

**Farm and Forestry
Production and Marketing profile for**

Lychee

(Litchi chinensis)

By Yan Diczbalis

USES AND PRODUCTS

The principal product derived from lychee is fresh fruit. In production areas where the quantity of fruit harvested exceeds demand, a range of processed products is produced that includes: whole in-shell and peeled dried fruit, processed and canned fruit, purees, and drinks.

World commercial lychee production is estimated to exceed 1.8 million metric tonnes (MT) with the bulk of world production occurring in China (1.0–1.3 million MT). Exporting countries include China, Taiwan, Thailand, South Africa, Mexico, Mauritius, and Australia. Export of lychee into the Pacific islands is minimal with Tahiti importing small amounts from Australia. New Zealand currently imports small volumes from Thailand and Australia. In Hawai'i, 2008 production was 105 MT which was sold at an average price of \$6.05/kg paid to the farmer (NASS 2009).

BOTANICAL DESCRIPTION

Preferred scientific name

Litchi chinensis Sonn.

Family

Sapindaceae (soapberry family)

Non-preferred scientific names

Non-preferred names include the following as reported by Galan Saucó and Menini (1989)

Dimocarpus litchi, *Euphoria litchi*, *Euphoria punicea*, *Euphoria sinensis*, *Litchi litchi*, *Litchi senensis*, *Nephelium dimo-*

carpus, *Nephelium duriocarpus*, *Nephelium litchi*, *Sapindus edulis*, *Scyotalia chinensis*, *Scyotalia litchi*, and *Scyotalia locacan*

Common names

Chinese: *li zhi*, *li zhi guo*, *lai gee*

English: lychee, litchi, lichee, litchee, leechee

Indonesia: *lici*, *litsi*

Philippines: *letsias*, *alupag-amo*, *licheas*

Portuguese: *lichia*

Spanish: *lechia*

Thailand: *lin-chi*

Tonga: *tava siaina*, *tava paelangi*

Brief botanical description

The lychee is a medium to large tree commonly growing to 12 m tall but some varieties such as 'Tai So' easily reach 20 m in height. Unpruned trees generally develop a spherical crown. Branching habit can be compact or relatively sparse and varies between varieties. Shoot growth occurs in successive flushes that are vegetative during summer and may be floral in winter if sufficient cool is experienced during early winter bud movement. The lychee is a terminal flowering plant and in most growing areas there are usually two vegetative flushes followed by one floral/fruitlet flush. The leaves of new vegetative flushes, dependent on variety, range from whitish green to pink to red and rapidly turn light green and then dark green at maturity. The leaves are arranged alternatively on the flush and are pinnately compound with elliptically shaped leaflets 7–12 cm long.

The flowers (3–5 mm wide when fully open) form on a terminal panicle and contain functionally female flowers and



Left: Lychee variety 'Kaimana' growing in South Kona, Hawai'i. Right: Fresh 'Bosworth 3' fruit for sale at local farmer's market in North Kona, Hawai'i.



Left: Honey bees are an important lychee pollinator. Right: Flowers and young fruits forming.

two types of functional male flowers, one with a undeveloped female organs and the other without. Flowers open in cycles of sex types. Male flowers usually precede female flowers. Overlap can occur within the panicle and between panicles to allow pollination to occur.

Lychee fruit takes up to 3 months to develop depending on variety and environment. The lychee pericarp (skin) develops first, followed by seed and then aril (flesh) development. Lychee skin has a rough texture comprised of many small pyramidal protuberances that flatten as the fruit matures. Fruit shape, skin protuberance characteristics, and seed shape vary with variety and are often used to identify varieties. Immature fruit are green in colour and develop a pink/red colour when mature. Lychee seeds are generally dark brown to black in colour with a shiny smooth coat. Seeds shape and size varies with variety and environmental conditions during fruit set and development. Large seeded varieties develop oblong to round seed 1–3 cm long and up to 1 cm wide. Popular varieties have a high proportion of shriveled (non viable) seed known as “chicken tongue,” which describes the shape of the seed. In rare cases seed can be almost entirely absent. The aril (edible flesh) is translucent off-white in colour and is sweet and juicy with a slight acid background depending on variety and fruit maturity.

