
Activity 1.5

This case study forms part of the
*2018–21 ACIAR Improving smallholder farmer incomes
through strategic market development in mango supply
chains in southern Vietnam project*

Activity: Value chain study – Mango processing

Project number: AGB/2012/061

Date: March 2020

Prepared by: Sub-Institute of Agricultural Engineering &
Postharvest Technology (SIAEP) Research
Team, Vietnam
San Tram Anh
Le Minh Hung
Le Thu Lam
Tran Thi Kim Oanh
Lam Dong Pho
Pham Nhat Hanh
Nguyen Vinh Phuc
Nguyen Hoai Nam
Peter Johnson, Griffith University, Australia

Contents

1	Introduction.....	1
1.1	Aim and scope	1
2	Methodology	1
2.1	Research approach.....	1
3	Processed fruit production	2
3.1	Background	2
3.2	Processed mango products	3
3.3	Market characteristics	6
4	Processed mango value chain	8
4.1	Supply	8
4.2	Pack houses.....	9
4.3	Processors	11
5	Conclusion and recommendations	13
5.1	Conclusion	13
5.2	Recommendations	13
6	References	14
7	Appendices	15
7.1	Processor interview checklist.....	15
7.2	Frozen mango process	17

1 Introduction

Vietnam has a productive mango industry that produces high-quality fruit. More than 80% of all fruit grown in Vietnam is consumed fresh, and 9% is processed. The fresh mango value chain has several points at which fruit can be damaged and value can be lost. Between 15% and 25% of harvested mangoes is estimated to be damaged along the chain. Much of this damage is superficial, which often makes the fruit unsuitable for sale or export; however, in most cases it is likely still suitable for processing.

Mango has a number of nutritional attributes that make it ideal for processing into healthy food and drink products. It is high in vitamin A, vitamin C, sugar, organic acids, minerals, and antioxidants such as polyphenols. The edible part of ripe mango fruit makes up about 80% of the total weight, and can be used to make dried fruit snacks, juices, and jams and other preserves. Mango stones contain fat, amylase (an enzyme), and starch, and can be used a component to make high-value products in nutraceuticals. During processing, significant amounts of flesh often adhere to the stone, and this can either be extracted or simply left on the stone for fermentation.

A number of mango processors are operating in Vietnam; however, their current product range is limited and targeted at niche export markets. The domestic market for processed mango products is relatively small and underdeveloped. Further development of the processed mango industry in Vietnam could contribute significantly to the value chain by helping to solve waste issues (and increase the amount of fruit suitable for market), and thus improve income for farmers.

1.1 Aim and scope

The aim of this study was to gain an understanding of the current status of the Vietnamese mango processing industry in the Mekong River Delta (MRD), its value chains, opportunities and constraints. The study concentrated on mango processing in Tien Giang and Dong Thap provinces.

2 Methodology

This report is comprised of a literature review (section 3) and interviews with processors, buyers, packhouses, and collectors (section 4). Secondary data was obtained from the following sources:

- Annual reports of People's Committees (government bodies responsible for formulating and implementing policy) at the village, district, and provincial levels
- Statistical data
- Scientific reports and other information from the Ministry of Agriculture and Rural Development (MARD), Department of Agriculture and Rural Development (DARD), NGOs, and research institutions.

2.1 Research design

Semi-structured interviews (see Appendix) were conducted in Dong Thap, Tien Giang, and Ho Chi Minh City (HCMC) provinces between March 2019 and July 2019 with processors, packhouses and their collectors, and buyers. Participants were identified by the use of a single pre-screening question to qualify the target sample.

The key research participants included mango processors, packhouses, and collectors.

- Collectors: nine collectors (56% male, 44% female) were interviewed in Tien Giang and Dong Thap provinces.
- Packhouses: eight packhouses (75% male, 25% female) were interviewed in Tien Giang, Dong Thap province, and HCMC. These packhouses sell mangoes to processing companies.
- Processors: four processors (75% male, 25% female) were interviewed in Tien Giang, Dong Thap, and HCMC (two in Tien Giang, one in Dong Thap and one in Hoc Mon, HCMC).

The interviews provided an understanding of the current value chains for processed mango from Dong Thap and Tien Giang, and assisted in identifying key research questions and interventions in the subsequent phase of the project.

3 Processed fruit production

3.1 Background

Production

Currently, processed fruit accounts for only a diminutive amount of the total fruit production in Vietnam. Most fresh fruit production is consumed as fresh fruit supplied through traditional markets and retailers, including supermarkets, convenience stores, and high-end fruit shops.

A large majority of mango production has a sub-standard fruit quality. Much of this production does not reach the domestic market, which contributes to an estimated post-harvest loss of around 27% (Report on Investigation of Mango Supply Chain in Mekong River, Vietnam, 12-2015).

Around 30% of fruit produced in Vietnam is used for processing. Processed fruit and vegetable products help to reduce economic losses, particularly at a community level. The number of enterprises currently investing in modern fruit-processing technology is limited.

