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Value Chain Analysis of Keo Romeat Mangoes in Cambodia

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Abstract

Mango is one of the important crops for Cambodian farmers as a source of income. Annual production reached more than one million tonnes in 2020. The most popular variety is Keo Romeat. It accounts for about 80 per cent of total production during the on-season and nearly 100 per cent during the off-season. Producers expect to get more profit from off-season production but limited knowledge on flower manipulation can cause unsuccessful production and may lead to health concerns for workers and growers. Price is highly variable because it is controlled by Thai and Vietnamese traders. The Cambodian industry lacks standard processing facilities, so mangoes are exported as a raw material with no value added. Forming grower groups, building trust between growers and buyers through contract farming, diversifying export markets, and improving processing and exporting abilities through public-private partnerships would contribute to a more successful mango industry in Cambodia.

Keywords: Cambodia, value chain analysis, Keo Romeat mangoes, markets, export

Introduction

Although the contribution of agriculture to Cambodian GDP decreased from 28 per cent in 2014 (Goletti & Sin, 2016) to 22.8 per cent in 2020 (MAFF 2021), agriculture gross value increased from 17,994 billion riels in 2011 to 23,639 billion riels in 2020 (MAFF, 2021). This shows that the agriculture sector plays a crucial role in Cambodia's economic development.

Among the four subsectors in agricultural GDP in 2020, the crops subsector contributed the most, accounting for 57.4 per cent. The livestock and poultry subsector, the fisheries subsector, and the forestry and logging subsector had shares of 11.4 per cent, 24.4 per cent, and 6.8 per cent respectively (MAFF, 2021).

To further develop the agriculture sector, the Ministry of Agriculture, Forestry, and Fisheries prepared a *Master Plan for Crop Production in Cambodia* for 2016-2030 (Goletti & Sin, 2016). This Master Plan has become a guideline for the socioeconomic development of the country's future in the agriculture sector. The main vision of the Master Plan was to develop Cambodia to become a country well-known in the world for supplying high-quality, safe, and competitive crops. Additionally, the Plan also aimed to ensure a sufficient volume of safe food, and nutrition for food security in the country and to adapt to climate change conditions (Goletti & Sin, 2016).

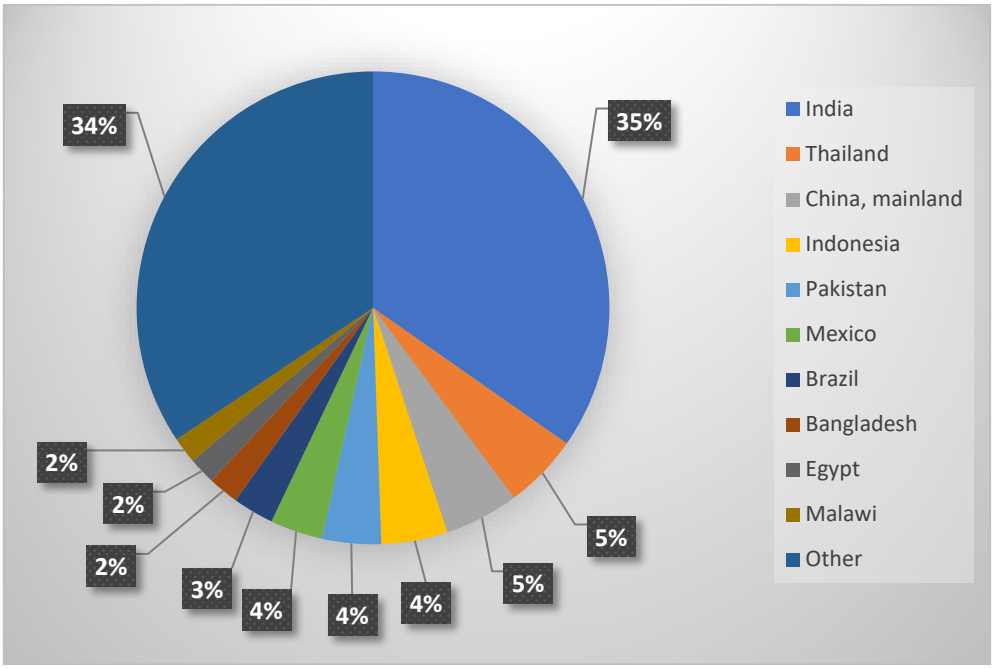
The Master Plan identified eight important crops and their value chains for policy implementation. Mango is one of the prioritized crops that were included in the Master Plan with the goal in 2030 that "Cambodia is one of the five major exporters of quality fresh mango in the world" (Goletti & Sin, 2016, p.2). Understanding the value chain of this crop will be an important element for improving the development of this sector and for illustrating the success of the Master Plan implementation in Cambodia.

