

**Farm and Forestry
Production and Marketing Profile for**

Chili pepper

(Capsicum annuum)

By Hector Valenzuela

USES AND PRODUCTS

Chili peppers are consumed fresh or in a variety of processed products in many cuisines worldwide. They are used as condiments or spices to add flavor or pungency to dishes. Use in processed products has increased dramatically in recent years. In the U.S., salsa sales now surpass ketchup sales, reflecting on the popularity of Mexican dishes. Chili peppers are used medicinally in Latin America and Africa. In many countries, chilies are part of the daily diet. Some cultivars are also used as ornamentals.

In many regions where chili peppers are widely consumed, they represent one of the few, if not the only, vegetable added to the diet to provide flavor, spice, and variety to grain- or root-crop-based diets. Their consumption represents a major source of vitamins and minerals in certain regions. Processed chili peppers are found in a variety of products

including main dishes, meats, salad dressings, dairy products, beverages, candies, baked products, snack foods, salsas, hot sauces, and even in ice cream. Extracts are also used in pharmaceuticals, as medicinals, and in cosmetic products (Bosland and Votava 2000).

Bird peppers (such as the popular “Hawaiian” chili pepper in Hawai‘i) can be pickled when green or ripe and the ripe fruit is used in hot sauces or ground and used as a seasoning. “Chili pepper water,” which is consumed as a condiment in rice, eggs, fried foods, and cocktails, is among the most popular uses for bird peppers in Hawai‘i. Bird peppers may also be combined with other milder but flavorful chili pepper varieties to create a more nuanced flavor profile in dishes.

Peppers are estimated to be grown on over 1.7 million hectares (ha) worldwide (FAO 2008). Major producers of peppers include China, Turkey, Nigeria, and Mexico.



Top left: Chili peppers are characterized by the large diversity of fruit types according to color, shape, fruit thickness, pungency, and taste. Based on particular taste preferences and adaptability, varieties have been selected for production in specific regions around the world. Top right: Chilis are central to the cuisine of many cultures. Bottom left: Certain cuisines, such as Thai dishes pictured here, are flavored with chili peppers at various intensities. Bottom right: Chili peppers can be processed into a variety of value-added products, such as pickled bird-type chili peppers, as shown here in a market in Guam.

BOTANICAL DESCRIPTION

Preferred scientific names

Capsicum annuum L. var. *annuum* (most cultivated types) and *Capsicum annuum* L. var. *glabriusculum* (Dunal) Heiser & Pickersgill (tabasco or bird types)

Family

Solanaceae

Non-preferred scientific names

C. frutescens L. (tabasco or bird-type chili peppers)

Common names (after PIER 2010)

Chamorro: *doni, doni halum tano, doni-halomtano, doni-sali, donné sali, dont sali*

Chinese: *la-chiao*

Chuukese: *amwiik, lonni mmwiik yammwiik, moek, muik, mwi, mwi, mwi, mwiik, mwik, yammwiik*

English: chili pepper

Fijian: *mboro, mboro nganga, mboro ni vavalangi, rokete*

French: *piment, poivre rouge, poivrons*

Hawaiian: *nīoi, nīoi pepa*

Hindi: *mircha*

I-Kiribati: *te beneka*

Maori (Cook Islands): *ōporo, oporo*

Marshallese: *peba, pepa*

Nauruan: *epeba*

Niuean: *polo magiho, polo mangiho, polo misi, polo miti*

Palauan: *meringel*

Pohnpeian: *chilee, mwik, sele*

Rakahanga-Manihiki: *oporo*

Samoa: *polo, polo, polo papalagi, polo vao, polu uli*

Satawalese: *amuek*

Spanish: *aji, ají picante, chile, guindilla*

Tahitian: *oporo, ōporo*

Tongan: *polo, polo fifisi*

Tongarevan: *ōpolo* (spoken), *ōporo* (written)

Ulithian: *mukh*

Vietnam: *ot, ot chn*

Yapese: *mwech mwig, t'ebil tebil, tabil*

Brief botanical description

Peppers have an erect, branched growth habit. Plants grow to a height of 60–75 cm, with a large number of fruit produced on lateral branches. New branches are produced at every flower node. The somewhat elongated heart-shaped leaves are arranged alternately. Single flowers are produced year-round on the axils of branches. Plants are primarily self-pollinating, but about 17% cross-pollination via insects or wind typically occurs. To avoid cross-pollination for seed production, pepper fields of different varieties should be separated by at least 150 m. Flowers are only open for 24–30

hours, and adverse environmental conditions during this period may decrease fruit set. The plants have strong and deep taproots and an extensive root system.

