

Specialty Crops for Pacific Island Agroforestry (<http://agroforestry.net/scps>)

Farm and Forestry  
Production and Marketing Profile for

# Black pepper

(*Piper nigrum*)

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## USES AND PRODUCTS

Aside from salt, pepper is the world's most important and valued spice. It is used as an important component of many recipes and to flavor foods. From the berries of *Piper nigrum* are produced several condiments: black pepper, white pepper, green pepper, and "Tellicherry" pepper. Many grades of these peppers are recognized in the spice trade.

Other important commercial products derived from the pepper plant are:

- Pepper oil (the vapor or steam distillation process widely used in fragrances or condiments; black pepper yields about 1–2.4% essential oil)
- Cookies and crackers
- Tea (pepper leaves combined with tea leaves)
- Perfumes (made from dried parts of the pepper plant)
- Candy, sweets (contain pepper oil/resin)
- Sausage preservation

Commercial production of pepper worldwide in 2000 was approximately 230,000 metric tons (MT) (254,000 T). Countries in the International Pepper Community, an inter-governmental organization of pepper producing countries, produce 84% of the world's crop (FAO 2000). Other countries such as Vietnam, China, and Madagascar produce the remaining 16%. Pacific island production probably comprises less than 1% of world production.

## BOTANICAL DESCRIPTION

### Preferred scientific name

*Piper nigrum* L.

### Family

Pepper family (Piperaceae). The family name, Piperaceae, is derived from *piper*, the Latin word for pepper. Most of the European names for pepper were derived from the Sanskrit, *pippali*, a word used for this plant at least 3,000 years ago in India.

### Common names

English: pepper, black pepper, white pepper

### International names

Chinese: *hu jiao* (*hu chiao*), *hei hu jiao* (medicinal name), *bai hu jiao*, *woo jiu*

French: *poivre commun*, *poivre blanc*, *poivre noir*

German: *Pfeffer*, *Grüner Pfeffer*, *Schwarzer Pfeffer*; *Weißer Pfeffer*

Japanese: *burakku peppaa*, *koshou*, *peppaa*, *pepaa*

Spanish: *pimienta*



Cluster of ripening peppercorns.

### Brief botanical description

Pepper is a woody, climbing vine growing to 9 m (30 ft) or more in length. The grayish stem may reach 1.2 cm (0.5 in) diameter. Numerous rootlets grow from swollen stem nodes. These stem roots allow the vine to attach to other surfaces for support, such as other plants or structures, and to climb them.

Leaves, dark green above and pale green beneath, are glossy, ovate and acutely tipped, and range in size from 13–25 cm (5–10 in) in length.

Elongated, slender spikes or catkins (1.6–2 cm [4–5 in] in length) bear minute, white flowers. The flower spikes, each producing from 50–60 single-seeded berries, always appear on stems opposite the leaves. Therefore yield of the berries (i.e., the peppercorns) depends upon leaf number.

True pepper is distinguished from the following different spices, which are sometimes designated as peppers:

- The capsicum group (paprika, cayenne pepper, chili pepper, red pepper, bell pepper, and other pod-like fruit of the nightshade family).



Green pepper berries and leaves.

- Jamaican pepper (pimento or allspice, which are the berries of *Pimenta dioica*).
- Melegueta pepper (“grains of paradise,” which are the small, darkly aromatic seeds of *Amomum melegueta*)
- Indian long pepper (*Piper longum* L.)
- Javanese long pepper (*Piper officinarum* L.)

The long peppers, not widely used in Western countries, still comprise condiments and medicines in Eastern lands.

There is significant intraspecific variation in the genus, such as the names of variants provided in Mathew et al. (2006).

## DISTRIBUTION

### Native range

*Piper nigrum* is native to the humid jungles of the Malabar Coast of southwestern India.

### Current distribution worldwide

Pepper is currently cultivated in the tropics worldwide. In the Pacific, it is an important cash crop in the Federated States of Micronesia (the island of Pohnpei). Although the plant grows well in Hawai‘i and many other Pacific islands, it is not widely cultivated there. Worldwide leaders in pepper production are India, Indonesia, Brazil, Malaysia, Thailand, Sri Lanka, Madagascar, Mexico, and some other countries.