Keo Romeat mango varieties account for about 80 per cent of total production in Cambodia during the on-season and nearly 100 per cent during the off-season (Hickey, 2019). Hence, the focus of this study is an analysis of the Keo Romeat mango value chain and the development of some recommendations to improve the performance of this chain.

World Mango Production and Markets

Mangoes represented about 52 per cent of the entire world's production of major tropical fruits in 2017 (Altendorf, 2019) . The world production of mangoes reached more than 55 million tonnes in 2019 (FAOSTAT, 2021). This volume had doubled over the last two decades. The average global mango production has risen 2.6 per cent annually over the last five years (Abbas et al., 2019). There are more than 100 countries growing mangoes (Siddiq, Brecht & Sidhu, 2017). According to FAOSTAT data, mangoes are recorded as one commodity together with mangosteens and guava, but mangoes dominate this commodity. India is the largest producer of mangoes, accounting for more than one-third of total world production (Figure 1). India produced more than 19 million tonnes of mangoes in 2019. Other major mangoes producers include Thailand, China, Indonesia, Pakistan, Mexico, Brazil, Bangladesh, Egypt and Malawi , but they each produce less than 5 per cent of the total output.

Figure 1. World mango production share in 2019



Source: FAOSTAT (2021)

Although the export of mangoes has increased about 2.4 per cent annually in the last five years, the vast majority of mango production is still supplied for domestic consumption. Less than 3 per cent or about 1.5 million tonnes of world mango production was traded in 2017 (Abbas et al., 2019). According to FAOSTAT, Mexico is the largest exporter of mangoes, accounting for 248,678 tonnes in 2019,

followed by India (146,931 tonnes), Brazil (103,671 tonnes), Thailand (93,552 tonnes), and Netherlands (80,983 tonnes) (FAOSTAT, 2021).

The import of mangoes in the world has risen from 600,000 tonnes in 2001 (Abbas et al., 2019) to 2,390,765 tonnes in 2020 (ITC Trade Map, 2021). The top five importing counties in 2020 were the United States with 573,751 tonnes, China with 378,778 tonnes, Netherlands with 230,221 tonnes, Germany with 101,261 tonnes, and Hong Kong with 100,801 tonnes (ITC Trade Map, 2021).

Mango Production in Cambodia

Mango is a popular fruit tree for Cambodian farmers, and it is grown in all provinces. There are several varieties of mangoes grown in Cambodia including Keo Romeat, Keo Chen, Kbal Damrey, Phomsen, Kh'tis, and Thai mango. March to May is the main season for harvesting these mango varieties. Keo Romeat is recognized as the most popular variety, grown for both consumptions domestically and for export (Goletti & Sin, 2016). It's skin and flesh have yellow colours when ripe. It has a range of fibrosity from low to medium, with high sweetness and aromatic flavor. Keo Romeat mangoes can be harvested three times a year. The natural harvest season is between March to May. The first off-season can be harvested between September and November and the second off-season can be collected during December and February. In addition to the varieties mentioned above, the General Directorate of Agriculture of MAFF imported Keitt and R2E2 mango varieties for testing in Cambodia and approved those varieties as suitable for Cambodian climate and soil conditions. However, only one farm has reported planting those varieties (GIZ, 2020).