Distinguishing scientific names of popular chili pepper varieties

Most chili peppers are classified as *Capsicum annuum* L. var. *annuum*. Exceptions include Tabasco peppers, which are classified as *C. annuum* L. var. *glabriusculum*, and ‘Scotch Bonnet’ pepper, which is classified as *C. chinense*. The so-called bird peppers, including the type that is called “Hawaiian chili pepper” in Hawai‘i, are classified as *C. annuum* L. var. *glabriusculum*. The very pungent “Hawaiian chili peppers” in general have yellow fruit that turn red when ripe, and remain productive for extended periods of time. The bird peppers have become naturalized in many islands of the Pacific region and in Asia.

DISTRIBUTION

The center of origin for peppers is tropical and subtropical America. The plants were likely domesticated in a region between Mexico and Guatemala. Today, chili peppers are planted and consumed worldwide including throughout the Pacific islands.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

Peppers are warm-season crops with a long-growing season. They are most sensitive to climatic conditions during blossom development and fruiting. Temperatures above 32°C may lead to flower abortion. For optimal production, peppers require between 2–5 cm of rainfall or irrigation per week, depending on the soil type and the stage of growth. In general, peppers require more water after fruiting than before fruiting. Light sandy soils will require more frequent irrigations than heavier soils. Irrigation should maintain adequate moisture on the top 30 cm of the soil, which is where

Elevation, rainfall, and temperature

Elevation range	lower: sea level
	upper: 3,000 m
	In tropical locations peppers generally grow best between 150–1,800 m elevation.
Mean annual rainfall	lower: 400 mm
	upper: 1,000 mm
Rainfall pattern	Uniform rainfall is preferred for production.
Mean annual temperature	lower: 15°C
	upper: 35°C
Mean maximum temperature of hottest month	lower: 15°C
	upper: 32°C



Left: Jalapeno pepper (*Capsicum annuum* var. *annuum*). Middle: Scotch Bonnet pepper (*Capsicum chinense*). Right: Bird type chili pepper (*Capsicum annuum* var. *glabriusculum*).

most of the roots develop. Lack of adequate moisture may also result in loss of flowers and fruit drop. Seeds germinate at temperatures of 15–30°C. Optimal growth is observed with daytime temperature highs of 25°C and nighttime lows of 15°C. Because of its wide genetic diversity, chili pepper varieties can be selected based on their adaptability to a range of environmental conditions.

Soils

Peppers do well on a range of soil types, but best growth occurs on fertile, well drained, sandy-loam soils. Ideal pH is between 6.0 and 6.5, but the plants can grow well in a pH range of 5.5 to 6.8. Peppers are moderately salt tolerant.

GROWTH AND DEVELOPMENT

Peppers are perennials in the tropics, but they are most often grown commercially as annuals to maintain high yields and to avoid declining productivity due to pests or diseases. However, under optimal growing conditions, chili pepper plants may be productive for several years.

Flowering and fruiting

Flowering begins 1–2 months after planting and fruit can be harvested about 1 month after pollination. Fruit is ready to harvest 65–90 days after planting. Fruit production takes place year-round, depending on plant vigor and environmental growing conditions.