## ENVIRONMENTAL PREFERENCES AND TOLERANCES

### Climate

Pepper vines thrive in moist, hot, tropical climates from sea level up to approximately 600 m (1,970 ft) elevation. It requires evenly distributed annual rainfall of about 2,500 mm (100 in) or more and grows best on flat or gently sloping

land. Soils rich in humus with acidic pH (5.5–6.0) and good drainage and aeration are preferred. Light shade is also beneficial

### Soils

Maximum production occurs in deep soils rich in organic matter and medium texture. Pepper can grow well in wet soils and is therefore suitable for planting near a pond.

## GROWTH AND DEVELOPMENT

Pepper is a woody, climbing liana or vine. In cultivation, the plant is grown on a support such as a trellis. It may grow to a length of 10 m (33 ft) or more in length. During the third year after planting, a small crop can be harvested, with full production realized 7–8 years after planting. Plants are most productive at 8–20 years of age, but can continue bearing for 30 years. Ripe berries may be picked about 9 months after flowering. Berries ripen over a period of 2–6 months depending on climate or latitude. Berries are usually harvested every 7–14 days during the harvesting period. The harvesting calendar months vary throughout the world. For example, in India, pepper is harvested from November through March, whereas in Madagascar the crop is harvested from June through October. There is potential for two crops per year in some regions. In Papaikou, Hawai‘i, harvest occurs in February/March and in May/June.

## AGROFORESTRY AND ENVIRONMENTAL SERVICES

Trees may be used to support pepper vines. Any tree or palm with rough bark that does not peel or slough off periodically, such as coconut, can be used to support black pepper plants. The plant grows well under light shade and thrives in soils

### Elevation, rainfall, and temperature requirements for cultivation

Elevation range	<b>lower:</b> sea level <b>upper:</b> 600 m (1,970 ft)
Mean annual rainfall	<b>lower:</b> 600 mm (24 in) <b>upper:</b> 2,000 mm (80 in)
Rainfall pattern	Black pepper prefers uniform rainfall.
Dry season duration (consecutive months with <40 mm [1.6 in] rainfall)	Avoid areas with long dry periods, short dry periods favor fruit ripening and harvesting.
Mean annual temperature	<b>lower:</b> 22°C (72°F) <b>upper:</b> 30°C (86°F)
Mean maximum temperature of hottest month	unknown
Mean minimum temperature of coldest month	unknown
Minimum temperature tolerated	12°C (54°F)



Top left: Preparing stolon cuttings for planting. Pohnpei. Top right: Vines climbing on fern stem support. Pohnpei. Bottom left: Pepper plants being established on fern stem posts. Pohnpei. Bottom right: Pepper plants growing on concrete posts. Thailand.

rich in humus, making it an excellent agroforestry cropping plant. However, too much shade reduces yield. Pepper plants also respond well to organic fertilization from mulch materials collected in or near forests.

## PROPAGATION AND PLANTING

There are at least three propagation methods for black pepper: 1) multiplication by seeds; 2) rooted stolon cuttings; and 3) grafted plants. Propagation is usually accomplished by stolon cuttings selected from the upper portions of young, vigorous, high-yielding, healthy vines. A stolon is a horizontal branch that produces new plants from buds at its tips. These cuttings are rooted and grown in shaded nurseries; plants are well watered and may be heavily fertilized.

### Outplanting techniques

Pepper is usually cultivated on 4 m (13 ft) high support stakes (timber or concrete posts, harvested stems of tree ferns, or young, living trees) at 2.4 m × 2.4 m (8 ft × 8 ft)

spacing. The stakes are set in place before planting rooted cuttings. Several cuttings may be planted adjacent to each support. Occasional pruning encourages lateral branching and a dense growth habit, and also keeps plants to the height of their support stakes. One recommended interplant spacing practiced in locations such as Malaysia and Sri Lanka is 2.5 m × 2.0 m (8.2 ft × 6.6 ft), which results in a population of 2,000 pepper plants/ha (810 plants/ac).

