

***Litchi chinensis* Sonn. Monograph**

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Table of contents

[Litchi Chinessis Sonn. Monograph](#)

[Table of contents](#)

[Introduction](#)

[1 Agroecology](#)

[1.1 Taxonomy](#)

[1.2 Affinities](#)

[1.3 Origin](#)

[1.4 Present Distribution](#)

[1.5 Environmental Factors](#)

[2 Biology](#)

[2.1 Chromosomes](#)

[2.2 Life Cycle and Phenology](#)

[2.3 Reproduction and Pollination](#)

[Chapter 3 Propagation and Management](#)

[3.1 Propagation](#)

[3.2 Management](#)

[4 Emerging Products and Markets](#)

[4.1 Market Projection](#)

[4.2 Exports](#)

[4.3 Imports](#)

[4.4 Market Challenges](#)

[4.5 Products](#)

Introduction

Litchi Chinensis Son. most commonly known as lychee is a subtropical fruit native to Southern China with roots dated back to the Tang Dynasty. In recent years, this fruit has been gaining popularity and is globally recognized for its aromatic scent, juicy texture, delicious fruit, and beautiful flowers. This fruit is part of the Sapindaceae family, which includes a variety of other asian-based fruits such as the Longan, Rambutan and Acer. Currently it is grown in multiple countries with its main producers being China and India. The fruit is recognized for multiple properties such as antioxidant capabilities and as a digestive tool.

Lychee is a staple in Asian horticulture with it being dated to more than 2,000 years ago. Because of its native roots to Southern China, this fruit is embedded into Chinese culture not only as a fruit but also as a part of Chinese art and literature. In Chinese culture Lychee is regarded as a symbol for love, beauty and prosperity, because of its attractive fruits and flowers whose harvest season in China generally lies in spring and summer. As well, because of the Lychee's almost heart-shaped fruits they are considered an aphrodisiac of love, and they are interconnected in many Chinese folklore stories. Over multiple centuries, the fruit's production has expanded to other countries such as Vietnam, Thailand, multiple regions of Africa, Oceania and even certain parts of South America.

Today, Lychee has become incredibly valuable for the global market. With multiple imports and exports this fruit has reached a key role in both local and international trade. Currently there are multiple producers of Lychee mostly in its originating countries, and the industry supports multiple large-scale and local farmers. Although this does not mean that the fruit does not have limitations, because of the strict environmental factors that the tree needs to produce the Lychee fruit, the peak harvest season generally lies in the months of May-August, which means that the fruit's market activity lies in the months of September and October internationally. Lychee also has an incredible amount of by-products that helps boost the market even more, with jams, canned lychee and lychee juice this product becomes more than a fruit but also a key role in cosmetic, cocktail and processed goods industries.

Litchi Chinensis Son. also has an outstanding nutritional value. It is rich in antioxidants because of the large amount that the fruit has of vitamin c. This also helps with immune function. Other than the antioxidant properties, lychee is also considered to be a great source of fiber which helps the digestive system and the regulation of blood sugar. In recent years, lychee fruit has become a popular snack because of its low calories and a great source of healthy carbohydrates. Lychee is also a good source of essential minerals such as copper, phosphorus and magnesium.

Overall this monograph is meant to show the qualities, necessities and structure of the lychee fruit. Many people believe this fruit to be obscure or unknown and that is why it is important to highlight all of the great attributes that it contains. This monograph is divided into four key sections that organize all the information. The first chapter is mainly about lychee's agroecology which is dedicated to the origins of the fruit, its taxonomy and some of the basic environmental factors the fruit needs. The second chapter goes more in depth with the biology of the fruit talking about reproduction, life cycles and structure of the fruit. Then the third chapter is all about the propagation and management of the fruit. Finally the fourth chapter talks about a more in depth analysis of lychee's role in local and international markets.

1 Agroecology

1.1 Taxonomy

Litchi chinensis Sonn. belongs to the kingdom Plantae, this kingdom includes all land plants (mosses, flowering plants, ferns, etc.) despite of all their variations all of these plants have common features such as being multicellular and **eukaryotic**¹, being independent on their nutritional needs (by means of photosynthesis) and reproducing through passing down genetic information (Burrows & McCubbin, 2018). Lychee also belongs to the phylum Streptophyta which are an assembly of **paraphyletic**² algae and land plants. They are also part Equisetopsida class which include spore-bearing vascular plants that have a specific reproductive structure made out of compressed stems and their subclass is Magnoliidae which include flowering plants that usually have pollen with one singular pore.