AGROFORESTRY AND ENVIRONMENTAL SERVICES

Chili peppers are suitable for planting in intercropping or agroforestry systems. They may be grown in alley cropping systems together with tree species such as *Leucaena*. In tropical regions chili peppers are also commonly interplanted with other vegetables or green manure crops. Competition for nutrients and light determine the performance and yield potential of chili peppers when grown in intercropping systems. An example of an agroforestry system used in soils with low fertility is the modified shifting-cultivation system used in parts of Indonesia. After growing a number of bamboo species for several years to build up the soil fertility and then clear-cutting, the open fields are planted with several intercrops including chili pepper, lab lab bean (*Dolichos lablab*), bitter melon (*Momordica charantia*), sweet basil (*Ocimum basilicum*), and cassava (*Manihot esculenta*) (Christanty et al. 1997). Similar shifting or slash-and-burn systems are observed in southern Mexico, in which cash crops such chili peppers, corn, beans, and squash are grown for a period of 1–2 years after the fields are cleared of trees and vegetation (Negreros-Castillo et al. 2003).

PROPAGATION AND PLANTING

To aid in field establishment, chili peppers are normally grown in nurseries in seedling trays and transplanted into the field 4–6 weeks after sowing. A well drained medium is used. Well aged composts may be used as an ingredient in the growing media. In commercial operations, 200-cell

seedling trays are commonly employed. In Indonesia, enclosing the seedling nursery with screen helped to minimize the level of arthropod pests and eliminated the need to use insecticides in the nursery (Vos and Nurtika 1995).

Outplanting techniques

Planting arrangements are discussed below under “Recommended planting density.” Because chili peppers are normally slow starters especially under cool or unfavorable growing conditions, a “starter” fertilizer low in nitrogen and proportionately higher in phosphorus is normally applied soon after transplanting to promote root growth. Typical formulas of commercial fertilizers that are used on seedlings are high in phosphorus such as 10-52-17, 11-48-0, or 11-55-0 ratios of N-P-K. For example, a starter solution may consist of 350 g of a 10-52-17 fertilizer per 50 liters (L) of water (or about 70 g per 10 L of water). Growers apply about 250 ml of stock solution per plant. An example of an organic starter nutrient solution would be to mix about 800 ml of fish-based fertilizer into 50 liters of water (or 160 ml per 10 liters of water) and apply about a cup (236 ml) of this solution to each seedling.

CULTIVATION

Varieties

Chili peppers are classified in the marketplace based on their shape, color, taste, pungency, uses, and/or other horticultural characteristics. Popular types of chili pepper include Thai, Asian, Jalapeno, Habanero and Serrano, in addition to many local or regional types.

For each fruit type, such as Jalapeno, there are typically many varieties (cultivars) to choose from. Overall there are literally hundreds of varieties of chili pepper. Local cultivars are usually the best adapted to local growing conditions and

likely have the flavors and shapes favored by local markets. However, the yields of local varieties may be moderate compared with major commercial varieties. Commercial seed companies provide both hybrid and open-pollinated chili pepper varieties. The key difference between hybrid and open-pollinated varieties is that growers cannot save seed from hybrid plants for replanting the following season, because the following generation will not be true-to-type. Seed from open-pollinated varieties can be saved for future plantings.

Commercial producers select their varieties based on their target market (e.g., tourist, local, processing, fresh). Because new high-yielding varieties are being introduced every year, it is important to conduct local variety trials every few years. Growers need to stay informed about variety trials that have been recently conducted somewhere in the Pacific region. Commercial varieties that excel in other countries or regions, may not necessarily do well on a particular farm. For this reason, it is always recommended to plant new varieties on a small scale, perhaps only in a few rows, and to increase the size of the plantings once a particular variety has proven itself on a particular site. Multi-year plantings are normally required to gauge long-term productivity and adaptability.

Other than the desired horticultural traits that are required to meet the needs of the target market (such as yield, color, shape, and flavor), other important considerations for the selection of varieties include adaptability to a particular location and tolerance or resistance to diseases such as root-knot nematodes, insects, viruses, and other foliar diseases.