DISTRIBUTION

Native range

The commercial form of *Litchi chinensis* (subspecies *chinensis*) originated in the moist tropical to subtropical forests of southern China and northern Vietnam. It can still be found in the wild in forests in Chinese provinces of Hainan Island,

Yunnan, Guangxi, and western Guangdong (Huang et al. 2005). Two other subspecies have been classified: *Litchi chinensis* subsp. *philippinensis* and subsp. *javensis*, native to the Philippine islands and the Malay Peninsula and Indonesia, respectively. Neither of the latter two subspecies is grown commercially.

Current distribution worldwide

Lychee is widely distributed throughout the world’s subtropical and tropical regions. Major centres of production are China, India, Vietnam, Taiwan, Thailand, Madagascar, Nepal, Bangladesh, and South Africa. Smaller production centres include Australia, South Africa, Israel, Mexico, Brazil, and USA (Hawai‘i and Florida). The lychee is sparsely distributed throughout the Pacific islands. In addition to Hawai‘i, minor production occurs in New Caledonia and Tahiti. A few specimen trees exist in Tonga.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

The lychee is arguably a species most suited to subtropical climates, however production can successfully occur in tropical regions where sufficient winter cooling occurs to simulate flowering. Examples of tropical production locations where commercial production occurs include eastern Australia (16°S to 23°S); Hainan Island (China) 18°N to 20°N; South Africa (15°S); Hawai‘i (19–22°N). Early flowering varieties such as ‘Souey Tung’, ‘San Ye Hong’, ‘Feizixiao’, and ‘Kaimana’ have a lower requirement for winter cool to stimulate flowering and hence can flower and set fruit suc-

Table 1. Elevation, rainfall, and temperature

Elevation range	lower: sea level upper: 1,000 m
Mean annual rainfall	lower: 1,000 mm upper: 4,000 mm
Rainfall pattern	Lychee generally flourish in environments with summer rainfall.
Dry season duration (consecutive months with <40 mm [1.6 in] rainfall)	2–3 months without supplementary irrigation and 7–8 months with irrigation
Mean annual temperature	lower: 19°C upper: 23°C
Mean maximum temperature of hottest month	lower: 29°C upper: 37°C
Mean minimum temperature of coldest month	lower: 7°C upper: 17°C
Minimum temperature tolerated	0°C

cessfully in warmer growing regions. Areas that have a cool winter followed by relatively humid and warm spring/summer periods are preferred. Hot, dry weather during fruit development can be associated with fruit drop, browning, splitting, and poor fruit colour.

Lychee are generally produced in areas experiencing regular rainfall and high humidity, hence the coastal/wetter areas are suited to production. There are examples of lychee producing well in drier climates (e.g., Israel, India), however, irrigation is essential when rainfall is poorly distributed and less than 1,200 mm/year. Seasonally high rainfall coinciding with late fruit maturity and harvest coincide can lead to pre-harvest rots and postharvest problems.

Ideal climatic requirements are:

- Absence of strong, regular wind throughout the year
- No hurricanes (syn. cyclones, typhoons)
- Dry conditions pre-flowering to deter late autumn vegetative flushing
- Regular minimum winter temperatures less than 18°C to stimulate panicle emergence, frost free
- Increasing temperature and humidity during flowering and fruit setting
- Warm temperatures and moderate rainfall and humidity during fruit development and harvest
- High temperatures, rainfall, and humidity postharvest to simulate rapid flush development post pruning.

In a maritime environment such as Hawai'i Island, experience and observation shows that better locations for lychee tend to be leeward areas that receive a cool and dry winter. Elevations of about 30–330 m on the windward side of Hawai'i Island are acceptable, but on the leeward (Kona) side, lychee can produce well at elevations up to 500 m. If temperatures do not go below 18°C during the flower in-

duction period, flowering is very poor (Mike Nagao, pers. comm.).

Soils

Lychee tolerates a range of soil types. Acidic (pH 5.5–6.5), well drained deep soils with good structure, water holding capacity, and organic matter are ideal for vegetative growth. In production regions where temperatures are higher than ideal during autumn and winter, tree productivity may benefit from planting on less ideal soils, which leads to a reduction in vegetative vigour. Poorly drained soils should be avoided unless mounding or extensive drainage infrastructure are provided. Seasonally flooded soils have been associated with “sudden death” in young trees. Likewise, soils high in soluble salts or areas where irrigation water is high in salt should be avoided.