## CULTIVATION

### Variability of species and known varieties

More than 40 pepper varieties are grown worldwide. Most of the varieties derive from India: 'Panniyur 1', 'Karimunda', 'Lampng', 'Bangka', 'Belontoeng', and 'Cers'. The varieties differ in raceme length, leaf size, berry attributes (size, color, etc.), pest and disease resistance, quality parameters, and yield. The varieties also differ in suitability to various climates, such as wet conditions or well defined dry periods.

## Basic crop management

Basic crop management after planting for pepper crops includes weed control, pest and disease management, fertilizing and/or mulching, irrigation during dry periods, training of vines, and pruning. Pruning the tips or stems of young plants promotes the development of dense canopies, whereas pruning of the vines near the top the stake (stakes should be about 3.7 m [12 ft tall]) keeps them trained to a manageable height. Protect young vines from direct sun during summer by shading with vegetation or other means such as coconut fronds or shade cloth. Applying mulch to the base of vines can be very beneficial to plant growth and health.

About 9 months after flowering, the berries are ready for harvest. Black pepper is made from the nearly ripe green berries and consists of pulp plus seed. White pepper derives from fully ripened, greenish-yellow berries that are almost turning red in color. White pepper is the peppercorn seed from which the outer, fleshy pulp is removed by fermentation followed by peeling away the softened skin. Green pepper is obtained from unripe pepper berries that are dried or preserved in vinegar or citric acid. Tellicherry pepper is produced from fully ripened, dried berries. This product has reddish brown color and a rather complex flavor profile. Tellicherry pepper production presents more risk to farmers due to potential loss of crop to feeding birds, molds, or spoilage before processing.

## Advantages and disadvantages of polycultures

One advantage of pepper cultivation is that the vines may be supported on the trunks or stems of young or small living trees, while not negatively impacting the trees or competing with them. Pepper can also benefit from moderate shade levels. Plants may also be trained to occupy vertical space, rendering them good crops to combine in polycultures with plants growing at ground level. Pepper is also a perennial

plant, and harvests and income can be generated in a field where other crops are simultaneously planted, grown, and harvested.

## PESTS AND DISEASES

### Susceptibility to pests/pathogens

#### Major diseases

Perhaps the primary disease problem with black pepper cultivation in some areas of the world is root rot and foot rot caused by *Phytophthora capsici* and some other *Phytophthora* species. These pathogens thrive in wet and poorly drained soils. Symptoms of root rot include wilting of leaves and discoloration of stems near the soil line. However, these pathogens may also attack the foliage, causing blights of leaves and berries. These diseases may rapidly kill pepper plants (within 10 days).

A stem rot and wilt disease of pepper has caused extensive damage to some pepper plantations. The fungal pathogen, *Fusarium solani* f. sp. *piperis*, is soilborne.

Cucumber mosaic virus can cause a severe mosaic disease of pepper in some locations. This plant pathogen has an extremely wide host range, attacking a large number of alternate host species around the world.

Plant-parasitic nematodes may also cause damage to pepper plants, including root-knot nematodes (*Meloidogyne* spp.) and burrowing nematodes (*Radopholus similis*), and others. These parasites cause root galls and rots, foliar yellowing, and slow plant decline.

There are also some nursery diseases caused by fungi such as *Rhizoctonia* sp. that, when established and conditions are wet and warm, can cause loss of leaves or young plants.



Left: Shading young pepper vines with palm fronds. Thailand. Right: Mulch applied at base of a young pepper vine. Pohnpei.



Algal leaf spot of pepper caused by a *Cephaleuros* species. Pohnpei.

Nutritional deficiencies for pepper plants may appear in fields with inadequate irrigation or insufficient amendments of fertilizers or mulches.

In some areas, other plant viruses cause severe disease in pepper fields. One, known as “stunted disease,” can result in severe leaf malformation and plant stunting.

Anthracnose, caused by the fungal plant pathogens in the genus *Colletotrichum*, can cause leaf spotting and blights.

A number of insect pests attack pepper, but usually do not pose production constraints for plants. In Hawai‘i, ants may build nests among developing peppercorns, creating a nuisance in cleaning them during processing.