Some for-trial varieties that have performed well in Hawai‘i include:

- Small fruit: ‘Super chili’, ‘Hawaiian’ chili (local variety).
- Jalapeno types: ‘Mitla’, ‘Jalapa’, Waialua (UH variety).
- Serrano types: ‘Camino Real’ (HMX-3673)



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Left: Chili peppers may be intercropped with a companion crop in every other row or every few rows. In this commercial field in Taiwan, chili peppers are interplanted with dragon fruit cactus. The trellis placed over the chili pepper beds helps to support the pepper canopy during periods of heavy fruit production. Middle: Chili peppers within a culinary herb garden in Thailand. Right: Chili peppers may be grown with a variety of compatible fruit and vegetable crops, as shown here with Mizuna, a leafy-green vegetable in the mustard family.

- Long yellow fruit (wax or banana types): ‘Inferno’, ‘Volcano’, ‘Hungarian Yellow Wax’
- Long green fruit: ‘Long Red’, ‘Anaheim’
- Ancho or Poblano fruit types: ‘Ancho Villa’

Chili pepper varieties that have performed well in Guam and in other Pacific or Asian countries include ‘Hot Beauty’ and ‘Chivalry’.

Basic crop management

For adequate plant establishment, soil preparation prior to planting is important. This includes a weed-free bed with good soil texture. Proper soil fertility and moisture levels help maintain crop quality and yields. It is recommended that growers obtain a nutrient analysis of their soils by submitting samples to a local soil diagnostic laboratory prior to planting. The growth of weeds and crops in the field also indicates the general fertility of soils. Nutrient amendments provided by the application of organic or synthetic fertilizers are applied to complement the natural fertility of the soil.

Organic mulches and rotations with green manures or other cover crops also improve soil fertility. Soils that promote microbial activity will likely host beneficial mycorrhizal associations with chili pepper. For instance, rich associations have been observed in the root systems of chili pepper with mycorrhizal populations of *Glomus macrocarpum* (Sreenivasa 1992). Mycorrhizal associations are known to increase the uptake of phosphorus and other nutrients, especially in P deficient soils.

Special horticultural techniques

Plants are staked or trellised, especially in areas that experience heavy winds or when growing prolific varieties that produce heavy fruit loads. Some growers prefer to use single stakes tied to each individual plant or to trellis their plants with string lines along both sides of a row.

The use of windbreaks is recommended to minimize excess water loss and to reduce metabolic stress caused by excessive wind desiccation. The use of organic mulches, cover crops, and composts improves soil organic matter content and moderates soil moisture. Organic mulches are helpful in suppressing weed growth and reduce splashing of soil particles onto the fruit, thus minimizing the incidence of diseases.

Advantages and disadvantages of polycultures

Intercropping and agroforestry systems are increasingly being recognized as low-input production systems that can help reduce the risk of significant crop losses caused by pests, inclement weather, or unexpected swings in the produce market. Intercropping systems also provide several ecological services, such as improved nutrient cycling and in some cases, reduced disease, weed, and pest levels in the farm.

Because so little research has been conducted and intercropping systems are location-specific, there are no specific recommendations for the best crop combinations. Farmers should select companion species that are known to be well adapted to their particular location. Companion species should also be compatible based on their growth rate, canopy and root architecture, and incidence of pests attracted to each individual crop. Species that farmers may evaluate for intercropping with chili peppers include beans/legumes, cucurbits, plants of the cabbage family, herbs, and root crops such as taro (*Colocasia esculenta*), cocoyam (*Xanthosoma* spp.), sweetpotato (*Ipomoea batatas*), yam (*Dioscorea* spp.), and cassava (*Manihot esculenta*). Because other solanaceous crops such as tomato, bell peppers, eggplant, and the Irish or Peruvian potato attract some of the same pests, it is normally not recommended that they be intercropped or used in rotation with chili peppers.

PESTS AND DISEASES

Susceptibility to pests/pathogens

Important arthropod pests of chili peppers include cutworms, aphids, whiteflies, flower thrips, mites, and the pepper weevil. Root-knot nematodes found in the soil around the root zone are also significant pests. Important diseases of chili peppers include bacterial wilt, bacterial spot, powdery mildew, damping-off, and other root-rots caused by *Phytophthora* or *Pythium*. Peppers are also affected by several virus diseases. In general, chili peppers are hardier than the sweet or bell peppers, but they share many of the same pests.