GROWTH AND DEVELOPMENT

Lychee trees are generally clonally propagated by marcotting (air-layering) or grafting to ensure that the fruit variety characteristics are maintained. Young trees require 2–3 years of growth before flowering and fruiting with full production generally occurring 5–6 years of age. In many climates, lychee can be biennial in production capacity with productivity closely linked to climate. Trees undergo a series of successive vegetative flushes during the wet summer months prior to a dormant stage during a drying and cooling autumn. If conditions during the cool season are conducive to flowering (mean daily temperatures below 18°C) the next flush will be reproductive with flowers developing on a terminal panicle. If insufficient cool weather occurs during bud development the winter flush will be vegetative or a mix of vegetative and reproductive.

Following successful panicle emergence, flower development, anthesis and fruit set, fruit development takes 90–120 days depending on variety and climate. Harvest occurs in late spring to mid summer.

Lychee trees take 2–3 years to flower when propagated clonally. Flowering occurs during late autumn to early winter depending on variety with late varieties generally requiring more cold for floral induction. Trees raised from seedlings can take up to 6 years for flowering to occur. Fruit development occurs during spring a period of increasing temperature and humidity with fruit maturity occurring in late spring to mid summer.

AGROFORESTRY AND ENVIRONMENTAL SERVICES

Agroforestry/interplanting

Lychee may be part of mixed fruit tree gardens throughout villages in Thailand, Laos, north Vietnam and southern

China, however, commercially it is generally planted as a monocrop. Various vegetables can also be interplanted with lychee when trees are young and there is ample space between them.

Environmental services provided

Lychee provides no major environmental services other than providing fruit. It may be used as an avenue tree. In SE China, ancient trees, approximately 1,000 years of age, are identified and protected as national monuments.

PROPAGATION AND PLANTING

Lychee is commonly propagated by air-layering (marcotting) or via grafting techniques. Air-layering is relatively easy and several hundred air-layers may be produced per day by an experienced propagator. Grafting requires more specialized skills and is most frequently utilized as a propagation technique in China. The varieties 'Tai So' and 'Wai Chee' are commonly utilized as seedling stock. For plant germplasm acquisitions and transportations, scion wood is the preferred vehicle to minimize inadvertent transportation of disease and insects.

Outplanting

Traditionally, air-layers were potted up for 3–4 months prior to field planting following removal from the mother tree when an adequate root ball has formed. Recent commercial practices in Australia suggest that direct planting of air-layers into a well prepared site with irrigation available is a viable technique, saving time and money. Tree guards are used to protect the newly planted marcotts while they establish. Heavy doses of fertilizer should be avoided in the first 6 months following planting. Organic and slow release fertilizers are preferred until the root development is well established.

CULTIVATION

Variability and known varieties

There are well over 400 lychee varieties identified in China, and 50 varieties identified in India. Despite the large gene pool available, the bulk of production in most countries is based on only a few varieties. Popular varieties for a range of growing locations are shown in Table 2.

Basic crop management

Basic crop management includes:

- Prune as soon as possible after harvest
- Fertilize and irrigate to ensure rapid production of new vegetative flushes
- Withdraw irrigation and fertilizer following maturity of the second vegetative flush. In warmer growing



Top: Lychee picking using aluminum picking ladders, secateurs and picking bags. Middle: Lychee picking using a motorized hydraulic picking ladder (cherry picker). Bottom: Squash plant (*Cucurbita* sp.) growing in the space around a young lychee tree. The lychee was planted on the edge of a coffee orchard in Kona, Hawai'i.



© Yan Diczbalis, DPI&F



© Yan Diczbalis, DPI&F

Left: Young lychee tree direct planted as a marcott. Note use of shade/wind protection, synthetic weed mat, drip tube, and Wynn cassia (*Cassia rotundifolia* cv. Wynn) as a permanent ground cover. Right: George Wahday, whose family introduced several named lychee varieties into Cairns (northern Australia) in 1918.

areas such as Hawai'i, fertilize and irrigate for the development of the first flush immediately after pruning. This ensures a drop in leaf nitrogen, which assists in promoting flowering.