### **Sustainable methods for pest and disease prevention**

Avoid planting pepper in heavy or poorly drained soils. Mulch pepper plants to help provide nutrition and increase soil aeration. Do not take cuttings from diseased pepper plants. Avoid rooting pepper stem cuttings in media that are infested with plant-parasitic nematodes. Keep plants

well fertilized and irrigated. Scout fields regularly for disease symptoms and pest incidence. If necessary, remove severely diseased pepper plants from fields and use appropriate insect control measures when necessary. Practice sanitation in nurseries and fields by removing severely infected leaves and clean up fallen plant debris. Plant a leguminous ground cover in fields to provide nitrogen and to prevent splashing of pathogen-infested soil onto foliage. Thin out pepper plant canopies by pruning if foliar blight diseases are a threat; this practice reduces relative humidity and leaf wetness in the canopy. Use chemical pesticides to manage diseases where possible and necessary. Intercrop pepper with non-hosts of the major diseases present in the area, and eliminate alternate hosts such as weeds from the area. Apply green manures and organic matter to control plant-parasitic nematodes. Avoid outplanting of diseased pepper plants; inspect their roots and foliage for disease symptoms before planting. Avoid very close spacing among pepper plants.

### **DISADVANTAGES**

Some drawbacks or problems associated with pepper production are:

- Lengthy time required between planting and first profitable harvests
- Large labor requirements for harvesting and processing
- Establishing effective quality control and appropriate markets
- High expense of establishing appropriate growth trellises or stakes

### **Potential for invasiveness**

Pepper is not invasive, although it can naturalize and grow wild.

## **COMMERCIAL PRODUCTION**

### **Postharvest handling and processing**

#### ***Black pepper***

Berries are harvested when their color is greenish yellow. In some places, the berries are dipped in boiling water for 10 minutes after harvest. This provides a surface disinfestation and starts the fermentation process, which turns the berries black. Berries are dried in the sun after the hot water treatment. About 14 days are required for sun drying in order to reach a moisture content of approximately 12%. Strive to produce berries that have uniform color (dark brown to black), have pungent aroma, and are free of mold. About 100 kg (220 lb) of green pepper can produce approximately 35 kg (77 lb) of black pepper.

### **White pepper**

Berries are harvested when about 75% of them have a red or reddish-orange color. The ripe berries are placed in water for about 8 days, which softens the skin enough for it to be peeled away easily. Thereafter, they are dried in the sun to a white-beige color. These berries are sun dried as are the black berries, but are re-submerged in water if weather becomes rainy or cloudy. Strive to produce berries of a uniform buff color and free of mold. The aroma is mild. About 100 kg (220 lb) of green berries can produce approximately 25 kg (55 lb) of white pepper. The discarded hulls can be processed for pepper oil.

### **Green pepper**

This product is obtained from unripe (green) pepper berries that are dried or preserved in vinegar or citric acid.

### **Tellicherry**

Berries are harvested when fully ripe (orange to red in color) and processed.

### **Value-added processing**

There are a number of methods that may be employed to add value to pepper at a community or farm level without large, expensive, highly technological industrial processes.

### **Dehydration and heat treatment**

Heat treatment lends a uniform, black luster to the peppercorns. Collect separated peppercorns using a perforated basket or coarse fabric. Dip the berries along with the container into boiling water for one minute. Then drain and spread the heated berries onto a clean surface for sun drying.