Sustainable methods for preventing pests and diseases

The most effective method to prevent pests and diseases in chili pepper is to foster a healthy ecological system (agroe-cosystem). A production program that is based on specific cultural practices will lead to ideal crop growth and minimize the incidence of pest outbreaks. Whenever possible, the goal is to create a beneficial microclimate, such as growing plants in raised beds, increasing biodiversity, or increasing the spacing between plants.

Intercrops may act as barriers, confound the behavior of pests, help to attract beneficial insects, or may act as repellents to keep pests away. In the event of crops losses, or low seasonal prices in the marketplace, intercrops provide the farmer with an alternative product for sale in the marketplace, or for consumption in the household.

Some of the key components of a healthy and resilient agroecosystem include:

- Proper soil preparation prior to planting



Top left: ‘Solanos’ is a long green fruited Anaheim type. This type of chili pepper can be used for chili rellenos (stuffed chili) or sliced for use in sauces, soups, and casseroles. Top right: The variety ‘Camino Real’ (HMX-3673) is a Serrano type chili pepper. Serrano types have a similar shape but are hotter than Jalapenos and are popular in salsa verde and in other southwestern relishes. Middle left: ‘Waialua’ is a University of Hawai’i bred Jalapeno type. This variety has reported resistance to bacterial wilt and tolerance of root-knot nematodes. Middle right: The ‘Volcano’ variety is an attractive yellow-waxed or Hungarian type. It can be pickled, used in salsas, or in relishes. Bottom left: The variety ‘Inferno’ is a hot banana type. Hot banana types can be picked at this stage or later after they have turned orange or red. The ‘Inferno’ variety performed well in observational trials conducted in O’ahu, Hawai’i. Bottom right: The ‘Tampico Fiesta’ variety is a Serrano type, grown here with black woven-polyethylene weed mats and drip irrigation. To avoid puncturing the weed mats for ease of re-use, a 1 m-wide weed mat was placed on each side of the row.

- Balanced soil fertility based on the use of organic amendments, organic mulches, cover crops, and rotation with other appropriate crops
- Selection of cultivars adapted to the farm
- Water management to prevent periods of drought or waterlogging
- The use of windbreaks and/or intercrops to minimize stress caused by excessive winds
- Interplanting of compatible cash crops, cover crops, or trees to minimize pest outbreaks.

An understanding of pest life-cycles helps to identify weak points where cultural practices may prevent pests from multiplying or spreading from plant to plant. University or extension bulletins may have information on the key pests of chili peppers in specific production areas with a description of their life cycles.

DISADVANTAGES

Vegetable crops such as chili pepper are often vulnerable to market volatility, meaning that there may be a wide price variation from month to month. To mitigate market volatility:

- Identify markets/buyers early on, and establish relationships with them
- Produce value-added products
- Diversify production by growing several cash crops, instead of relying on only one or two major cash crops. Crop diversification helps to reduce the risk of crop losses from pests, inclement weather, or unexpected market conditions
- Write a business plan as part of the farming operation to better understand the economics and labor demands of maintaining and harvesting a labor-intensive crop such as chili pepper.

Growers often experience what is called “yield declines” with chili peppers, where yields decline from year to year. Yield declines may be due to increased pest pressure from nematodes, soil diseases, viruses, or the combined cumulative effect of these pests. It is important that growers make an effort to improve soil quality over time by increasing the soil organic matter content, and establish an integrated program to minimize the buildup of pests. The selection of varieties that are locally adapted and that have tolerance or resistance to important pests is another key strategy.

Potential for invasiveness

This species is considered to have a low risk for invasiveness.

