	63,531	24,578	38,954
1997	698.2	94.7	66,123	24,578	41,546
1998	721.5	140.0	101,013	24,578	76,435
Average			64,190	24,578	39,612

Sources: Appendix Table 1, 2, and 8

Appendix Table 4. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Murik

	Pepper			Annual		Coffee			Annual	
	Yield	Price	Revenue	costs	Net Return	Yield	Price	Revenue	costs	Net Return
Year	kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha	kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha
1984	209.1	61.5	12,856	12,924	-68	78.8	120.3	9,480	6,072	3,408
1985	159.3	85.4	13,602	12,924	677	144.8	117.4	16,993	6,072	10,921
1986	268.8	151.3	40,676	12,924	27,751	88.6	172.1	15,249	6,072	9,177
1987	239.0	159.5	38,126	12,924	25,202	122.6	71.9	8,808	6,072	2,736
1988	318.6	163.1	51,978	12,924	39,054	78.7	86.5	6,810	6,072	738
1989	268.8	113.2	30,429	12,924	17,504	137.2	73.7	10,113	6,072	4,041
1990	318.6	99.7	31,770	12,924	18,845	74.3	59.1	4,392	6,072	-1,680
1991	278.8	65.3	18,212	12,924	5,288	92.7	60.3	5,589	6,072	-483
1992	278.8	62.9	17,529	12,924	4,604	112.5	44.9	5,047	6,072	-1,025
1993	308.7	53.3	16,455	12,924	3,531	99.3	57.6	5,721	6,072	-351
1994	268.8	57.3	15,392	12,924	2,468	117.5	117.0	13,749	6,072	7,677
1995	318.6	82.2	26,197	12,924	13,273	111.9	108.1	12,091	6,072	6,019
1996	308.7	88.1	27,178	12,924	14,254	127.7	88.1	11,252	6,072	5,180
1997	298.7	94.7	28,287	12,924	15,363	131.6	116.1	15,278	6,072	9,206
1998	308.7	140.0	43,212	12,924	30,288	144.0	92.0	13,245	6,072	7,173

Sources: Appendix Table 1, 2, and 8

Appendix Table 4. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Murik (Continued.)

Arecanut Yield kg/ha	Price Rs/kg	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha	Coconut Yield nuts/ha	Price Rs/pair of copra	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha
199.3	14.9	2,965	2,642	324	1887.1	11.6	21,824	1,370	20,454
356.8	10.6	3,786	2,642	1,144	1898.0	14.6	27,675	1,370	26,305
250.2	11.4	2,841	2,642	199	1876.2	7.0	13,212	1,370	11,843
264.1	8.7	2,301	2,642	-340	1876.2	8.9	16,646	1,370	15,276
259.5	9.8	2,533	2,642	-109	1872.5	10.9	20,383	1,370	19,013
273.4	8.6	2,361	2,642	-281	1872.5	9.8	18,413	1,370	17,043
301.2	9.2	2,769	2,642	127	1876.2	6.6	12,414	1,370	11,044
319.7	14.4	4,612	2,642	1,970	1876.2	7.3	13,631	1,370	12,261
319.7	15.5	4,955	2,642	2,313	1868.9	9.3	17,306	1,370	15,937
495.8	15.2	7,521	2,642	4,880	1908.9	9.2	17,537	1,370	16,168
532.9	14.2	7,559	2,642	4,917	1879.8	6.6	12,378	1,370	11,008
583.9	13.6	7,930	2,642	5,289	1879.8	5.4	10,096	1,370	8,727
551.4	12.9	7,140	2,642	4,499	1898.0	5.5	10,490	1,370	9,120
532.9	12.6	6,712	2,642	4,070	1879.8	6.8	12,831	1,370	11,461
542.2	12.0	6,506	2,642	3,864	1898.0	6.7	12,690	1,370	11,320

Appendix Table 4. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Murik (Continued.)