Lychee is a member of the Sapindaceae family that includes almost 2,000 species and 150 genera (Menzel, & Pacific, 2002) such as chestnut (*Castanea Sativa* L.), maple (*Acer spp.* L.) and Spanish lime (*Melicoccus bijuga* L.). This family consists of flowering plants which occur in tropical and subtropical areas like South America, Asia and Africa. Lychee is considered a prominent member of this sub-family due to its appeal and history in Asian culture.

Lychee is the only member of the Sapindaceae family with the litchi genus. The sapindaceae family is commonly known as the soapberry family, all plants that belong to it have pollen-bearing flowers and usually have a tropical origin. Within the genus there are three subspecies but *Litchi chinensis* Sonn. is part of the Indonesian and Chinese species. This specific species produces pink Lychee with a rough red shell.

¹ Eukaryotic means organisms whose cells have a membrane bound nucleus

² Paraphyletic means descendant from an evolutionary ancestor but not including all descendant groups.

Table 1*Taxonomy of Litchi chinensis Sonn.*

Domain	Eukarya
Kingdom	Plantae
Phylum	Streptophyta
Class	Equisetopsida
Sub-class	Magnoliidae
Order	Sapindales
Family	Sapindaceae
Genus	<i>Litchi</i>
Species	<i>chinesis</i>

1.2 Affinities

Fruits that have affinity with Lychee are ones that are in the same family and subfamily considering that the *Litchi* genus is unique to Lychee. Longan's (Figure 1, below) genus is *Dimocarpus*, which causes the flavor and outside look to be distinct from Lychee but they share similarities like being products of a flowering tree and having white flesh. Rambutan is also part of Lychee's family but its genus is *Nephelium* (Figure 2, page 4), they are both part of the soapberry (Sapindaceae) family but they differ in appearance and taste. As well, more than 400 lychee cultivars are preserved at the National Lychee Germplasm in Guangzhou, China (Hu, G et al., 2022)

Figure 1:

Dimocarpus Longan Lour. (Singapore Flora and Fauna, 2022)



Figure 2:

Nephelium lappaceum L. Rambutan. (Ahmad Fuad Morad, 2011)