COMMERCIAL PRODUCTION

Postharvest handling and processing for commercial use

Because chili peppers are a perishable product, farmers should maintain a well tuned fertility, irrigation, and pest management program during the production cycle, which will lead to higher yields and product quality. Some key considerations:

1. Harvest at the correct maturity to meet the needs of your buyer/market. Green fruit should be firm and crisp at harvest. If green peppers are harvested too early, the shelf-life will be reduced. Immature fruit will also have thinner flesh, resulting in lower yields by weight.
2. Fruit harvested for drying or canning are picked when fully ripe, normally red or yellow.
3. Pick the fruit with the stem still attached to the fruit. This will reduce the rate of infection by postharvest diseases.
4. Minimize fruit injury during harvest and transport.
5. Establish a grading system and maintain high quality standards. The quality of the product and consistency of production (ability to deliver a product on a timely basis, seasonally or on a year-round basis) will help establish a good reputation, long-term relationships with buyers, and will help to differentiate an operation from competitors.
6. When growing excessively hot or pungent peppers, workers must use proper protection and techniques to avoid injury when coming in contact with the fruit.

Adding value at a community or farm level

Because of their versatility, chili peppers can be processed and developed into a myriad of value-added products. Producers should explore market potential in their community and conduct basic feasibility studies (including cost analysis) to determine the potential of value-added products obtained from chili peppers. Products that may contain chili peppers include meat dishes, salad dressing, mayonnaise, dairy products, beverages, candies, baked goods, salsa, hot sauces, pharmaceuticals, and cosmetics (Bosland and Votava 2000). Processing methods include canning, pickling, fermentation, dehydration, and freezing.

Product quality standards

There are no recognized U.S. or international grading standards. However generally recognized quality traits in the marketplace include uniformity of shape, size, an intact stem, ripeness, and color. The skin should have a glossy appearance and be firm and free of soil or debris. Fruit defects that will render the product off-grade or unmarketable in-

clude cracks, decay, sunburn, mechanical damage, and skin that is dull (over mature) or softening (Acedo 2006).

Markets for particular types of chili peppers may have specific requirements. For instance export markets for Habanero peppers in Mexico classify them based on size, including large (10 g or greater), medium (7.5–10 g), and small (5.0–7.5 g). Quality traits for Habanero types in the marketplace include size, color, weight, appearance, and firmness (De la Cruz 2002).

Product storage requirements and shelf life

The shelf life of fresh peppers is extended considerably if the fruit is cooled down soon after harvest. Recommended holding temperatures for peppers are 7–10°C with a relative humidity of 95%. Chili peppers are sensitive to chilling injury, when exposed to temperatures below 7°C. Symptoms may occur within days if exposed to 0°C, or within weeks if exposed to 5°C.



Top: Overview of a chili pepper field about 3 months after transplanting. The rows were spaced about 1.8 m (6 ft) apart to allow ease of access for weekly harvests over an extended period of time. Bottom: Commercial pepper farm in Dededo, Guam.

Recommended labeling

Chili peppers for market are loosely packed into cartons with no separate size grading, as long as minimum size requirements are met. If large cartons are used, they should include central dividers. Some standard carton dimensions are 20 × 51 × 34 cm and 16 × 37.7 × 27.9 cm. Chili peppers in the eastern U.S. are typically shipped in cartons weighing 12–15 kg, or in loose packed lugs or cartons that weigh 7–11 kg. In California, however, chili peppers are often marketed in 4.5 kg boxes. Chili peppers for export are normally transported by air, preferably the day after harvest. Shipment by sea is possible if travel duration is less than 14 days and the fruit is maintained at temperatures of 12–13°C.

Labels should be placed on shipping cartons to identify the producer and to provide a description of the product. Boxes for export should contain labels at each end and on top. Information for product labels includes: commodity type (chili peppers); variety, size, and weight; grade (such as U.S. No. 1 or Extra Fancy); name and address of packer or grower; packing date; and any quality or certification programs, such as for organic products, or for food safety certification. If sold locally the label may include a “locally grown” statement. If exported the label may include the country of origin.

SMALL SCALE PRODUCTION

Chili peppers are well adapted for production levels ranging from a few plants grown in a kitchen garden to small- to large-scale production. Because it is a labor-intensive crop, many small farmers may only be able to handle small plots. Some farmers may be able to grow unique or unusual cultivars for sale to local restaurants and hotels or for direct sale to consumers at local farmer’s markets.