- Girdle (cinch) main trunk and/or branches on matured growth to reduce the chance of late flush.
- Control late, unwanted autumn flush by tip pruning and or using chemical pruning agents (e.g., Ethrlyl)
- Fertilize and irrigate following floral initiation to ensure panicle development
- Prune panicles in fruit setting shy varieties such as Feizixiao.
- Maintain irrigation and fertilizer inputs during fruit development with emphasis on potassium inputs in the later half of fruit maturity
- Netting trees or bagging fruit for protection against fly foxes and birds. Bagging fruit may also be used to protect mature fruit from fruit fly infestation and increase fruit quality.
- Allow fruit to mature on the tree before harvesting. Use a taste test to determine maturity.

Special horticultural techniques

In growing regions where temperatures are not consistently cool enough to stimulate flowering or late autumn rains induce a late, unwanted flush, a range of techniques have been developed to improve flowering.

Girdling (cincturing), the removal of a small strip of bark (1.5–4 mm wide) in a full circle or spiral pattern is the major technique used to control late flush emergence and improve flowering and subsequent fruit set. Physical or chemical

methods to remove late emerging flush are also commonly used.

Table 2. Some popular lychee varieties, their country of origin and where commonly grown.

Variety	Country of origin/selection and (regions where commonly grown)
'Bombai'	India
'Bosworth 3' ('Kwai Mai Pink')	Australia (Hawai'i)
'Brewster'	Florida
'Calcutta'	India
'Chakkraphat'	Thailand
'China'	India
'Dazao' ('Tai So', 'Hong Huai', 'Mauritius')	China (Thailand, South Africa, Florida, Israel, Australia)
'Feizixiao' ('Fay Zee Siu')	China (Taiwan, Australia)
'Floridian'	California (Israel)
'Groff'	Hawai'i
'Guiwei' ('Kwai Mai')	China (Taiwan)
'Heiye' ('Haak Yip')	China (Taiwan, Hawai'i, Florida, Australia)
'Huaizhi' ('Wai Chee')	China (Australia)
'Kaimana'	Hawai'i (Australia)
'Khom'	Thailand
'No Mai Chee'	China (Taiwan)
'Sah Keng'	Taiwan (Australia)
'Salathiel'	Australia
'San Yue Hong' (3 month red)	China (South Africa)
'Shahi'	India
'Souey Tung'	China (Australia)

Advantages and disadvantages of growing in polycultures

Lychee lends itself well to polycultures where the tree can be incorporated into a broader production and subsistence system. Other trees such as coffee or small crops such as pineapple and vegetables can be grown in between the lychee trees. The crop diversity offered in this situation is excellent where a year round food and fruit supply is desired. One or two lychee trees can be more than adequate to supply a family and offer income opportunities.

PESTS AND DISEASES

Susceptibility to pests/pathogens

Lychee is susceptible to a range of pests and diseases. Commonly experienced insect and mite pests include:

- Erinose mite (*Aceria litchi*)
- Leaf and flower eating caterpillars
- Fruit borers
- Fruit spotting bugs
- Mealybugs

- Scale
- Leaf miners
- Leaf feeding beetles and weevils

Common fungal problems include:

- Anthracnose (Pepperspot)
- Flower blight
- Root rot
- Postharvest fruit rots

Common vertebrate pests include:

- Birds
- Bats (flying fox)

Before introducing lychee trees to a new region, ensure that the material is free of erinose mite. A number of pre-export sprays of insecticide (dimethioate and or wettable sulphur) are required. Following importation, a prerelease period in quarantine (3–9 months) will allow material to be inspected for introduced pests that can be eliminated before plants are established in the field.



Top left: Mature fruiting lychee ('Bosworth 3') grown under permanent netting in north Queensland. Top right: Mature lychee trees regrowing following a heavy top prune. Bottom left: Bird damage on fruit that was not bagged or protected with netting. Bottom right: Bagging fruit is a way to improve quality and net profits.

Sustainable methods for pest and disease prevention

Netting is commonly used to deter fruit-eating birds and bats. In Australia, the majority of growers use temporary and permanent netting systems to prevent predation by birds and bats.