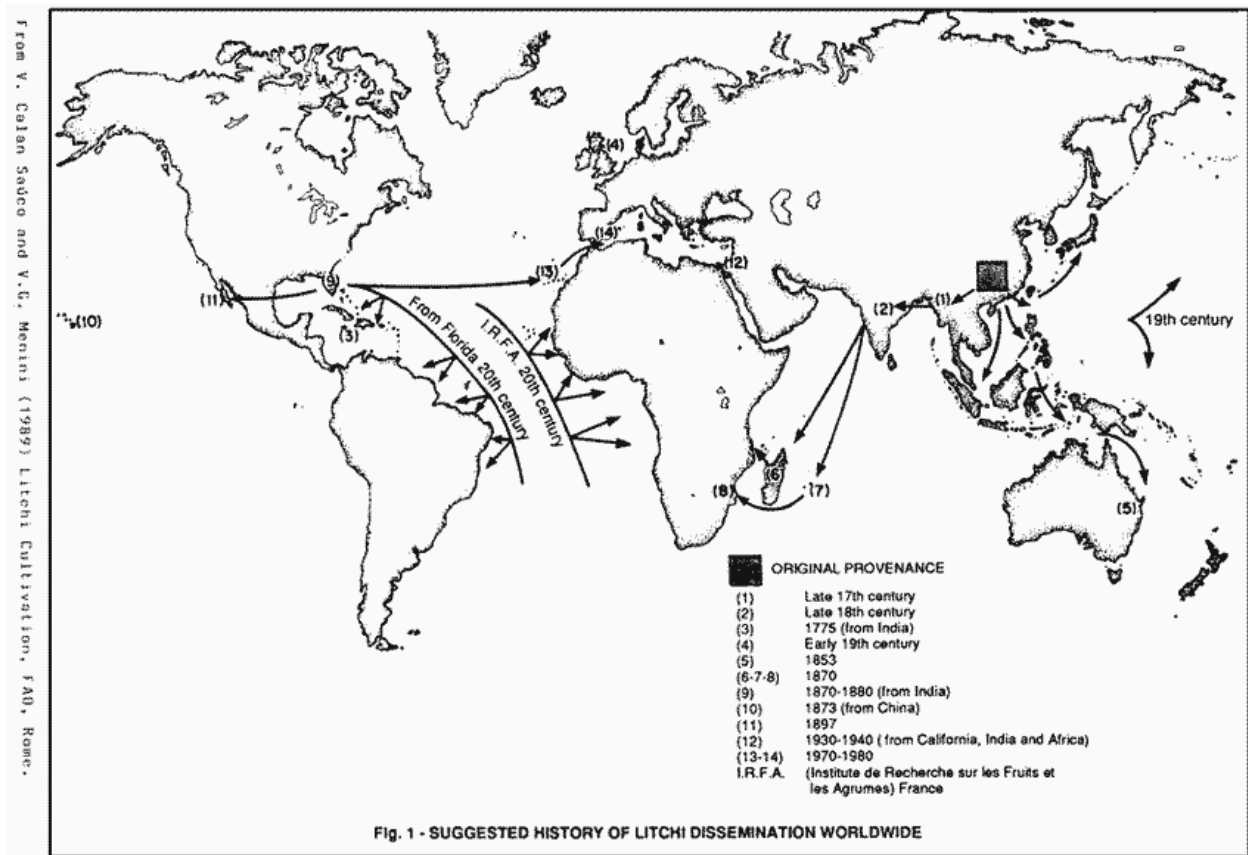


1.3 Origin

Lychee has been cultivated in China since the second century B.C. During the Tang Dynasty (607-918), (Hu et al., 2022) Lychee first gained its popularity for its flavor, freshness and productive lifespan. Even so, the oldest Lychee tree was from this era, located in Fujian, China and it is over 1250 years old (Hu et al. 2022). Wild lychee first originated in Southern China in Hainan and Yunnan rainforests, from there lychee became domesticated by Chinese farmers, although it is unknown who was the first to do this and there are no known fossil records.

Figure 3:

Map of lychee origin and distribution, in it you can see the original province of lychee and it's distribution during different centuries (Calan Saúco FAO Rome, 1989)



1.4 Present Distribution

The map in figure three shows the distribution from the late 17th century all the way up to the 1980s. What we can see is that the Lychee originated in China and through the 17th and 18th century expanded towards Vietnam, Thailand and India. Though native to China, Lychee's production drastically increased when the plant arrived in Bruma and later spread through Bengal, because of the proper weather adaptation. This then led to Lychee's distribution to the Americas, most specifically the Caribbean.

Through the years Lychee has been planted in mostly tropical areas, and since then the market for them is not as globalized and distribution is limited.

1.5 Environmental Factors

1.5.1 Climate

Lychee is really affected by the climatic conditions of the area, since lychee uniquely grows in tropical weathers the main plantings are located in Australia and India.

Figure 4:

A table of the different climate conditions in the growing areas.

Location	Winter		Spring		Summer	
	Mean min. temp. (°C)	Rain (mm)	Mean max. temp. (°C)	Rain (mm)	Mean max. temp. (°C)	Rain (mm)
Fuzhou, China (26°N, 88 m)	7.8	27	16.6	124	32.1	170
Guangdong, China (23°N, 18 m)	9.2	45	20.8	101	32.7	215
Hanoi, Viet Nam (21°N, 16 m)	13.3	18	23.3	38	32.8	318
Chiang Mai, Thailand (19°N, 317 m)	13.3	<3	34.4	8	31.1	210
Patna, India (26°N, 58 m)	10.6	15	32.2	10	32.8	290
Mareeba, Australia (17°S, 404 m)	11.2	5	28.1	5	31.2	195
Cairns, Australia (17°S, 3 m)	16.7	30	27.9	36	31.5	399
Nambour, Australia (27°S, 29 m)	6.9	50	24.2	45	28.0	284

As seen in the table above Lychee can adapt through the seasons especially considering that the originating country of Lychee is China. The lowest temperature that Lychee can adapt to is 6.5 degrees celsius but it is usually planted at an average temperature of 20-25 degrees celsius. Lychee has a cycle of growing, which means that during the spring and summer the plant mainly elongates its shoots and during the winter lychee centers on flowering. Although it is important to keep it at this average temperature because extended exposure to temperatures over 30 degrees might result in a setback in fruit development and quality.