Adding value on a small family farm

Possible ways of processing chili peppers include dehydration via ovens or solar drying, the preparation of smoked chilies (such as the popular chipotles or smoked Jalapeno peppers from Mexico) or by pickling, roasting, and in salsa. The Serrano-type peppers are popular for salsa.

With some of the small hot chili types, the green fruit is used for pickling, while the ripened red fruit is dried for use as seasoning and often used in soup, stew, sausage, as well as in a host of Asian and Pacific dishes. When used as seasoning, peppers are usually dried and ground. To improve the flavor of some seasonings it is possible to combine the flavor of a hot or pungent chili pepper variety with a milder but more flavorful variety.

In Mexico, most snacks are spiced with chili flavors, including lollipops, tamarind snacks, chocolate pepper cookies, jellies, and potato chips.

Household use in the Pacific

While chili pepper is a popular condiment throughout the Pacific and found in most home gardens, there is little data on consumption levels in the region. Overall in the U.S., the consumption of pepper types has grown over the past decade. The per capita consumption of all pepper types increased from about 6 kg per person in 2000 to 7.3 kg per person in 2008 (USDA Agricultural Marketing Resource Center 2010).

Nutrition

Chili peppers are a rich source of vitamins C and A. Nutritional descriptors for chili peppers used by the U.S. Food and Drug Administration include fat-free, saturated fat-free, very low sodium, cholesterol-free, and low in calories (Bosland and Votava 2000). Peppers also contain vitamin E, capsanthin, zeaxanthin, and carotenoids. With regard to its use as a medicinal, capsaicin, the compound responsible for the pungency in peppers, is used to relieve pain from arthritis and migraines and for cough or stuffy nose relief. It has also been shown to have anti-clotting properties.

Import replacement

Chili pepper is an important vegetable that can add diversity to modern diets that are based on the consumption of only a few staple crops. By serving as a condiment, it adds flavor and diversity to daily dishes. The daily consumption of chili pepper may also contribute to the intake of vitamin C and other nutrients.

YIELDS

Expected yield per plant

Depending on the type of fruit, the yield of chili peppers in Hawai'i ranges from 2,000 to 6,000 kg per hectare, although commercial yields of jalapeno peppers under intensive commercial conditions in states such as North Carolina can

reach 40,000 kg/ha. The yield of jalapenos is about 0.9–1.4 kg per plant. “Hawaiian” chili pepper fruits are approximately 2 cm long and 1 cm in diameter and are estimated to produce about 2,000 kg/ha during a 6-month harvest period.

Recommended planting density

The planting arrangement depends on the cropping system and whether the plants are grown in monocultures or as part of an intercropping system. The growth habit of a particular variety, length of the growing season, and whether the plants are grown as annuals or as perennials, also determine planting distances.

Depending on the growth habit of the variety that is used, peppers may be planted in single or double rows. In the double-row system, plants may be staggered with the double rows spaced 30 cm apart and beds 100 cm apart. Planting distance between plants within the row are usually 60–120 cm. The wider spacings are used for varieties with a larger canopy and when plants are under production for several months.

MARKETS

Local markets

Chili peppers have a broad market appeal and varied potential market distribution channels. However, growers should first identify a buyer, prior to embarking on a large production program. Because a few farmers can easily flood the market leading to a downward price spiral, farmers should carefully plan which varieties are used and weekly production targets.

Export markets

The export market for chili peppers is very competitive and it may be difficult for small production regions to compete with well established exporters in Asia, Mexico, and Central America. The best option is to initially focus on meeting local demand and then develop niche markets for specialty chili varieties or value-added products.

Specialty markets

There may be a potential for the organic production and sale of chili peppers in areas with a growing tourism industry. The production of value-added or processed products may have greater potential in areas with higher tourist/visitor numbers.