### **Oil/resin extraction (bulk, fragrance, sausage preservative)**

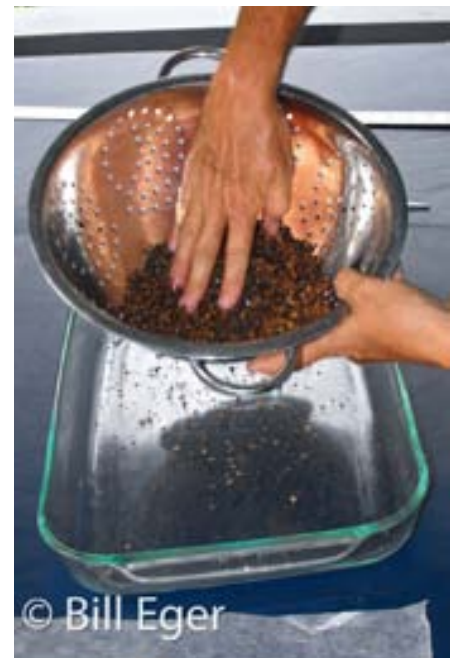
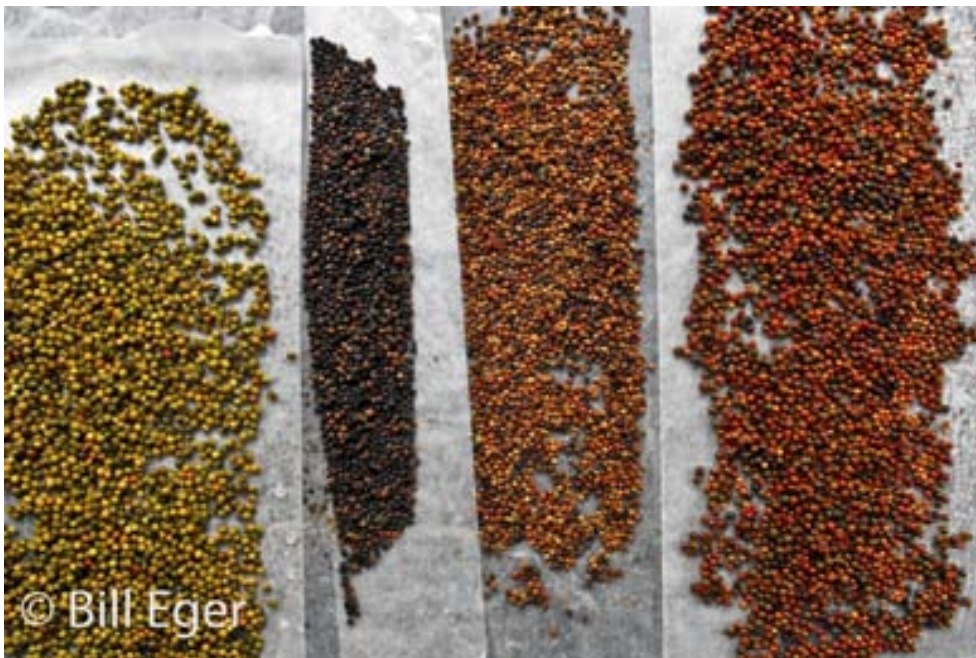
The geographic origin of black pepper berries and the method of their preparation determine the chemical composition of pepper oil. The oil and/or oleoresins are produced from imported black pepper berries principally in North America or Western Europe. But small amounts of oil from black pepper are produced elsewhere using various methods such as fractionation, distillation, or extraction by solvents (i.e., ethanol, acetone, or dichloroethane). Oleoresins (used in pickles, canned meats, and dressings) may be produced using solvent extraction, and have similar pungency, odor, and flavor. The essential oils can also be obtained by cold pressing.

### **Milling or grinding**

Ground black pepper is stored in sealed containers and shipped promptly to minimize loss of quality.



Left: About 1 kg (2.2 lb) freshly harvested peppercorns. Right: A 10-minute soak of berries in near-boiling water.



Left to right: Green berries that have been soaked in near-boiling water for 10 minutes; Dry green berries that have fermented and turned black; dry Tellicherry berries; Ripe berries that have been soaked in near-boiling water for 10 minutes and will become Tellicherry. A colander is helpful for sorting out small peppercorns and debris after drying.

### Product quality standards

International phytosanitary requirements for pepper include the following parameters:

Black pepper must be free of whole insects, alive or dead, be almost free of fecal matter from mammals or other animals, have a maximum of 1% by weight of berries damaged by insects, berries with rustiness, and non-pepper materials. Additionally, there must be a maximum of 2% by weight of light berries, a minimum of 500 pepper berries per liter, no black-grey berries, and no more than 12% moisture.

White pepper has the same quality parameters as black pepper, except that there must be a minimum of 600 pepper berries per liter, a maximum of 1% black-grey berries, and no more than 14% moisture.

### Product storage requirements

Shelf life for properly stored pepper is 12–18 months. At temperatures higher than 15–20°C (59–68°F) and relative humidity of over 60%, harmful molds or aflatoxins (harmful substances produced by some molds) may form on peppercorns.