Cardamom			Annual		**Banana**			Annual		**Total**	Annual	
Yield kg/ha	Price Rs/kg	Revenue Rs/ha	costs Rs/ha	Net Return Rs/ha	Yield kg/ha	Price Rs/kg	Revenue Rs/ha	costs Rs/ha	Net Return Rs/ha	Revenue Rs/ha	costs Rs/ha	Net Return Rs/ha
18.5	1081.6	19,993	2,279	17,714	168.3	11.8	1,980	959	1,021	69,099	26,246	42,853
19.3	923.6	17,872	2,279	15,593	172.3	10.8	1,859	959	900	81,786	26,246	55,540
19.0	468.9	8,902	2,279	6,622	180.8	6.7	1,209	959	250	82,089	26,246	55,843
17.7	388.4	6,888	2,279	4,609	181.3	5.3	970	959	11	73,739	26,246	47,493
16.4	323.0	5,311	2,279	3,031	197.0	5.0	984	959	25	87,999	26,246	61,753
19.0	267.8	5,084	2,279	2,805	197.0	5.7	1,130	959	171	67,529	26,246	41,283
18.4	327.3	6,019	2,279	3,740	195.9	4.8	933	959	-26	58,296	26,246	32,050
18.4	415.7	7,647	2,279	5,367	196.5	3.9	774	959	-185	50,464	26,246	24,218
21.7	397.9	8,622	2,279	6,343	203.4	6.7	1,367	959	408	54,826	26,246	28,580
24.4	508.4	12,426	2,279	10,147	202.8	10.6	2,159	959	1,200	61,820	26,246	35,574
23.6	443.9	10,486	2,279	8,207	205.8	6.9	1,415	959	456	60,979	26,246	34,733
21.6	307.4	6,639	2,279	4,360	211.6	8.3	1,752	959	793	64,706	26,246	38,460
21.6	231.8	5,006	2,279	2,727	211.3	8.1	1,702	959	743	62,768	26,246	36,522
21.6	338.6	7,315	2,279	5,035	209.7	7.6	1,598	959	639	72,020	26,246	45,774
21.6	286.5	6,189	2,279	3,910	211.1	7.0	1,477	959	519	83,320	26,246	57,074
									Average	68,763	26,246	42,517

Appendix Table 5. Imputed Net Return Per Hectare of Mono-Cropping Pepper Farm Using Wooden Stakes

Year	Yield kg/ha	Price Rs/kg	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha
1984	1466.3148	61.0	89,419	57,794	31,625
1985	1117.1923	71.2	79,513	57,794	21,719
1986	1885.2619	164.9	310,865	57,794	253,071
1987	1675.7884	154.9	259,588	57,794	201,794
1988	2234.3845	132.0	294,891	57,794	237,096
1989	1885.2619	89.8	169,281	57,794	111,487
1990	2234.3845	74.2	165,692	57,794	107,898
1991	1955.0865	44.5	87,077	57,794	29,283
1992	1955.0865	50.3	98,341	57,794	40,546
1993	2164.56	52.8	114,391	57,794	56,597
1994	1885.2619	53.3	100,492	57,794	42,698
1995	2234.3845	76.7	171,387	57,794	113,593
1996	2164.56	82.6	178,776	57,794	120,982
1997	2094.7355	86.0	180,139	57,794	122,345
1998	2164.56	109.9	237,855	57,794	180,061
Average			169,180	57,794	111,386

Assumption: pepper yield increases three times when Murik is replaced with a stake
price premiums on Indian pepper were removed

Sources: Appendix Table 1, 2, and 8

Appendix Table 6. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Wooden Stakes

	Pepper			Annual		Coffee			Annual	
	Yield	Price	Revenue	costs	Net Return	Yield	Price	Revenue	costs	Net Return
Year	kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha	kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha
1984	627.27677	61.0	38,253	30,392	7,861	78.8	120.3	9,480	6,072	3,408
1985	477.92516	71.2	34,015	30,392	3,623	144.8	117.4	16,993	6,072	10,921
1986	806.49871	164.9	132,985	30,392	102,594	88.6	172.1	15,249	6,072	9,177
1987	716.88774	154.9	111,050	30,392	80,658	122.6	71.9	8,808	6,072	2,736
1988	955.85032	132.0	126,152	30,392	95,760	78.7	86.5	6,810	6,072	738
1989	806.49871	89.8	72,417	30,392	42,025	137.2	73.7	10,113	6,072	4,041
1990	955.85032	74.2	70,882	30,392	40,490	74.3	59.1	4,392	6,072	-1,680
1991	836.36903	44.5	37,251	30,392	6,859	92.7	60.3	5,589	6,072	-483
1992	836.36903	50.3	42,069	30,392	11,677	112.5	44.9	5,047	6,072	-1,025
1993	925.98	52.8	48,935	30,392	18,544	99.3	57.6	5,721	6,072	-351
1994	806.49871	53.3	42,990	30,392	12,598	117.5	117.0	13,749	6,072	7,677
1995	955.85032	76.7	73,318	30,392	42,926	111.9	108.1	12,091	6,072	6,019
1996	925.98	82.6	76,479	30,392	46,087	127.7	88.1	11,252	6,072	5,180
1997	896.10968	86.0	77,062	30,392	46,670	131.6	116.1	15,278	6,072	9,206
1998	925.98	109.9	101,752	30,392	71,360	144.0	92.0	13,245	6,072	7,173