Copper fungicides are commonly used to control anthracnose and flower blight. Regular pre-harvest application can minimise the incidence of postharvest rots.

Insecticides are occasionally required to deal with severe outbreaks of insect or mite pests. Pesticide labels must always be followed.

As a cleansing spray of the tree trunk after pruning or protective sprays on shoots just prior to flushing, wettable sulfur has been observed to reduce and prevent erinose mite damages to leaf, flower, and fruit.

It is critical to maintain even soil moisture as fruit matures. Heavy rain on a water stressed orchard frequently results in fruit splitting. A simple way of maintaining even moisture is to retain a clean layer of leaf mulch around each tree.

DISADVANTAGES

Lychee is not an ideal crop for warmer tropical areas that do not experience a period of cold temperature required to induce flowering. Early varieties such as 'San Ye Hong', 'Souey Tung', 'Kaimana', and 'Feizixiao' may be more suited to warmer growing areas.

Fresh fruit shelf life is relatively short. Fruit postharvest life is short (5–7 days) unless moisture retention and cooling technology is available. Fruit dehydration and enzymatic process in the pericarp (skin) contribute to skin browning. Brown fruit have low visual appeal yet internal fruit quality may still be acceptable.

Potential for invasiveness

There is minimal potential for invasiveness. Although lychee seeds germinate readily, young seedlings require care to establish and flourish.

COMMERCIAL PRODUCTION

Postharvest handling and processing

Lychee fruit are best eaten fresh and fruit postharvest life is relatively short. Fruit browning due to the rapid rate of moisture loss from the fruit following harvest and the commencement of enzymatic browning are two major postharvest factors. In rural Asian growing regions, lychee is usually picked, packed, and sold on the panicle (stem) in the local community. Fruit postharvest life is not an issue where fruit is rapidly consumed at the local level.

In commercial production environments where fruit have to be transported to distant markets or the rate of consumption does not match the supply, fruit postharvest technology is critical to successful marketing.

Lychee fruit are best picked early in the morning either on the panicle or as single fruit. The maintenance of a moist and cool chain is imperative to maintaining fruit quality. Fruit should be rapidly graded, removing damaged, split, insect-stung, and below grade fruit, ensuring that fruit are handled carefully and kept moist along the grading packing line. The use of hydro cooling (12°C) baths can rapidly reduce fruit temperature prior to packing. Fruit should be packed in polyethylene bags or similar material to ensure retention of high humidity around the fruit.

For short-term storage, fruit are best maintained at 10°C whereas for longer storage options a temperature of 5°C is preferable. Cooler storage options (1–2°C) have been assessed as part of fruit disinfestation programs, however, these temperatures should be avoided if not necessary for quarantine requirements because fruit quality can be compromised during storage at such low temperatures.

Processed products

Lychee fruit can be processed in many ways. Drying, in particular solar drying, is a potential low technology solution to dealing with production in excess of the demand for fresh fruit. Lychee can be dried at home in shell using a very simple drying box with mesh rack enclosing a commercial dehumidifier. At a medium setting of 7 or 8, fresh lychee fruit without stem and leaf can be dried sufficiently for storage in about 10 to 12 days (results vary with variety and fruit size). When properly dried, the skin will be brittle and crack when pressed. The intact dried fruit can be stored in a plastic bag for at least a year and retains good eating qualities. It is important not to use high heat for drying, which will give a charred and bitter flavor to the final product and over-dried aril is hard, stiff, and tasteless. Soft and pliable amber colored dried lychee aril is a superior product.

Home scale preserves and jams are also options. At a commercial scale, the cost of the technology and machinery involved becomes prohibitive for small scale producers.

Product quality standards

Industries in Australia, Hawai'i, and Florida have developed fruit quality standards for marketing purposes. These standards are generally developed for 1st and 2nd grade fruit. Fruit are deemed suitable for 1st grade if they are free of blemishes (abrasion damage, browning, pepper spot, and sooty mould). Fruit categorized as 2nd grade may have a small percentage of their surface area affected with one or two of the blemishes listed above. Both 1st and 2nd grade fruit must be free of fruit with split skin, pulled stems, insect stings/dam-



Left: Maintaining the wet chain prior to transporting fruit to the packing shed. Right: Typical postharvest handling machinery used by Australian lychee growers. It includes: manual destalking, grading, in-line hydro-cooling, and size grading.

age, and scale. Quality standards are best developed for the market where fruit will be sold. International Codex standards are also available (Codex Standard 196-1995).