### Recommended labeling for products

Packaging pepper properly ensures protection against aroma loss and absorption of undesirable flavors and odors. Packaging should occur in the country of origin. The packaging should prevent or minimize humidity loss or absorption. Packages

should be easy to open and easy to close, which ensures that pepper always remains fresh.

The best containers are made from glass and have screw caps. Thin plastic bags may be used (polyethylene or polypropylene), or paper bags with treated or coated surfaces, but these may allow water vapor to pass through and degrade quality.

Labeling should include information specific to the product. Labeling of pepper products can follow the coffee model: using terms that add value, such as single estate, hand-picked, sun-dried, and organic (if certified by a third party). A mention of the pepper variety or location could be made on the label.



Jars of dried black pepper packed for shipping. Hawai'i.



## SMALL SCALE PRODUCTION

A commercial pepper crop may be readily grown in urban gardens, home gardens, or farms of less than 0.5 hectare (1.2 ac). The primary requirements are level, fertile soil and growth supports or stakes for the vines.

Live trees can also be used as supports. Examples include coral tree (*Erythrina indica*, *E. variegata*, or *E. lithosperma*), *Gliricidia sepium*, *Leucaena leucocephala*, and *Garuga pinnata*. In some regions, *Ailanthus malabarica* is used at lower altitudes and *Grevillia robusta* at higher elevations.

The fruit may be dried on a small scale to produce commonly used spices (black and white pepper). Essential oils can be extracted by steam vapor.

## Nutrition

Black pepper is an excellent source of manganese, a very good source of iron and vitamin K, and a good source of dietary fiber.

### *Basic nutrients in 2 tsp (4.28 g)*

calories	10.88
calories from fat	1.24
calories from saturated fat	0.36
protein	0.48 g
carbohydrates	2.76 g
dietary fiber	1.12 g
fat—total	0.12 g
saturated fat	0.04 g
mono fat	0.04 g
poly fat	0.04 g



Left: A polyculture of black pepper and dragon fruit growing on a trellis of tamarind. Right: Pepper plants trellised on *Leucaena* trees.

### Vitamins in 2 tsp (4.28 g)

vitamin A IU	8.12 IU
vitamin A RE	0.80 RE
A—carotenoid	0.80 RE
A—beta carotene	4.88 mcg
thiamin—B <sub>1</sub>	0.00 mg
riboflavin—B <sub>2</sub>	0.00 mg
niacin—B <sub>3</sub>	0.04 mg
niacin equiv	0.04 mg
vitamin C	0.88 mg
vitamin E alpha equiv	0.04 mg
vitamin E IU	0.08 IU
vitamin E mg	0.04 mg
folate	0.44 mcg
vitamin K	6.88 mcg

### Other components (per 100 g)

Component	Black pepper-corns (dried)	White pepper
Water	9.5–12.0 g	9.5–13.7 g
Protein	10.9–12.7 g	10.7–12.4 g
Starch	25.8–44.8 g	53.9–60.4 g
Fiber	9.7–17.2 g	3.5–4.5 g
Ash	3.4–6.0 g	1.0–2.8 g
Piperine (pungent) C <sub>17</sub> H <sub>19</sub> O <sub>3</sub> N	4.9–7.7%	5.5–5.9%
Essential oils (odiferous)		
Note: mainly monoterpene and sesquiterpene hydrocarbons	1.0–1.8%	0.5–0.9%

Source: de Waard and Anunciado 1999

### Medicinal qualities

Black pepper has a number of medicinal uses, including the ability to control worm infestations, and may have the ability to provide relief for a number of ailments including asthma, cough, heart diseases, throat inflammations, night blindness, urinary disorders, tooth and muscle aches, inflammations, snake bites, eye diseases, cholera, and swoons. It is regarded as a purgative, an antidote for poisons, and an aphrodisiac. Pepper can enhance digestion of food because after its ingestion, secretions of the pancreas and gastric system increase. The roots of pepper also have medicinal qualities, as a stomach anesthetic (causes loss of feeling or awareness), analgesic (relieves pain without causing a complete loss of sensation), muscle relaxant, digestive stimulant, antiseptic, diuretic (increases urine flow), sudorific (diaphoretic, promotion of sweating), anxiolytic (reduces anxiety), and as a hypnotic.