At present, dried mango products dominate the domestic market in Vietnam. According to the consumption trends, convenience is important in purchasing decisions, as is minimum use of preservatives or other additives in order to retain the characteristic flavor of the mango. Domestic manufacturers have not met the domestic market demand both in quality and category requirements (dried and frozen).

Processors

Industrial fruit and vegetable processing in Vietnam is concentrated in approximately 28 provinces and cities. The northern region has 71 enterprises, the central region has 18, and the southern region has 56. Localities with 10 or more enterprises include Hai Duong, Hung Yen, Bac Giang, Lam Dong and HCMC (General Statistics Office, 2017).

The distribution of mango processing is shared between state-owned entities, local firms, and foreign investment companies. One third of mango processing firms in Vietnam are in the north, while the majority are in the central region and the remainder in the south (General Statistics Office, 2017).

Industrial fruit processing enterprises produce around 500,000 tonnes of products per year. Concentrated fruit juice and canned fruit are the key products accounting for most of the total production. Dried fruits, soft drinks, and instant quick freeze (IQF) products (8%) make up the remainder of production outputs. Processed fruit products are mainly directed to the export market and have little share in the domestic fruit market.

Labor

Discussions with companies revealed that the average labor force in fruit processing companies is around 130 people per enterprise. State-owned organisations tend to utilise more labor, averaging 160 people per enterprise; foreign investment companies employ an average of 90 people per enterprise; and private companies employ an average of 140 staff per enterprise. Productivity in foreign investment enterprises is quite high, at about 50 tonnes of product per person per year (approximately VND2,935 million/person/year). Annual productivity of state-owned enterprises is around 7 to 8 tonnes of product per person (VND412 million/person/year), and for private enterprises this is around 20 tonnes per person (VND1,008 million/person/year). Therefore, the average annual productivity of fruit is quite low. This may suggest that foreign fruit processing enterprises have greater automation of their processing lines than other enterprises.

Technology and equipment

Recently, processing factories (supported by foreign investment) have updated their technology to include modern equipment, such as Tetrapak cartons for packaging, evaporation equipment for cold drying, and heat-pump drying. At the end of 2018, Vietnam had only nine registered factories processing fruits and vegetables using advanced technology from regions such as Europe and countries such as Japan.

Policy

There are 12 fruit listed in the Vietnam Government Fruit Priority Program. These include: mango, dragon fruit, rambutan, durian, star apple, pomelo, longan, banana, pineapple, orange, custard fruit, and tangerine.

Investment in the food-processing industry in Vietnam is attractive due to multiple tax incentives relating to raising production volumes and export incentives.

Wastage

One of the larger processors interviewed reported mango wastage of 12–15 tonnes per day due to product not meeting specifications. Similar wastage occurs during drying. Another firm, specialising in high-quality dried agricultural products, reported that up to 30% of mango flesh is considered a waste product for which they have no reasonable treatment. These companies are keen to undertake research into how to improve their waste utilisation.

3.2 Processed mango products

Beverages

Beverages made from mango in Vietnam include juice and cordial, and are generally non-alcoholic. They are typically made from pulp and mango juice with added sugar, and can be liquid or concentrate. Juice is preferred in Vietnam, due to its high nutritional value and local customs.

Concentrates are mainly processed from Cat Chu mangoes, are generally used to make drink products, and can be stored for up to 24 months. Most of the concentrate produced in Vietnam is exported to European and American markets by sea. Opportunities for concentrate are dependent on beverage and other value-added businesses developing new products and market opportunities.

Mango-based beverages make up approximately 6–8% of the fruit-based beverage market in Vietnam. Most beverages are produced for export; however, there is significant

potential for the domestic market, which has a growing demand for more non-carbonated, healthy, fruit-based beverages.

Dried fruit

Dried mango products are produced in Vietnam to deal with oversupply in the peak season and to enhance the value of second-grade mangoes. Currently, there are limitations on available technology for preservation and colour and flavour retention. They are mainly exported to Russia and China by a continued growth in demand in the local and export market, and a smaller volume to EU countries. There is an increasing demand for dried mangoes in both the export and domestic markets.

There are a number of techniques for making dried mango products, including:

- **Soft drying:** soft-dried fruit is prepared by immersing slices of 6–8mm thickness in either 40° Brix for unblanched mangoes or 45° Brix for blanched mango for up to two hours at 28°C. It is then dried at 60°C for the product to equilibrate with air at 15% relative humidity.
- **Freeze drying:** the fruit is frozen and placed in a vacuum, and the water sublimates. Several companies in Vietnam are currently producing freeze-dried mango; however, freeze drying is an expensive process and, as such, these products have limited market appeal due to the high price. Freeze-dried mango products do have potential to target mid- and high-end consumers and perhaps the tourist trade (similar to what has already occurred in Thailand).
- **Mango leather:** a specialty of Khanh Hoa province that is only produced small quantities and is mainly consumed locally and for sale to tourists in Nha Trang and a few provinces in the domestic market.