Despite the development of fruit quality standards, during times of fruit shortage fruit quality becomes less important when market demand is high.

Product storage requirements and shelf life

The establishment of a moist and cool chain through the use of packaging and refrigeration can extend fruit life to 2 weeks. In production regions where cool storage is not readily available, fruit packaging (plastic bags, cling wrapped punnets) can help extend the shelf life of fruit for 5–7 days.

Fruit should never be stored loose (unpackaged) in cool, dry environments typically found in the grocery section of western style supermarkets.

Recommended labeling and packaging

Fruit packaging and labeling standards vary depending on country of production and market requirements. In Australia cling wrap, lidded punnets, or sealed polyethylene bags have been successfully used to market “retail ready” fruit.

The minimum labeling requirements for a local domestic market may include fruit name, grower identification and net weight of package. Labeling requirements become more strenuous for export markets.

SMALL SCALE PRODUCTION

Fresh lychee fruit is eagerly consumed by many people is well known for its flavor, juiciness, and texture. Lychee can be well suited, where favorable climatic conditions exist, to small-scale production particularly where there is no competition from large commercial orchards or cheap imported fruit. This is particularly relevant on Pacific islands, where air shipping has become very expensive.

Variety selection and plant spacing should be considered to allow high density planting. Recent plantings on commercial farms in Queensland are at densities of 600–700 trees/ha, which is considerably higher than a traditional density of 100–200 trees/ha. At high densities, yearly heavy pruning is undertaken after harvest to keep the trees small.

Small-scale value-adding

The real value of lychee is for its fresh fruit, particularly in a market that is not oversupplied. The production of lychee for processed product is unlikely to be economic unless high volumes of fruit are available. However a number of specialty products have emerged from production regions where fruit is produced in excess to demand. These include lychee wine and or mixed tropical fruit wines with lychee as a base.

Use in the Pacific

The distribution of lychee in the Pacific is limited to island groups north or south of 20° latitude. Lychee does not per-



Left: A 375 g lidded punnet “retail ready pack” (variety ‘Feizixiao’). Right: A 5 kg box of lychee (‘Wai Chee’) packed in a perforated plastic bag at the Sydney, Australia, wholesale market.

form well in tropical zones. Hawai‘i and New Caledonia both have small commercial production areas that produce fruit for the local and tourist communities.

Nutrition

Lychee has a minimal contribution to the nutritional health of pacific communities given its limited distribution and commercialization in the Pacific. However, where it is produced it offers an important healthy fruit alternative to the community.

Import replacement

Where the crop can be successfully produced, it will contribute to reducing imports and also to boosting local crop production and marketing opportunities.

YIELDS

Expected range of yields per plant

Fresh fruit yields range from 5 to 20 MT/ha depending on variety, plant spacing, and growing climate. Individual tree yields can vary from 5 to 100 kg depending on variety, tree size, management, and seasonal influences.

Recommended planting density

Recommended density is from 200 (10 × 5 m) to 350 (8 × 3.5 m) trees/ha. However, in climates where cool to cold winter conditions occur, the more adventurous may wish to explore higher densities. For home gardens or polyculture situations a few trees 12–20 m apart may be more appropriate.

MARKETS

Local markets include roadside sales, farmers markets, retailers, restaurants, and agritourism opportunities. Export market opportunities in the Pacific are most likely limited to interisland trade where frequent, rapid, and inexpensive transport opportunities are available. Export markets into Europe, North America, and Asia are already well supplied by existing producing countries. Europe is well supplied by Madagascar, South Africa, Mauritius, and the Seychelles. North America (the mainland U.S.) has production in Florida and imports fruit from China and Mexico as well as from Hawai‘i. Canada imports the bulk of its lychee from China. In Asia, fruit is exported from early producing regions such as Thailand to China, Hong Kong, and Singapore. Chinese fruit are exported to Hong Kong and Singapore.