1.5.2 Water requirements

Lychee's irrigation has a correlation to its origins. The water requirements of Lychee vary depending on the crop distribution and the area where the crop is located. In tropical areas with irregular rainfall, the lychee fruit excels but there is a possibility that the flower may not grow, on the other side if the crop is planted in a rainfall area, the flowering of the plant has a better and more productive cycle but it might affect the quality of the fruit. In crops with dry winters (winters with less rainfall during this season.) droughts may be used specifically for flowering or fruit goals. According to the nation research center of Lychee, once the lychee tree has grown and fruits attain a cm of side, watering is done at a rate 1350 liters per week

1.5.3 Soil requirements

Lychees are found in a range of different soils, such as alluvial sands, loams, heavy clays, and soils with a high content of organic matter (Menzel, 2002) Even though lychee trees are found in multiple different soils they might perform better when they are planted on well drained clay soils rather than heavy clays, because with heavy soils the drainage of water might affect the roots of the tree. Taking India as an example, most lychee crops are planted in alluvial soils that are easy to drain with an average pH level of 8.0. The ideal soil requirements for Lychee crops are well drained thick loamy soils that have a PH level of 6 or 7 (neutral or slightly acidic soil pH.) (Evans, 1997)

1.5.4 Latitudes and Altitudes

Litchi chinensis is usually grown in places with lower elevations such as 300 to a maximum of 1,500 meters above sea level. The crops are usually located north in climate zones between 19 and 24 degrees north latitude. (Menzel, 2002)

1.5.5 Diseases

Lychees are currently not affected by a major disease that affects their production although there are a few pests and diseases that affect certain aspects of the tree's development. Some of the diseases include

- *Peronophythora litchi* most commonly known as Brown Blight. This fungal disease affects both Lychee and Longan, by turning their immature fruit brown.
- Parasitic nematodes, microorganisms that feed on living plant tissue and create a parasitic relationship with the crops. These not only affect Litchi, on the contrary nematodes affect every type of crop.
- Insect groups such as fruit borers, moths, leafrollers, beetles and others can critically affect the health of a lychee tree. Many of these pests disintegrate the stems or fruit of the Lychee tree which damages the crops.

2 Biology

2.1 Chromosomes

Due to Litchi chinensis Sonn.'s wild progenitor, its chromosomes are not stable and often exhibits a variability in their diploid chromosome number $2n= 28, 30, 32$ or 34 . This fact is usually related to the fact that Lychees have an inherited relationship with Longan. This variation later creates a facility for those who plant and commercialize Lychee because there are multiple cultivars with similar genetic markers and a DNA sequence. (Menzel, 2002). Recent genomic³ studies have studied and mapped the complete genetic sequence of *Litchi Chinensis* and later organized the different plausible sequences into 15 different pseudo-chromosomes to form and artificially assemble a similar chromosome structure that can be used for genomic analysis of the fruit. Through this analysis it was determined that the total megabases that Lychee has is around 470. This means that the plant contains 470 million base pairs of DNA that give growing and fruit production instructions. (Huang et al., 2021) Another interesting fact of Lychee is that its genome and chromosomal analysis leads scientist to believe that it has undergone multiple independent domestication events, this belief is rooted from Lychee's high heterozygosity⁴.

2.2 Life Cycle and Phenology⁵

Lychee has seven growth stages according to Scientia Horticulturae. The first stage of the cycle is called bud development, which is a small part of the plant from which the first flower or leaf comes out. The development of this part of the plant is key for the growth of the plant, and they arrive from meristem tissue. The second stage of the development is called leaf blooming, in which as the name implies the first leaf starts growing from the bud of the plant. The third stage is called shoot elongation, during this period that lasts roughly 8 weeks the shoot of the plant starts to grow. The fourth stage is called inflorescence emergence, during this state of Lychee the plants produce and structure flower clusters. This in lychee usually occurs during the spring. From this period of time comes the fifth state which is called flowering, during this time the multiple little clusters grow into flowers which can now start the pollination process. From those flowers come the sixth stage called fruit development, in which the actual Lychee starts developing but during this time they are not yet ripe and edible. Finally the last stage is when fruit reaches maturity and they are ready to be picked and commercialized. Lychee is actually a fruit which has a really long growth cycle, for this whole cycle to occur and for the tree to start producing a good amount, it usually takes 3 to 5 years depending on how good of a care you take of it. All of these growth stages were identified by an extended study using BBCH scale (Wei et al., 2013)