Jams, jellies, pickles, and chutneys

Jams are usually made from pulp and juice of one fruit, rather than a combination of several fruits. Berries and other small fruits are most frequently used, though larger fruits such as apricots, peaches, or plums cut into small pieces or crushed are also used for jams. Good jam has a soft even consistency without distinct pieces of fruit, and has a bright color, a good fruit flavour, and a semi-jellied texture that is easy to spread but has no free liquid (the ideal final parameters for jam are 70% soluble solids and pH >4). After three months of preservation, all fruit jam products retain quality on sensory indicators such as colour, smell, taste, and consistency (Nguyễn Đức Tuấn, 2014).

Mango jam is prepared using a modified processing method. The pH is adjusted to ~4 and the soluble solids to 68° Brix and total sugar to 60%. The optimum vacuum pressure is 0.86kg/cm², giving a boiling point of 95°C. Mango jam has limited domestic market potential.

Chutney is a traditional dish of South Asian cuisine, often including vegetables, spices, and/or fruits mixed together. The authors note that chutney is popular around the world but currently has limited production and potential in Vietnam. Pickled mango is relatively cheap and popular, and is widely sold in supermarkets and street food stalls. It is easily made by small-scale processors and is sold domestically all year round, but has a short shelf life. There still appears to be many development opportunities to diversify these products for mangoes.

Mango jelly products are consumed in Vietnam, but they are mostly imported from China, Taiwan, and Thailand. Currently, there are no companies in the country processing these products.

Frozen mango

Freezing is the most appropriate technical method for food processing and preservation (see Figure 1). The food retains most the original properties of its appearance and nutritional qualities. Freezing even increases the quality of some vegetables and fruits in some cases.

To retain flavor, texture and color, it is important to cool products to the freezing range (0.-5°C to -5.5°C) as quickly as possible. This prevents large ice crystals from forming in the tissue and causing damage. Freezing slowly will also cause the remaining cellular fluid to become concentrated, lowering the pH. This phenomenon will cause even more tissue damage, and results in sloppy food that has poor texture and little similarity to fresh fruit. A study by San (2019) on rapid freezing of mangoes with liquid nitrogen illustrates a suitable process for fast freezing Cat Chu mango.

Another way to fast-freeze mango is with instant quick freeze (IQF) technology. This process retains the flavor, colour, freshness and nutritional value of the fruit. It involves selecting second-grade fruit with good internal quality, which is frozen immediately after processing and packaged in different forms including whole, half-cut, chunk, diced, irregular cut, and on-the-stick. A high proportion of exported product goes to secondary industries such as bakeries, producers of frozen meals, beverages (juices and smoothies), jams, and dairy (ice cream and milk-based drinks).

Strong demand for frozen mango products exists for the export markets in countries such as Korea, Australia, the US, Japan, and in Europe. Domestic demand for frozen mango products is not high; however, opportunities exist in the growing demand for convenient and faster-to-prepare foods such as homemade smoothies.