### Insecticidal use

Piperine, one of the alkaloids in pepper, is effective against houseflies, and gardeners use pepper sprays against several kinds of pests.

### Import replacement

The crop is widely used in households in the Pacific where the crop is grown. A family that grows a small number of few pepper plants can completely replace their retail purchases of this spice. Off-island imports can be reduced significantly where pepper is farmed successfully.

### YIELDS

#### Expected range of yields per plant

Yields per plant: a full-grown (7–8 years old), well developed mature vine can yield about 1.8–2.3 kg (4–5 lb) of dried berries each harvest season. About 11,230 kg/ha (10,000 lb/acre) of green berries can be produced, which converts to 3,140 kg/ha (2,800 lb/ac) of dried white pepper or about 3,930 kg/ha (3,500 lb/ac) of dried black pepper. There are



Home garden production. Pohnpei.

about 17,600 dried black peppercorns per kg (8,000/lb), and 24,200 dried white peppercorns per kg (11,000/lb).

Yield can vary significantly among regions. For example, in 2000 the yields of black and white pepper in Brazil, India, and Mexico ranged from approximately 3,053–29,034 kg/ha (2,720–25,860 lb/ac) (Corpei–CBI 2001).

### Recommended interplant spacing

Recommended planting density is up to 2,000 plants/ha (800 plants/ac) for monocrops of black pepper. Standard interplant spacing is 2.4 m × 2.4 m (8 ft × 8 ft). Polycultures could range to any density below this, depending on the polyculture system employed.

Different companion crops allow somewhat different planting densities or configurations of black pepper. Possible interplanting species that have proven successful are jackfruit (*Artocarpus heterophyllus*), areca palm (*Areca catechu*), and kapok (*Ceipa pentandra*). In the year a pepper plantation is established, it can be intercropped successfully with short-term crops such as beans, fodder crops, peanut, and soybean. Since these other crops take up space, the density of pepper plants would be somewhat less than in a monoculture.

## MARKETS

### Local markets

Pepper products are highly valued by tourists where the crop is cultivated in the Pacific. They may be found in attractive packages in small shops in some Pacific island locations, such as Pohnpei. Packaged pepper products, locally grown and produced, are well suited for sale at farmers markets, retailers, various aspects of the visitor industry, and for use by local chefs and restaurants in preparation of menus and recipes.

### Export market

Worldwide pepper production was about 254,000 metric tons in 2000, with 376,000 ha (928,000 ac) under cultivation. World pepper production in 2003 was estimated to be 327,250 metric tons (Corpei–CPI 2001). The export market for pepper is significant. The major world importers of pepper are (1993–1997 average) the United States (46,616 MT), Singapore (35,042 MT), Germany (17,518 MT), Holland (12,772 MT), France, (8,847 MT), Japan, (7,464 MT), the United Kingdom (6,458 MT), Russia (5,820 MT), Spain (4,315 MT), Canada (4,036 MT) and others (68,300 MT). The worldwide demand for pepper increases 2.5% annually. The consumption of pepper by importing countries in 1997 was an estimated 400,000–450,000 MT. Approximately 60% of the pepper produced worldwide is consumed in food and service industries (Corpei–CPI 2001).

## Specialty markets

Specialty markets for pepper include organic, rainforest, bird friendly, fair trade, health and nutrition, and cosmetics. Pepper products can carry a local brand name or location identity to distinguish them from other peppers. For example, black and white pepper products from Pohnpei are highly regarded by consumers and demanded very high prices in the late 1990s. Tellicherry pepper from single estates in India is highly regarded by professional and amateur gourmet chefs and commanded very high prices in the early 2000s.

### Potential for Internet sales

Pepper products are well suited for Internet sales by small or large growers or processors. The products are light in weight relative to their value and therefore ship inexpensively, have long shelf life, and can fetch high price for high quality material.

## ECONOMIC ANALYSIS

### Production expenses

Production expenses are incurred at each step of the pepper production process. Labor costs vary among locales. Planting stakes may possibly be harvested inexpensively or free of charge from a forested area nearby.