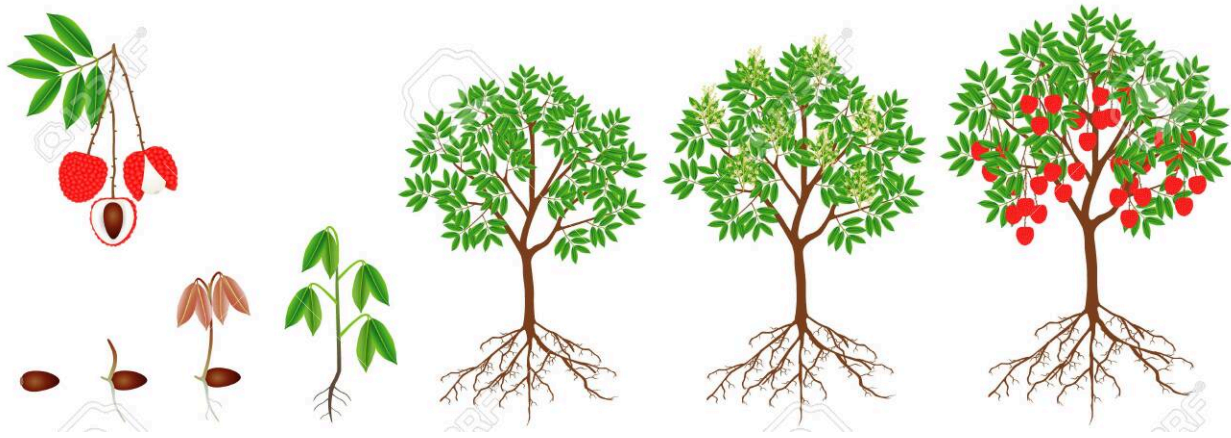
³ the study of an organism's genome – its genetic material – and how that information is applied

⁴ refers to the presence of two different alleles at a specific genetic locus in an organism's DNA.

⁵ The study of cycles, patterns and timing in the natural world.

Figure 5

This is a graphical representation of Lychee's life cycle (Alamy)



2.3 Reproduction and Pollination

Litchi chinensis reproduces through a process of pollination, flowering and fruit production. In the fourth and fifth stage of development when the Lychee tree starts producing flowers, they are exposed to the process of pollination. Lychee plants have a varied pollination process, due to the amount of cultivars that Lychee has, their degree of self-pollination varies. Although almost all cultivars can self pollinate and as a result reproduce on their own, some cultivars have higher levels of efficiency. Some self pollination of lychee plants can even occur through winds (Australian Tree Crop, 2020). Even though some Lychee plants can self pollinate, it is most common that cross pollination is done by bees and other pollinators. There is even research to point that although both methods are efficient, it can better the fruit result if there is cross pollination especially from honeybees (Klatt et al., 2013) After a successful pollination and fertilization Lychee can start reproducing and fruit can start growing, from each fruit a singular large seed is also produced. A productive reproduction of Lychee can be achieved with an adequate pollination, a good cultivar and their correct environmental factors.

Figure 6

Lychee flower being naturally pollinated by a bee (Folino, 2010)



Chapter 3 Propagation and Management

3.1 Propagation

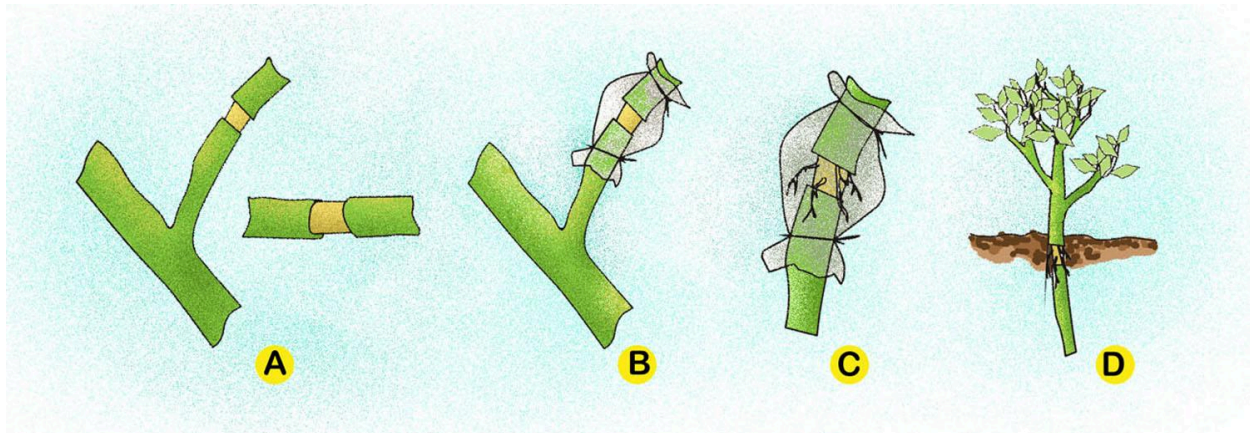
Propagation refers to the methods of creating a new plant of the same species through a seed, a cutting, a stem or any other plant part. Lychee propagates through various methods, each with its own advantage. Some propagation techniques favor genetic fidelity while others promote a faster growth rate.