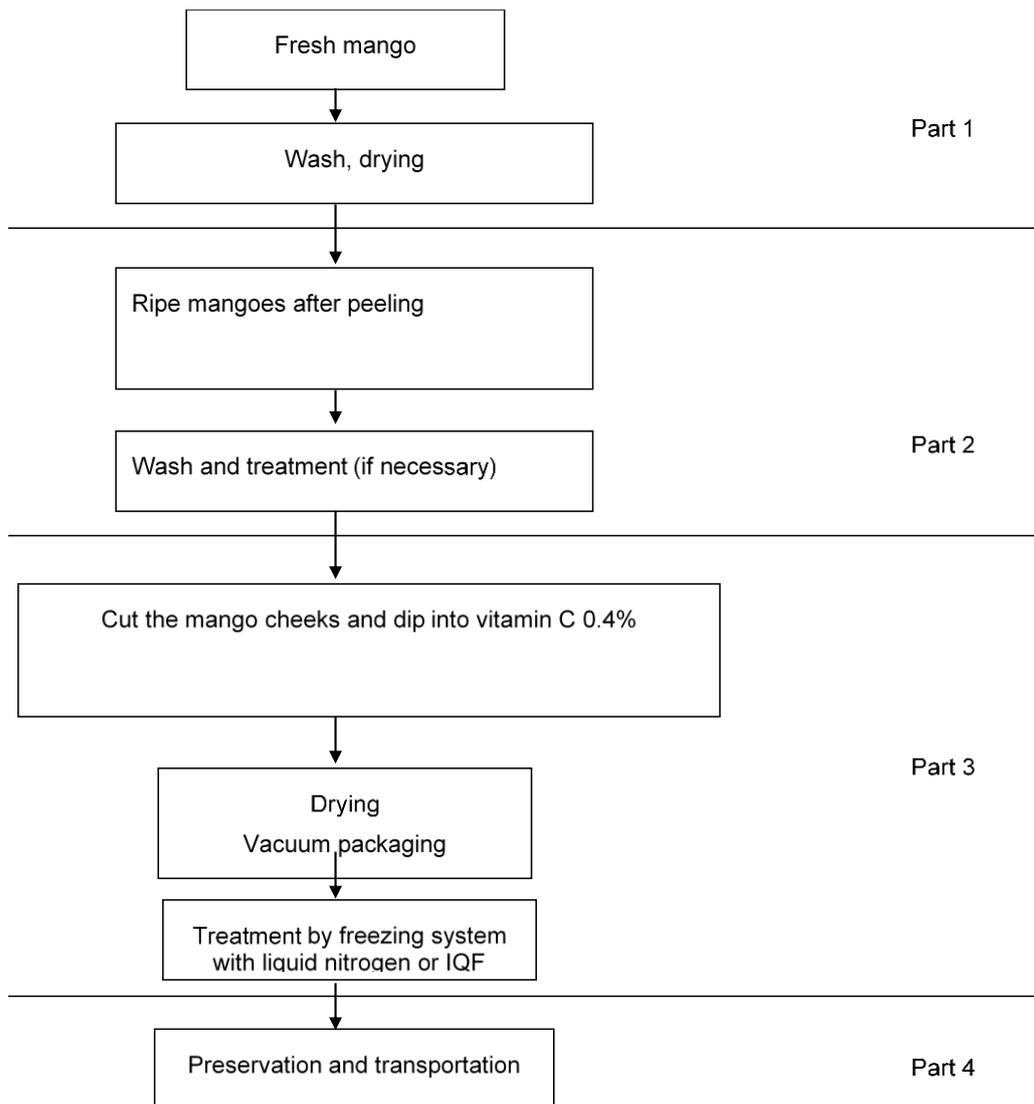


Figure 1. Flow chart for frozen mango processing

Source: Author's analysis

3.3 Market characteristics

Fresh fruit is favoured in Vietnam; however, the country's young population (more than 50% of Vietnam's population is estimated to be under 30 years of age), improved income, growing awareness of food safety, increased focus on convenience foods, and changing attitudes towards processed products all support a growing trend in the domestic markets. This is supported by the increases in raw material supply from increased planting.

The authors believe the food and beverage industry currently accounts for about 15% of GDP and is predicted to increase over the next ten years. Vietnamese consumers spend more on food and beverages than any other product (approximately 35% of household spending). In the last five years, consumption of processed food and beverages experienced average annual increases of 9.68% and 6.66%, respectively. In order to increase competitiveness, the components of fruit processing production must link to create a safe, sustainable chain with traceability to each product in order to provide market assurance of product supply.

Industry growth

Processed fruit products enhance the value of overall production outputs by utilising all grades of fruit. The value of the fruit industry in Vietnam will increase over time to promote fruit exports and soon strike \$5 billion. To achieve its objectives, the fruit processing plants need to be large and resource intensive for each specific fruit.

The export market for processed fruits has significant potential. In 2018, many fruit-processing plants were put into operation in Gia Lai, Long An, Xining, and Tien Giang. Vietnam currently has a total of 18 fruit-processing factories.

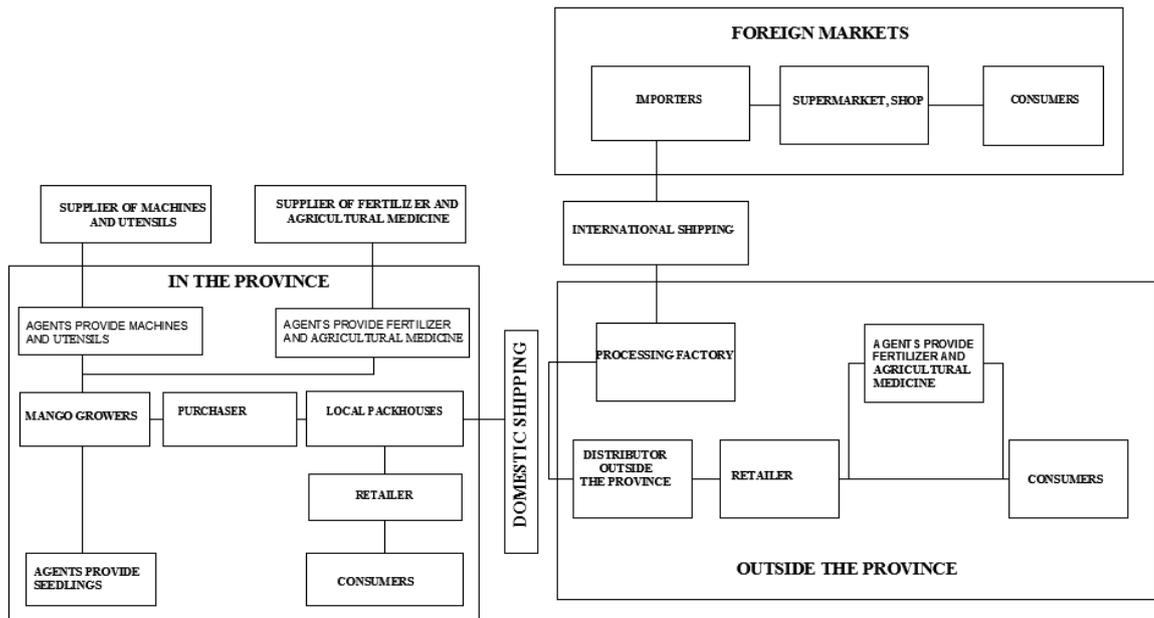


Figure 2. Mango supply chain

Source: Author's analysis

4 Processed mango value chain

This section presents the selected findings from the semi-structured interviews, which were conducted in Dong Thap, Tien Giang, and Ho Chi Minh City (HCMC) provinces between March 2019 and July 2019 with processors, packhouses and their collectors, and buyers. Buyers play a particularly important role in the processed mango value chain in Vietnam because they interact with both farmers and processors.