Specialty markets

Specialty market opportunities may exist depending on growing location and markets. In Australia and Hawai‘i, organic market opportunities are being explored by some producers. However, consumers may be reluctant to pay a price premium for organic fruit relative to cheaper alternatives. Insufficient information is available to comment on how these opportunities may be explored in the Pacific. Organic fruit still needs to meet importing country quarantine requirements.

Branding possibilities

Branding opportunities vary with the variety, growing location, markets, and the skill of the marketing personnel involved. There is no immediate opportunity that presents it-

self. However, in more developed commercial lychee growing regions there is a trend to grow small seeded varieties with a better flesh-to-seed ratio, as these fruit command a higher market price.

Potential for Internet sales

Internet sales potential exists, however, order fulfillment must be firmly linked to regular, rapid, and inexpensive freight connections. Fruit sales on the Internet must meet importing country quarantine requirements.

EXAMPLE SUCCESS

Love Family Farms, Captain Cook, Hawai'i

Ken Love had a passion for lychee since his childhood when he tasted preserved lychee in Chinese restaurants in Chicago. When establishing a farm in Hawai'i in the 1980s, he planted lychee together with a diversity of other fruit crops.

When in season, Ken sells fresh lychee. The varieties he sells include 'Kaimana', 'Groff', 'Kwai Mi', 'Bosworth', 'Brewster', 'Emperor', and 'B3'. By bagging fruit in the field, he has little damage from insects and birds, and therefore a much higher quality product that is sought after by consumers.

To serve his customers in the off-season, Ken preserves fresh lychee in a simple syrup (sugar, pectin, and calcium water) and bottles it for sale. The preserves are made in small batches with all the fruit preparation done by hand. The process takes more time than citrus marmalade, and is not profitable. However, having the preserved lychee available increases rapport with visitors to his booth at the farmers market, which helps sell other fruits.

Ken also freezes whole lychee to keep on hand for visitors to try. Freezing is a simple process that can be done on any farm. Ken washes the fruit and seals it in freezer bags prior to freezing. When thawed, lychee that has been frozen retains much of its flavor and texture. Ken has also tried drying lychee, but thinks the taste is disappointing compared with fresh or even frozen lychee.

Ken sells his 100% locally grown and processed fruit preserves at farmers markets and on an Internet e-commerce site. He sells fresh fruit at farmers markets, to a local distributor, to grocery stores, and sometimes directly to hotels. Direct to resort hotel sales have grown tremendously with the increased awareness and advantages of good farmer-chef relations. He believes the best strategy is to have several outlets for his produce in order to diversify his markets and strengthen the local food economy.

ECONOMIC ANALYSIS

Expenses of production

Production expenses are highly variable depending on labour rates and input costs, which are dependent on the location.

In SE Queensland a gross margin analysis conducted in 2002 indicated the following variable costs for conventional production systems:

Costs	Amount in AUS\$/ha
Weed control	132
Pest and disease control	1,271
Nutrition	832
Irrigation	2,200
Canopy management	180
Harvesting and marketing	19,972
Total variable cost	24,587



Love Family farms lychee preserves for sale at farmers market.

The gross margin per hectare based on the above variable costs is AUS\$21,814/ha assuming a yield of 11.6 MT/ha and fruit valued at AUS\$4/kg.

Prices for lychee in production areas vary enormously. Retail prices range from \$7.70/kg to \$13.20/kg in Hawai'i. Low prices can be \$0.50/kg in China and \$3.00/kg in Australia. High prices for small seeded varieties on the cusp of the season can vary from \$10/kg in China to \$20/kg in Australia. However these high prices are not indicative of average returns, which are closer to the low price range.

FURTHER RESEARCH

Potential for crop improvement

Major crop improvement issues are regularity of flowering and fruit set and varietal improvement.

Improving potential for family or community farming

In a favorable production environment, lychee can add to the productive potential of family and community farms.

Genetic resources where collections exist

Extensive collections exist in China, Taiwan, Thailand, Vietnam, Hawai'i, and Australia.

REFERENCES AND FURTHER READING

Chia, C.L., R.A. Hamilton, and D.O. Evans. 1997. Lychee. Fact Sheet Horticultural Commodity No. 1. University of Hawai'i CTAHR, Honolulu.