1. Air layering

Air layering is a common technique to propagate Litchi Chineseis Sonn. This method consists of picking a healthy lychee branch, preferably a thicker one (half or an inch of width) and cutting the outside layer of the branch exposing what is called the xylem⁶ layer. This cutting in the xylem layer is later surrounded by either soil or moss which is later enclosed in a plastic or aluminum wrap. The soil promotes the growth of roots while the wrap around it sustains moisture and controls the environment. This method takes a minimum of 8 weeks for the roots to develop correctly. Once the roots have sufficiently grown the branch along with the roots are cut off the tree and planted independently. There are multiple benefits to air layering, the first and most important is the genetic fidelity that comes along with it, the tree that comes from air layering is an exact clone of the original tree. Another benefit is that because the branch is already developed, the fruit tends to grow faster than when just planting a tree from zero.

Figure 7

A graphic which shows the process of Air Layering as a method of propagation (NatureBing, 2020)



<https://www.naturebring.com/propagate-plants-plant-cutting-air-layering-plants/>

2. Seed propagation

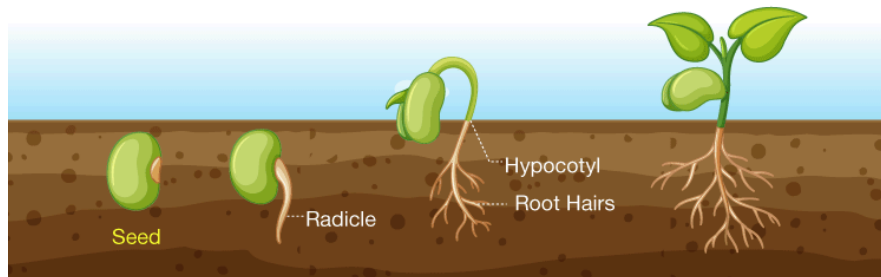
Seed propagation is as the name implies the process of planting a lychee tree through the seeds. Although this method might sound easier, it is a little trickier. The seed must be harvested from a fresh ripe fruit, once the fruit is ripe the seed will only be viable for seed propagation for around 4 days (Frederick, 2022). This process also involves seed germination, in which the seed goes through a process from an

⁶ the vascular tissue of a plant that is responsible for transporting water and minerals throughout the plant.

angiosperm seedling, to roots and finally to a shoot. For this process to be successful the germination must take place in high humidity. After getting the seed from the ripe fruit, the first step for seed propagation is to soak the seed in water, preferably mineral water and wait one to two days. Next decide on the seeds with the best germination (with the longest and strongest roots) and plant them in a well drained preferably heavy soil. Although this method sounds easier, it is extremely lengthy because lychee starts to grow fruit when the tree is almost fully developed meaning that this process may take up to 10 years. Another negative side effect is that through seed propagation seeds may not be identical genetically which can create certain counterproductive genetic conditions which would affect the quality of the fruit. This is why many cultivate lychee through seed propagation using seedlings with improved genetic characteristics to ensure a good tree and good fruits.

Figure 8

A graphic representation of the process of seed germination (BYJU, 2020)



3. Cuttings

The cutting method is vastly similar to the air layering method. The difference between the two, is that in the cutting method, instead of waiting for the roots to grow out without immediately cutting it from the plant, the first step is to cut out a piece of the tree, usually a stem or a root, dipping it in water and then planting it immediately. Similarly as air layering, through this method there is a higher chance of genetic fidelity but also it promotes a faster growth cycle. This method is relatively easy, and much faster than seed propagation but it is still lengthy meaning that for fruits to grow it may take up to 3 years.

4. Micropropagation

This method of propagation is usually used for large scale lychee cultivars. The process of micropropagation refers to the practice of growing plants under laboratory conditions with plant tissue culture and exposing them to nutrients and genetic improvement through laboratory vessels. This practice is commonly used in commercial horticulture. (Menzel, 2001). Lychee micropropagation is not as common but it does exist. What this means is that it has been proven that lychee can grow from harvested plant tissue, but this does not mean that it has a high success rate, usually lychee micropropagation

exhibits a varied rate of success. Usually the methods of propagation used in lychee are vegetative which is why micropropagation has proved to be a good alternative for mass production.

All the methods of propagation work, but the most popular method is air layering not only because it has the best results genetically it also is the fastest vegetative method.