4.1 Supply

The main cultivar used for processing is Cat Chu. Others used include Keo, green-skin mangoes, and Cat Hoa Loc. Supply fluctuates significantly during the year. The main on-season is from March to May. During this time, supply is plentiful, and prices are lower. The off-season is from August to February, and supply can be intermittent due to irregular production. Some processors are sourcing fruit from Cambodia during these periods to ensure continuity of supply.

Role of collectors

Collectors are responsible for collecting mangoes at the farm and supplying them to packhouses. They are not involved in farming (e.g. spraying or fertilising before collection) but are responsible for on-farm grading. Collectors make decisions for grading based on the requirements and the price offered by the company and the packhouse.

During the peak season, collectors usually hire seasonal workers to pick mangoes and pack and transport them. The number of seasonal employees varies between collectors; of those interviewed, 22% had four workers, 67% had six workers, and 11% had more than 10 workers. Collectors also vary in the number of farmers they source fruit from: 33% of interviewed businesses had between 40 and 50, 22% had 100, 11% had more than 500, and 34% were undefined. Most collectors come directly to the farm to oversee collection, grading, and delivery, but some do this via phone and rely on the farmers' discretion to undertake collection and grading.

The majority of collectors have long-term relationships with their suppliers but will change as seasonal and market demands require. Collectors tend to have long-term relationship with their buyers either packhouses or processors.

Postharvest losses are perceived by collectors to occur at the farm, which is graded out before selling to the packhouse. All mangoes are transported to packhouses for second grading and packing. Transport is by truck or tricycles (for small volumes).

A Tien Giang processing company provides container trucks to farmers' clubs and cooperatives to transport mangoes to the company. Customers provide containers to pick up mangoes and pay for transportation costs. Domestic market transportation occurs by container. Mangoes sold to China are sometimes transported by refrigerated trucks, and exported mangoes are shipped by sea or air.

Feedback from the customers about quality or market demand is variable: 44% of collectors received positive feedback from customers, 45% of collectors did not receive any feedback, and 11% received feedback from their buyers about pests, diseases, and slow ripening of mangoes. Most collectors did not impose any requirements on their suppliers for quality specifications or chemical residue levels, although a few did impose quality requirements based on packhouse guidelines.

Grading

Mangoes are often graded twice: once at the farm immediately after collection, and again before the mango is sold to the packhouse according to the process outlined in Table 1.

Table 1. Mango grading criteria

Grading	No grading
Grade 1 > 70%	Grade 1 < 70%
Grade 1: > 330 gram	Grade 1: 60%
Grade 2: > 250 gram	Grade 2: 33%
Grade 3: < 250 gram	Grade 3 and low-quality mangoes: 7%

Source: Author's analysis

Mangoes are rejected for processing for several reasons, such as weight (less than 180g) or having wrinkled, blemished, or diseased skin. The rate of rejection is between 1% and 30%. Mangoes returned to the farm are ripened for fish feed and some are sold to small markets.

Pricing and payment

Prices vary according to season and mango cultivar (see Table 2). Collectors buy and sell mangoes to packhouses via oral agreements based on market prices, rather than through contracts. Most participants in this study conducted their payment transaction in cash. Only a few used a bank transfer process.

Table 2. Indicative farm gate prices

Season	Cat Hoa Loc (VND/kg)	Cat Chu (VND/kg)
Early	70,400	22,400
Mid	45,300	18,800
Late	37,700	13,100
Average	47,800	18,400

Source: Author's analysis

Issues for collectors

The collectors interviewed raised a number of factors that impact on their businesses, such as:

- Access to capital
- Price uncertainty
- Disease and weather
- Quality requirements
- Inconstant supply

4.2 Packhouses

Packhouse role

The packhouses interviewed in this study consisted of different organisation structures, including packhouses, companies, farmers' clubs, and farmers' cooperatives. They mainly supplied grade 2 Cat Chu mangoes to processing companies. In addition, they also bought other mango varieties such as Cat Hoa Loc, Keo, and Tuong Da Xanh. Cat Chu and Cat Hoa Loc mango were supplied to wholesale markets, retail markets, and

supermarkets in HCMC and Hanoi, whereas the Tuong Da Xanh mango is exported to China.

The packhouses mainly bought mangoes from collectors (see Figure 3). Traders transport mangoes to the packhouse, where workers grade and pack mangoes. Companies also encourage traders to guide farmers in good harvest methods, such as picking mature mangoes and not letting mangoes fall to the ground.