Branding possibilities

In the long run, each farm establishes its own reputation based on product quality (based on following good grading standards), consistency of production, and timely delivery to buyers. While large-scale growers may have the ability to develop their own brands, in the Pacific it may be more ap-



Chili peppers are found fresh or in processed products in most farmers markets, as seen here in Samoa.

appropriate to develop product brands for a specific region or community. The success of community-based brands (e.g., such as a hypothetical “Palau Organics” brand), will depend on extensive coordination, technical exchange, and community participation/cooperation.

Internet sales

There is a potential for Internet sales with the production of value-added products such as jellies, jams, dried products, candies, and so on.

EXAMPLE SUCCESSES

TJ Enterprises, Sinapalo, Rota, Northern Mariana Islands

A family business in the mid-1970s, Frank M. and Ofelia Atalig started selling their chili pepper products under the Pacific Red Hot brand name in 1984. Originally they grew all their peppers on their farm. Today, they use both their own peppers grown on 1–2 ha as well as peppers that they purchase from other local farmers.

The Ataligs produce two main pepper products. The first is a chili paste that is used in many dishes including soups, barbecue sauce, and meat and fish marinades. The second is “Rotabasco,” a hot sauce similar to popular sauces made from tabasco peppers. All processing is carried out at their facility in Rota. The University of Hawai‘i’s Pacific Business Center Program helped to develop the product labeling as well as in making expiration determinations for product shelf life.

TJ Enterprises also does its own packaging and shipping. Most of their production is shipped to five distributors in Guam, who deliver the products to retailers and other large outlets, such as U.S. military bases. Their products are also sold through a web site, which has received orders from consumers in all 50 U.S. states, many Pacific islands, and other countries.

The Ataligs believe that the uniqueness of their product lies in the ingredients and the special processing methods that they have developed. For example, their chili sauce is unfermented and made without vinegar, so it retains the nuanced flavors of the chili pepper and other flavorings. Their biggest challenge is to find capital to expand their business so that they can reach new markets at the retail level, such as the U.S. mainland.

ECONOMIC ANALYSIS

For chili pepper production, major production expenses include nursery production of seedlings, transplanting into the field, management, fertilizers, irrigation, pest management, weed management, harvest, and postharvest han-

dling. In New Mexico when harvests are conducted by hand, labor costs amount to 47–49% of total production costs.

FURTHER RESEARCH

Potential for crop improvement

There is considerable potential for crop improvement through traditional classic breeding techniques. With the many hundreds of varieties available in the marketplace (over 250 in the U.S. alone), there is also considerable potential to select varieties that are best adapted to a particular location. Breeding programs can then be used to further improve adapted varieties.

Improving potential for family or community farming

The production of fresh chili peppers is best suited to individual farms. However, for the production of value-added products (such as jelly, jam, and salsa), there may be a potential for community-based production/marketing programs.



TJ Enterprise’s chili pepper products are sold under the Pacific Red Hot label, designed by the University of Hawai‘i’s Pacific Business Center Program.

Genetic resources where collections exist

Commercial seed companies from Asia and North America have available a wide-range of chili pepper varieties. Local varieties are also available from gardeners and small farmers in most communities. UH Manoa sells the Jalapeno type variety 'Waiialua' which has reported resistance to root-knot nematodes and to bacterial wilt. Before growing this variety in large-sized plots, it is recommended that growers first try it out in only a few rows to make sure that it is adapted to their location and that it meets their production and marketing needs. The UH variety 'Waiialua' is currently grown mostly by home-gardeners in Hawai'i. Small seed samples of chili pepper varieties developed in the U.S. may be obtained from the U.S. Department of Agriculture National Plant Germplasm System. Small seed samples of improved chili pepper lines developed for tropical regions may also be obtained from the Asian Vegetable Research and Development Center.

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

Farm and Forestry Production and Marketing Profile for Chili Pepper (*Capsicum annuum*)

Author: Dr. Hector Valenzuela, University of Hawai'i at Manoa, 3190 Maile Way No. 102, Honolulu, HI 96822; Web: <http://www2.hawaii.edu/~hector/>; <http://www.ctahr.hawaii.edu/organic/>

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