3.2 Management

Lychee needs meticulous management for it to grow correctly, this means in climate, soil, watering, pest control and much more. They usually thrive under tropical weathers especially in their early stages because they are susceptible to freezing in colder weathers. The ideal weather range goes from 25 to 35 degrees Celsius. (Menzel 2002) Lychee also needs good soil conditions, although lychee can and will grow in multiple types of soils it is best for it to be planted in well drained, slightly acidic to neutral soil. Lychee is very prone to root diseases and to malformation and because of this it must be taken care of with the best of care. Lychee plants especially when they are developing fruit have a high demand for irrigation because the plant can suffer from dry spells. Fertilization is also sensitive, because young trees can suffer from fertilizer burn. Overall the treatment of Lychee trees is very sensitive because in the early years of the tree's lives it is easy for it to malformate or damage.

4 Emerging Products and Markets

4.1 Market Projection

The lychee market has recently been expanding due to its rising popularity and important role in Asian cuisine. In the past, the market for lychee was limited to Asia and parts of Europe but currently exports and imports of Lychee have become global. Currently the lychee market is estimated to be \$7.49 billion USD as of 2025 (Mordor, 2025) and according to Mordor Intelligence's projection of the market it is expected to reach \$9.79 billion USD. It also has a CAGR⁷ of 5.5% in the forecast period of 2025-2030. As seen in Figure 9, the market for lychee is especially growing in Europe and North America, as well as the constant growth for the market in Asia.

Figure 9

A map of the world showing the global lychee market growth rate from 2022 until 2027. (Research and Markets, 2022)



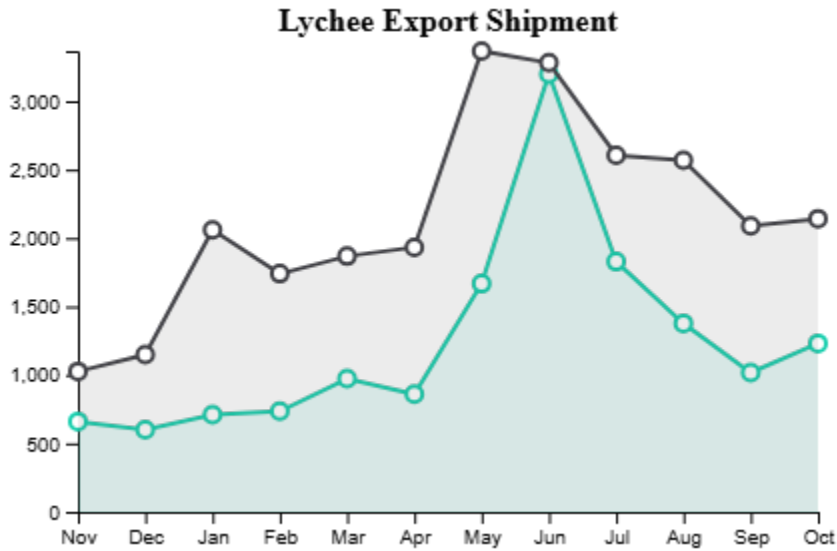
4.2 Exports

Because of lychee's origins the leading exporters of the products are most notably Asian countries. According to Volza's global export data Lychee's top three exports are Vietnam, China and Thailand with a total of 25,828 exported shipments of lychee. Vietnam is the world's biggest lychee exporter with a total of 17,930 shipments, followed by China with 11,366 and finally Thailand with 8,165 shipments (Volza, 2024).

⁷ CAGR stands for compound annual growth rate. This is a unit used to see the projection of a market or a product used by investors.

Figure 10

This graph shows a comparison of export shipments with the green representing exports from Nov. 2022-Oct. 2023 and the black representing Nov. 2023-Oct. 2024. (Volza, 2024)



4.3 Imports

The principal importers of lychee are the United States, Indonesia and Vietnam, although this fruit has a huge importation rate due to the little supply that the industry has. Although collectively these three countries make up 57% of the world’s lychee imports. For example in the 2024 market the U.S received an approximate of 11,261 shipments which stands as 23% of the world’s imports. As seen in figure 11, the U.S is followed by countries like Vietnam, Indonesia, and Malaysia.