The farmers' club has a schedule to assign harvest to the members; farmers harvest and transport mangoes to the packhouse according to the schedule of assignment, and the processing company sends staff to grade the mangoes and transport them to their factory.

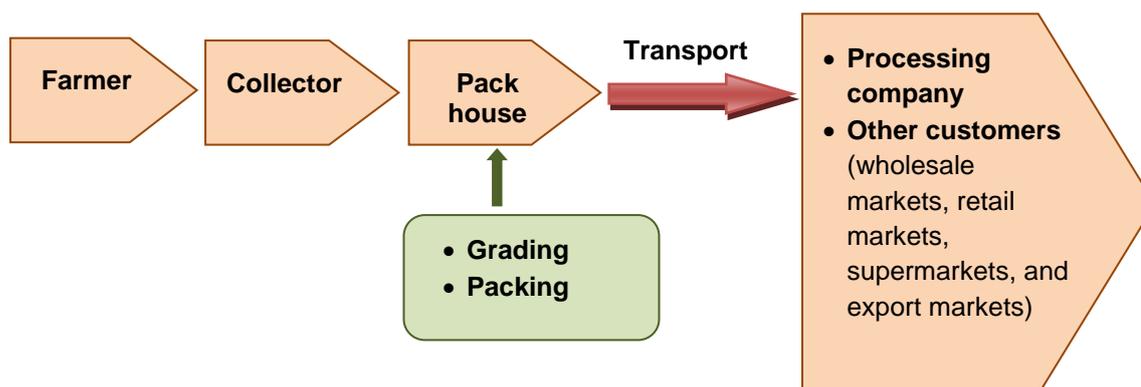


Figure 3. Supply chain

Source: Author's analysis

Supply base arrangements

Pack houses buy mangoes from many traders and farmers in and outside the province. Typically, this is 70% from traders and 30% from farmers. Packhouses select suppliers based on whether they register and comply with the packhouse's regulations. Companies choose experienced and reputable traders who supply mangoes of good quality and stable supply, and tend to establish ongoing trade with them.

The cooperatives and farmers' club generally have a stable number of members (for example two cooperatives have 120 and 152 members, respectively, and a farmer's club has 42 members), which ensures consistent supply. However, a few suppliers will follow the price and regularly change packhouses.

Grading and rejects

Grading and packing mangoes according to customer standards and preserving mangoes takes place at the pack house. The Tien Giang large processor supplies the cooperatives and farmers' club interviewed. It arranges for staff to grade mangoes directly or supervise mango grading. Other companies and packhouses have managers who decide on the classification of processed mangoes according to standards set by processing companies.

Most losses occur at harvest and during transporting to the packhouses. Few losses are reported at the packhouses. Mangoes preserved in cold storage before shipment usually incur losses and damage during transport.

The rate of mango rejection at packhouses was reported to be less than 10%, and at the farmers' club and other packhouses, it was reported to be only 1%. One company had almost no mango rejection because they bought and sold all grades of mangoes, even low-quality ones. At one cooperative, the highest rate of rejection was 30%. For the cooperatives and farmers' club, the quality and losses of mangoes were controlled by

farmers. Packhouses occasionally receive some feedback from customers about the quality and maturity of their mangoes.

Customers

A small number of packhouses sell only to processors and do not supply the fresh market. The majority of packhouses sell to processors and other buyers, including wholesale markets, retail markets, supermarkets, and exporters.

Finance

Processing companies sign contracts with packhouses and the farmers' club at the beginning of the crop, whereas the cooperatives sign contracts with five farmer groups rather than with the farmers themselves. Companies and pack houses have verbal contracts with mango suppliers and pay them cash, but they sign contracts with customer companies and exporters.

4.3 Processors

Supply and quality inspection

In general, the characteristics of mangoes sought by processing companies are: thick skin, long post-harvest life, good flavour when dried, pliable and aromatic, and competitive prices. The quality criteria such as size, weight, ripeness, uniformity, and colour applied by each company depends on the requirements of its market. Maturity is the most important factor affecting the quality of dried mangoes.

Two of the four interviewed processors bought directly from farmers, and three bought from larger suppliers with whom they had established contracts. Two of the processors had a quality control system (The Tien Giang large processor has international accreditation ISO 22000, BRC) and a quality management team, but they all undertake quality inspection at the factory and the majority have inspection staff in the field. Two of the companies test MRLs on received products, and most also will remove damaged fruit on receipt.

All processing companies remove untreated raw materials. The majority do not use surplus materials for processing. The processing companies stop producing when the season ends due to lack of supply of raw material. Most then switch to processing other fruits, and this time is often used to undertake maintenance.

Raw materials are mainly transported to processing companies by farmers and collectors. Processed product for the domestic market is shipped by express delivery service if the quantity is small, and containers are used for large quantities. Refrigerated reefers are used for frozen exports.

Markets

Dried and other processed products are mostly sold in the domestic market, in areas such as HCMC, Hanoi, Da Nang, and some other provinces. Supermarkets are the main outlets but traditional retail sales channels, such as supermarkets, still comprise a significant proportion of the business. One processor exports large volumes to Australia, America, Europe, and Korea and another exports processed fruit products, not mango, to China.