#### Year 1

Labor maintenance costs for first 24 months (no peppercorn production) consist of one permanent worker per hectare. Total site development and planting costs include

- Site/ground selection
- Stake acquisition and establishment
- Generation of planting material (usually from cuttings)
- Outplanting

#### All years

Crop management (weeding, fertilizing, composting, irrigation, pruning, disease or insect pest management)

#### Years 3–15

Beginning in the third year, a hectare of pepper produces approximately 1,820 kg (1,620 lb/ac) of black pepper. In the fourth year, one hectare produces about 2,730 kg (2,430 lb/ac) of black pepper. Production costs involve the following activities

- Harvesting
- Transportation and receipt
- Weighing
- Pre-drying treatment
- Drying

- Threshing
- Cleaning, selection and classification
- Packing
- Transportation

### Expected income per plant

Wholesale. Pepper prices fluctuate yearly and there has been much price volatility in past years. The black pepper wholesale price in New York in 2009 ranged from \$2.53 to \$3.34 per kg (\$1.15–1.52/lb) (Business Day 2009). Black pepper prices may be substantially higher in specialty markets or where only limited quantities of high quality product are available. Profitability of a farm at the wholesale level will depend on keeping production costs low and yields high. A retail, value-added market is best for small farmers, who should be encouraged to process and market their own pepper.

Retail. Prices for pepper vary considerably in the retail market, with rarer or higher quality pepper products having very high values. For example, pepper from Pohnpei is regarded to be of exceptionally high quality and a relatively rare commodity which was absent from the market for the early part of the 2000s. Dried peppercorns currently sell for \$150/kg (\$68.00/lb) from a Pohnpei source (PPC 2009).

## FURTHER RESEARCH

### Potential for crop improvement

Through plant breeding and selection, varieties of pepper have been improved in recent decades for pest and disease resistance (e.g., resistance to *Phytophthora*) and for drought tolerance. There is more room for variety improvement in many horticultural aspects.

For example, it is important to select and develop germplasm that is well suited for growing conditions in the Pacific islands region.

### Improving potential for family or community farming

Pepper is a valuable, healthful commodity and is highly desired for cuisines throughout the world. The potential for specialty pepper production on small farms in the American-affiliated Pacific should be strengthened through extension education, awareness building, and disseminating plant materials.

### Genetic resources where collections exist

The primary center for germplasm of *P. nigrum* is India, where large collections are grown at various sites associated with the Institute of Spices Research. Other important col-



Variety trials. Thailand.

lections of *P. nigrum* germplasm exist in Brazil, Indonesia and Sarawak.

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- Indian Department of Agriculture, Andaman & Nicobar: <http://agri.and.nic.in/farmpractices.htm#BLACK%20PEPPER>

## OTHER RESOURCES

### Internet

- Kew Gardens black pepper: [http://www.plantcultures.org/plants/black\\_pepper\\_grow\\_it.html](http://www.plantcultures.org/plants/black_pepper_grow_it.html)
- International Pepper Community: <http://www.ipcnet.org/?p=about&sp=his&act=>
- FAO Spices Processing Toolkit (Black pepper): <http://www.fao.org/inpho/content/ftp/SPICES/infBP.htm>
- Gernot Katzer's Spice Pages – Black pepper: [http://www.uni-graz.at/~katzer/engl/Pipe\\_nig.html](http://www.uni-graz.at/~katzer/engl/Pipe_nig.html)
- Cultivation of pepper (South Africa): <http://www.nda.agric.za/docs/pepper/pepper.htm>
- Global Commercial Services for the Spice Industry–black pepper: <http://web.archive.org/web/20040811103656/www.spizes.com/spiceonline/CategoryList/Peppercat.asp>
- Product profile – pepper (2001), Corpei – CBI project “Expansion of Ecuador's Export Commodities” <http://www.sica.gov.ec/agronegocios/productos%20para%20invertir/CORPEI/pimienta.pdf>
- Sorting pepper names—*Piper nigrum*: <http://www.plantnames.unimelb.edu.au/Sorting/Piper.html#nigrum>
- The World's Healthiest Foods: <http://whfoods.org/genpage.php?tname=foodspice&dbid=74#nutritionalprofile>

Specialty Crops for Pacific Island Agroforestry (<http://agroforestry.net/scps>)

## Farm and Forestry Production and Marketing profile for Black pepper (*Piper nigrum*)

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