Assumption: pepper yield increases three times when Murik is replaced with a stake
price premiums on Indian pepper were removed

Sources: Appendix Table 1, 2, and 8

Appendix Table 6. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Wooden Stakes (continued)

Arecanut Yield kg/ha	Price Rs/kg	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha	Coconut Yield nuts/ha	Price Rs/pair of copra	Revenue Rs/ha	Annual costs Rs/ha	Net Return Rs/ha
199.3	14.9	2,965	2,642	324	1887.1	11.6	21,824	1,370	20,454
356.8	10.6	3,786	2,642	1,144	1898.0	14.6	27,675	1,370	26,305
250.2	11.4	2,841	2,642	199	1876.2	7.0	13,212	1,370	11,843
264.1	8.7	2,301	2,642	-340	1876.2	8.9	16,646	1,370	15,276
259.5	9.8	2,533	2,642	-109	1872.5	10.9	20,383	1,370	19,013
273.4	8.6	2,361	2,642	-281	1872.5	9.8	18,413	1,370	17,043
301.2	9.2	2,769	2,642	127	1876.2	6.6	12,414	1,370	11,044
319.7	14.4	4,612	2,642	1,970	1876.2	7.3	13,631	1,370	12,261
319.7	15.5	4,955	2,642	2,313	1868.9	9.3	17,306	1,370	15,937
495.8	15.2	7,521	2,642	4,880	1908.9	9.2	17,537	1,370	16,168
532.9	14.2	7,559	2,642	4,917	1879.8	6.6	12,378	1,370	11,008
583.9	13.6	7,930	2,642	5,289	1879.8	5.4	10,096	1,370	8,727
551.4	12.9	7,140	2,642	4,499	1898.0	5.5	10,490	1,370	9,120
532.9	12.6	6,712	2,642	4,070	1879.8	6.8	12,831	1,370	11,461
542.2	12.0	6,506	2,642	3,864	1898.0	6.7	12,690	1,370	11,320

Appendix Table 6. Imputed Net Return Per Hectare of Mixed-Cropping Pepper Farm Using Wooden Stakes (continued)

Cardamom			Annual		**Banana**			Annual		**Total**	Annual	
Yield	Price	Revenue	costs	Net Return	Yield	Price	Revenue	costs	Net Return	Revenue	costs	Net Return
kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha	kg/ha	Rs/kg	Rs/ha	Rs/ha	Rs/ha	Rs/ha	Rs/ha	Rs/ha
18.5	1081.6	19,993	2,279	17,714	168.3	11.8	1,980	959	1,021	94,496	43,714	50,782
19.3	923.6	17,872	2,279	15,593	172.3	10.8	1,859	959	900	102,199	43,714	58,486
19.0	468.9	8,902	2,279	6,622	180.8	6.7	1,209	959	250	174,398	43,714	130,685
17.7	388.4	6,888	2,279	4,609	181.3	5.3	970	959	11	146,663	43,714	102,949
16.4	323.0	5,311	2,279	3,031	197.0	5.0	984	959	25	162,172	43,714	118,459
19.0	267.8	5,084	2,279	2,805	197.0	5.7	1,130	959	171	109,518	43,714	65,804
18.4	327.3	6,019	2,279	3,740	195.9	4.8	933	959	-26	97,408	43,714	53,694
18.4	415.7	7,647	2,279	5,367	196.5	3.9	774	959	-185	69,503	43,714	25,789
21.7	397.9	8,622	2,279	6,343	203.4	6.7	1,367	959	408	79,367	43,714	35,653
24.4	508.4	12,426	2,279	10,147	202.8	10.6	2,159	959	1,200	94,300	43,714	50,587
23.6	443.9	10,486	2,279	8,207	205.8	6.9	1,415	959	456	88,577	43,714	44,863
21.6	307.4	6,639	2,279	4,360	211.6	8.3	1,752	959	793	111,827	43,714	68,113
21.6	231.8	5,006	2,279	2,727	211.3	8.1	1,702	959	743	112,069	43,714	68,355
21.6	338.6	7,315	2,279	5,035	209.7	7.6	1,598	959	639	120,795	43,714	77,082
21.6	286.5	6,189	2,279	3,910	211.1	7.0	1,477	959	519	141,860	43,714	98,146
									Average	113,677	43,714	69,963