Finance

Only two of the companies had signed contracts with suppliers. The two that bought directly from farmers had oral agreements only and paid cash on receipt. Contracts with larger suppliers were mainly short-term, and cash payments or transfers were made after receiving the fruit.

Long Uyen pays directly to farmers in the farmers' club. For cooperatives, the company advances money to pay farmers. For stalls and companies, Long Uyen pays cash to suppliers when buying mangoes. For traders with which the company has a long-term relationship, it can pay up to 50% of the order value in advance and the balance on receipt.

Process flow

The large processor in Tien Giang selects its raw material for processing depending on production requirements such as Brix, maturity, size, and weight (300–320g). The material is 100% Cat Chu mango. The majority of this is from Dong Thap and Dong Nai, and some comes from Cambodia.



Figure 4. Process flow for Long Uyen

Source: Author's analysis

Another processor selects mangoes with high Brix, maturity, size, and weight from 200g-230g. It also uses Cat Chu mango exclusively. The basic production process involves mango purchase and transfer to the factory, followed by washing, cutting, drying, and packing. A freeze-drying processor uses technology, which requires high-quality materials, using the one variety of mango, Cat Chu. It mainly selects ripe, big (class 1) mangoes weighing from 300g-320g.



Figure 5. Process flow – Freeze drying

Source: Author's analysis

A smaller processor uses the second and third-grade mangoes, with Cat Chu being the main cultivar (70%). The other mangoes used are Keo (20%) and Hoa Loc (10%).



Figure 6. Process flow – dried mango

Source: Author's analysis

Current issues raised by processors

When processors ripen fruit, a high rate of rot is occurring. This leads to high losses; however, there is a lack of awareness on how to address the issue. In addition, the shelf life of some dried mango products is short and they are susceptible to browning, but technology to improve this is not available.

Processors express a desire to expand into other processed mango products, including canned, frozen, and flour, but there is a lack of technical expertise in the industry to achieve this. Processors would also like to learn how to improve their competitiveness and expand into new markets.

5 Conclusion and recommendations

5.1 Conclusion

This study presents the results of interviews conducted in southern Vietnam to form a profile of the mango processing sector. Key conclusions include:

- The fruit and vegetable and processing industry is considered one of the most promising sectors in Vietnamese agriculture. Enterprises in this sector account for a low volume. Currently, the country has 150 fruit processing factories.
- The mango processing industry in Vietnam accounts for less than 10% of production.
- Losses after harvesting are high (26.9%) in the processed mango chain.
- Waste (skin, seed, etc.) from processors is currently underutilised or discarded.
- Due to small-scale production units, the stability and variation in supply in Vietnam is a challenge for processors.
- A significant number of large-scale processors are outside mango production regions.
- Industrial-scale fruit processing enterprises mainly produce canned food and similar products (68%), including concentrated fruit juice, due to the relatively simple requirements in processing technology. Limited access to technology and infrastructure has impeded the growth of more sophisticated processed products.
- Processed fruit products are mainly aimed at exports, with little attention paid to the domestic market. However, many processors are experiencing difficulties in meeting the export market requirements.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made for developing and improving the standard of the mango processing industry in Vietnam.

- Examine challenges with commercially acceptable frozen processing product outputs and packaging formats.
- Capture accurate percentage of current total loss in the mango processing supply chain to consolidate and contribute to consistent supply.
- Develop new products, streams, and uses for processing waste.
- Introduce new technology and capacity-building to address issues such as poor processing techniques and post-harvest product management.
- Investigate if there is an opportunity to supply processed mango and other tropical fruit for domestic market trade.

6 References

Đậu Thị Như, (2017) Nghiên cứu quy trình sản xuất nước lên men từ trái xoài *Mangifera Indica*, Đồ án tốt nghiệp, Đại học Bà Rịa Vũng Tàu,

Lê Mỹ Hồng, Nguyễn Thị Minh Duyên, Võ Ngọc Thúy, Nguyễn Thái Hiếu Hạnh, Quá trình chế biến nước trái cây hỗn hợp (Sơ ri, khóm, chanh dây), Tạp chí khoa học, trường Đại học Cần Thơ, 2009:11, 235-244

Lê Thị Hồng Xuyên, 2007, Nghiên cứu sản xuất xoài miếng sấy, Luận văn tốt nghiệp kỹ sư, Trường đại học Cần Thơ.

Lê Trung Thiên, Lê Thị Thùy Dương, 2018, Chế biến Jam (Mứt) Sơ Ri và sự biến đổi hàm lượng vitamin C và polyphenol trong quá trình chế biến và bảo quản, Tạp Chí KHKT Nông Lâm Nghiệp, trường Đại học Nông Lâm Tp Hồ Chí Minh số/2018.

Nguyễn Đức Tuấn, 2014, Nghiên cứu xây dựng quy trình sản xuất một số sản phẩm mứt nhuyễn quả, Đề tài nghiên cứu cấp trường Đại học Nông Lâm thành phố Hồ Chí Minh.