Galan Saucó, V., and U.G. Menini. 1989. Litchi cultivation. FAO Plant Production and Protection Paper 83. Food and Agriculture Organisation of the United Nations, Rome.

Greer, N., and T. Campbell. 1990. Growing Lychee in north Queensland. Queensland Department of Primary industries, Nambour, Australia.

Menzel, C. 2002. The Lychee Crop in Asia and the Pacific. Food and Agriculture Organisation of the United Nations. RAP Publication 2002/16, Bangkok.

Menzel, C., and I. Kernot. 2002. Litchi—Information Kit. Queensland Department of Primary Industries and Fisheries.

Nagan, M. 2010. Personal Communication.

National Agricultural Statistics Service (NASS). 2009. Hawaii Tropical Specialty Fruits. http://www.nass.usda.gov/Statistics_by_State/Hawaii/Publications/Fruits_and_Nuts/index.asp [accessed July 27, 2010]

Menzel, C.M., and G.K. Waite. 2005. Litchi and Longan. Botany, Production and Uses. (editors). CABI publishing, Wallingford, UK.

Zhang, Z. (ed.). 1997. Litchi Pictorial Narration of Cultivation. Pomology Research Institute, Guangdong Academy of Agricultural Sciences.

Zee, F., M. Nagao, M. Nishina, and A. Kawataba. 1999. Growing Lychee in Hawaii. Fruits and Nuts, F&N-2. University of Hawaii Cooperative Extension Service. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/F_N-2.pdf [accessed July 20, 2010]

Internet resources

Australian Government Rural Industries Research and Development Corporation for electronically available research reports: <http://www.rirdc.gov.au>

California Rare Fruit Association: <http://www.crfg.org/pubs/ff/lychee.html>

Purdue University Center for New Crops and Plant Products: http://www.hort.purdue.edu/newcrop/nexus/Litchi_chinensis_nex.html

Lychee postharvest information from UC Davis Postharvest Technology Research and Information Center: <http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/lychee.shtml>

Farmer's Bookshelf: Lychee. Department of Tropical Plant & Soil Sciences, University of Hawai'i at Mānoa: <http://www.ctahr.hawaii.edu/fb/lychee/lychee.htm>

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

**Farm and Forestry
Production and Marketing profile for
Lychee (*Litchi chinensis*)**

Author: Yan Diczbalis, PhD, Department of Primary Industries and Fisheries, Centre for Wet Tropics Agriculture, PO Box 20 South Johnstone, Qld, 4859, Australia; Email: yan.diczbalis@dpi.qld.gov.au, Web: <http://www.dpi.qld.gov.au>

Recommended citation: Diczbalis, Y. 2011 (revised). Farm and Forestry Production and Marketing Profile for Lychee (*Litchi chinensis*). In: Elevitch, C.R. (ed.). Specialty Crops for Pacific Island Agroforestry. Permanent Agriculture Resources (PAR), Hōlualoa, Hawai'i. <http://agroforestry.net/scps>

Version history: July 2010, February 2011

Series editor: Craig R. Elevitch

Publisher: Permanent Agriculture Resources (PAR), PO Box 428, Hōlualoa, Hawai'i 96725, USA; Email: par@agroforestry.net; Web: <http://www.agroforestry.net>. This institution is an equal opportunity provider.

Acknowledgments: Comments on the manuscript from Robert Paull, Mike Nagao, and Francis Zee are greatly appreciated. Photos contributed by Scott Ledger and Ken Love are gratefully acknowledged.

Reproduction: Copies of this publication can be downloaded from <http://agroforestry.net/scps>. Except for electronic archiving with public access (such as web sites, library databases, etc.), reproduction and dissemination of this publication in its entire, unaltered form (including this page) for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holder. Use of photographs or reproduction of material in this publication for resale or other commercial purposes is permitted only with written permission of the publisher. © 2010–11 Permanent Agriculture Resources. All rights reserved.

Sponsors: Publication was made possible by generous support of the United States Department of Agriculture Western Region Sustainable Agriculture Research and Education (USDA-WSARE) Program. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, and Agricultural Experiment Station, Utah State University, under Cooperative Agreement 2007-47001-03798.