Figure 11

This graph shows a comparison of export shipments with the green representing imports from Oct. 2022-Sep. 2023 and the black representing Oct. 2023-Sep. 2024. (Volza, 2024)

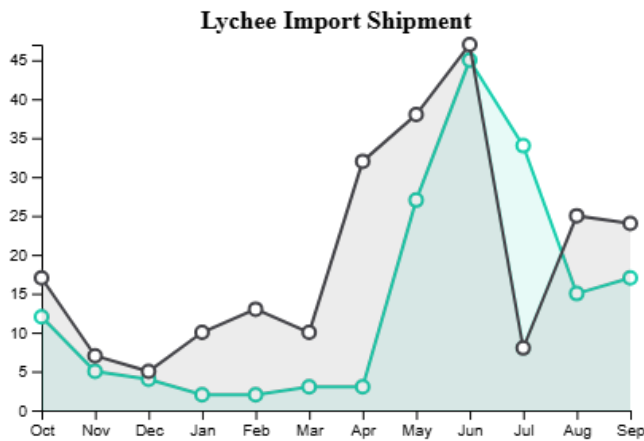
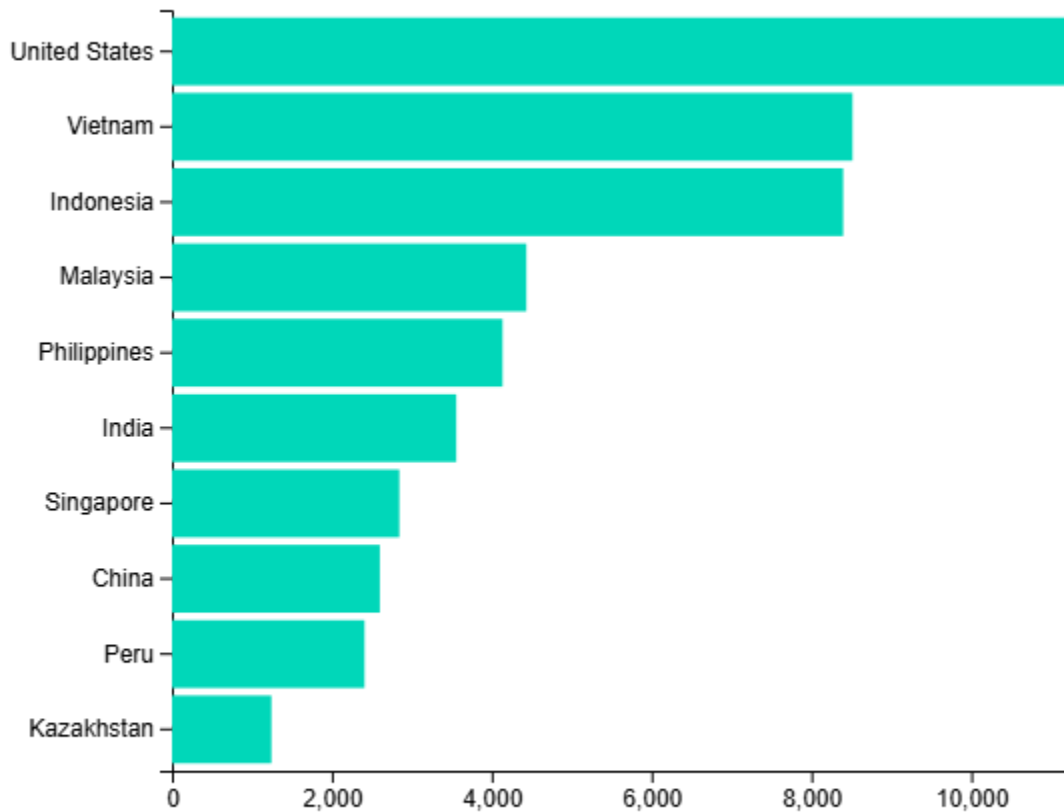


Figure 12
Lychee importing countries as of 2024 (Volza, 2024)



4.4 Market Challenges

The lychee market faces multiple challenges including extreme weather conditions which impact the production process, especially because of the short harvest period, low periods of preservations and difficult post-harvest logistics. According to the International Society of Horticultural Sciences “Indian litchi industry is also plagued by limitations in fresh fruit logistics which is the challenge to ensure postharvest cool chain integrity and limited value addition or processing.” (ISHS, 2025)

4.5 Products

Lychee also has multiple by-products, which increase the market of the fruit. This includes a range of value-added products such as canned lychee, lychee juice, jams, jellies and more. This caters to multiple international markets with these products being used in multiple products such as cosmetic products, cocktails and desserts. These lychee products increase the value of lychees because it helps solve multiple market challenges regarding the fresh fruit such as an extended shelf life, and reduce post harvest loss.

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Chapter 4

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