Nguyễn Thị Phương, “Nghiên cứu quy trình sản xuất rượu vang từ Xoài”, Luận văn tốt nghiệp

Phan Uyên Nguyên, Nghiên cứu chế biến rượu mít chất lượng cao bằng phương pháp chưng cất lạnh đông, Journal of Science – 2014, Vol. 4 (3), 102 – 108 An Giang University.

Trần Thị Định, Nghiên cứu quy trình chế biến đồ uống từ Bưởi và Lô Hội, Tạp chí Khoa học và Phát triển 2012 Tập 10, số 5: 714-722

Cục chế biến và phát triển thị trường nông sản - Agrottrade, 2017, “Lễ công bố xuất khẩu lô trái vú sữa Việt Nam đầu tiên sang thị trường Hoa Kỳ”
<http://www.chebien.gov.vn/NewsDetail.aspx?ID=1845>

1Tổng cục thống kê, 2017, “Thông cáo báo chí tình hình kinh tế - xã hội năm 2017”
<https://www.gso.gov.vn/Default.aspx?tabid=382&ItemID=18667>

1Phạm Nguyễn Phương Nam, 2018, “Bản đồ Xoài Việt Nam”,
<https://chamkhanhhoa.wordpress.com/2018/05/15/ban-do-xoai-viet-nam/>

SIAEP, 2015, “Báo cáo Điều tra chuỗi cung ứng Xoài Đồng Bằng Sông Mê Kông, Việt Nam”

Lê Minh Hùng, Ngô Văn Bình, Trần Thị Kim Oanh, Đặng Thị Sáu, Phạm Nhất Hạnh, San Trâm Anh, 2018, Tài liệu tập huấn Thu hoạch, sơ chế, bảo quản, chế biến và vận chuyển Xoài thuộc dự án UNIDO.

7 Appendices

7.1 Processor interview checklist

A. GENERAL INFORMATION

I. Introduction about the company

1.1 Interview date.....Interviewee..... Interviewer.....

1.2. Company's name:

1.3. Director:M/F

1.4. Address:

I. Company Background

Q1 We are excited to be working together we are keen to know your company's business journey

Years established:

Types of business enterprise:

Capacity of the plant (total and current operational capacity)

Organizational Structure (Makeup of workforce involved in management, technical general labourer QA etc) (Employees Determine seasonality high /low season).....

II. Structure of business.

Q2 To help understand your business can you describe to me how your processing lines work

Types and volumes of products processed.....

Juice	%	Puree bulk 200 Litre drums	%
Retail cans puree (400- 500g)	%	Canned mango in syrup (retail)	%
Free-flow frozen	%	Dried mango slices	%
Mango confection (soft cheeks)	%	Powder	%
Jam/ice cream topping	%	Sauce/chutney	%
Component of canned fruit salad	%	Others	%

Sources of raw material, where from grades, how they are graded who sets grading standards, issues with the grades.

Origin	Grade 1	Grade 2	Grade 3	Reject
Trader	%	%	%	%
Farmer	%	%	%	%
Commune	%	%	%	%

Company farm	%	%	%	%
Other (please specify)	%	%	%	%

Q3 How do you deal with the seasonality of mango supply?

Q4 Can you describe to me the quality management process from fruit received to the finished product.

Q5 What happens to fruit that doesn't meet your specifications.

III. Input value chain.

Q1 Can you describe to me the way you source your raw material

How do you decide on a supplier?

Reliability of supplier's (do they change often or not)

Q2 Thinking about the suppliers from whom you source raw material from. Could you share with me the way the contracts and payments are arranged?

Agreements or contracts with suppliers? Suppliers payments - advance or on receipt.

Q3 What mango varieties have you been using?

Why is this the main variety

Do you have problems with supply of this variety and are their substitutes?

Q4 What characteristics do you look for in mango variety?

IV. Output value chain

Q1 Can you share with us where your processed products goes?

Domestic	Major Products	Proportion of Production (%)
Ho Chi Minh		
Hanoi		
Other domestic		

Q2 Can you describe to us how is the product distributed from the factory to the customer?

Q3 Can you share with us how your trading arrangements are structured

V. General enquiry

Q1 What do you see as working well with your business?

Q2 What are the biggest barriers.

Q3 Where do you see the future opportunities

Q4 If there was one thing you could change in your business what would it be?

7.2 Frozen mango process

Material

Cat chu mango: ripe fruits and the flesh inside is golden.



Raw material of Cat Chu mango for processing frozen

Preliminary processing and material treatment

The process includes ripe mangoes after preliminary processing, peeling, cutting mango cheeks, dipping in vitamin C solution 0.4%, draining, and vacuum packaging.

Purpose: to reduce oxidation and assure quality of mango during frozen storage.



Cat Chu mango after preliminary processing and material treatment

Frozen

Mango after vacuum packaging, frozen by freezing system with liquid nitrogen or IQF. Next, preserved cold samples are stored in the freezer.



Frozen mango vacuum packaging