Appendix Table 7. The 1998 Kerala Pepper Survey: Cultivation Costs Per Plant In Kerala, Selected Crops, In Rs.1998

	Pepper Murik	Pepper Stakes	Coffee	Arecanut	Coconut	Cardamom	Banana
Initial costs	12.75	72.79	9.90	32.47	50.13	11.17	11.27
support stands	2.96	60.00	n.a	n.a	n.a	n.a	n.a
planting stands	4.00	7.00	n.a	n.a	n.a	n.a	n.a
crop	3.14	3.14	2.05	14.20	17.82	3.00	0.00
planting crop	2.65	2.65	7.85	18.27	32.31	8.17	11.27
Operational costs	20.55	44.97	18.48	23.92	35.21	24.58	4.45
cow dung	2.37	0.00	2.35	4.86	4.90	2.33	0.00
fertilizer	0.05	13.00	0.08	0.11	4.69	1.39	0.08
protection chemicals	0.09	0.09	0.11	3.19	0.65	1.44	0.00
applying cow dung	1.88	0.00	1.86	3.33	6.75	1.72	0.00
applying fertilizer	0.02	2.50	0.03	0.22	2.76	1.53	0.06
sprying chemicals	0.02	0.02	0.09	1.74	0.56	1.45	0.00
pruning stand	2.97	n.a	n.a	n.a	n.a	n.a	n.a
pruning crop	1.80	1.80	4.27	n.a	n.a	4.21	n.a
harvesting/processing	8.79	25.00	7.38	7.74	9.51	8.12	3.12
miscellaneous	2.56	2.56	2.31	2.73	5.39	2.39	1.19
Crop life (years)	20	15	20	60	60	15	1
Annual costs	21.19	49.82	18.98	24.46	36.05	25.32	15.72

Note: Annual cost = amortized initial cost by crop's life span + operational cost

Source: *The 1998 Kerala Pepper Survey*

Appendix Table 8. Imputed Cultivation Costs Per Hectare in Rs. 1998, Selected Crops

	Pepper (Mono,Murik)	Pepper (Mixed,Murik)	Pepper (Mono,Stakes)	Pepper (Mixed,Stakes)	Coffee	Arecanut	Coconut	Cardamom	Banana
No. of plants per hectare	1,160	610	1,160	610	320	108	38	90	61
Initial costs	14,790	7,778	84,436	44,402	3,168	3,507	1,905	1,005	687
Operational costs	23,838	12,536	52,165	27,432	5,914	2,583	1,338	2,212	271
Annual costs	24,578	12,924	57,794	30,392	6,072	2,642	1,370	2,279	959

Sources: *the 1998 Kerala Pepper Survey* and Appendix table 7

Appendix Table 9. Imputed Total Annual Costs Per Hectare in Rs. 1998, By Cultivation Methods

	Mono, Murik	Mixed, Murik	Mono, Stakes	Mixed, Stakes
Initial costs	14,790	18,050	84,436	54,674
Operational costs	23,838	24,854	52,165	39,750
Annual costs	24,578	26,246	57,794	43,714

Source: Appendix Table 8

Appendix Table 10. Total Setup Costs Per Hectare in Rs. 1998, By Cultivation Methods

	Pepper (Mono,Murik)	Pepper (Mixed,Murik)	Pepper (Mono,Stakes)	Pepper (Mixed,Stakes)
clearing	2,472	2,472	2,472	2,472
cost of support stands	3,434	1,806	69,600	36,600
Other	11,356	16,244	14,836	18,074
Total	17,262	20,522	86,908	57,146

Sources: Appendix Table 7

The 1998 Kerala Pepper Survey

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