Mango cultivated areas have increased significantly from 5,048 ha in 2016 to 137,950 ha in 2020. Of the total planting area, 3,421ha is owned by companies. The total production of mango reached 1,495,989 tonnes in 2020 (MAFF, 2021). Kampong Speu, Battambang and Udor Meanchey provinces are the major mango production areas, accounting for nearly 50 per cent (61,181 ha) of total mango production in the country (GDA, 2021).

Table 1. Cambodia mango production area and volume for the last five years

Year	Cultivated area (ha)	Production volume (tonne)
2016	5,048	67,319
2017	94,202	798,323
2018	100,092	1,042,469
2019	124,319	1,448,678
2020	137,950	1,495,989

Sources: GDA (2021), FAOSTAT (2021)

Mango market in Cambodia

According to ITC trade map, guavas, mangoes, and mangosteens are considered as one commodity. This official data shows that the total volume of mango exported from Cambodia increased significantly from just 332 tonnes in 2016 (ITC Trade Map, 2021) to 97,628 tonnes in 2020 (GDA, 2021). The ASEAN countries are the main import destinations for Cambodian mangoes. The top importer is Vietnam (39.4 per cent), followed by the Philippines (34.9 per cent), Korea (9.1 per cent), Singapore (6.1 per cent), and Thailand (3.5 per cent). The two European countries that imported Cambodian mango the most are the United Kingdom (1.9 per cent of total exports), and France (1.7 per cent) (ITC Trade Map, 2021).

Table 2. Cambodia official mango export for the last five years

Year	2016	2017	2018	2019	2020
Export volume (tonne)	332	3,005	7,661	6,138	97,628

Sources: ITC Trade Map (2021), GDA (2021)

However, there are significant quantities of mangoes exported unofficially from Cambodia to neighbouring countries without records. For example, the Minister of Agriculture, Forestry, and Fisheries announced in a preliminary report on the progress of major agro-industrial crop production in 2020 that 945,274 tonnes of Cambodian fresh mangoes were exported to international markets in 2020 with a total value of approximately $US 473 million (Phal, 2020). This data implies that 63 per cent of total mango production in Cambodia was exported, while about 37 per cent was consumed locally in 2020. It is important to note that among the total volume of fresh mango exported, announced by the Minister, only 97,628 tonnes (about 10 per cent) were officially certified by phytosanitary officials (GDA, 2021). This means that 90 per cent of Cambodian fresh mangoes were exported illegally or unofficially to neighbouring countries.

Hickey (2019) reports that the majority of Keo Romeat mangoes were traded in grey areas near Cambodian borders but no official data on quantity movement between the neighbouring countries were recorded. The price of mangoes fluctuates based on the requirements of traders. The average price to mango growers is between 1,500 Riel to 2,000 Riel/kg (around $US0.50/kg). However, during the peak season, the price can plunge to about $US0.10-0.20/kg (Emily, 2021; GoCambodia, 2021). Farmers have no control over when the mangoes leave their farms. Value-added activities such as grading, packaging, and processing are done in Vietnam or Thailand. Growers cannot get the benefits of this value adding because of limited capacity, knowledge, and information about market requirements (Hickey, 2019).

Market arrangements for mangoes in local markets is poor because no quality assurance system is provided. Post-harvest facilities for mangos are underdeveloped. The informal trade to Vietnam has a good arrangement between growers and traders who sent mangoes to Vietnam buyers. Traders negotiate a price with farmers before harvesting seasons and take care of all activities during harvest (Goletti & Sin, 2016).

To expand mango exports, Cambodia negotiated with China and received a 500,000 tonne quota to export mango to China. On 9 June 2020, specific requirements of phytosanitary for mango export were officially signed by both countries (Emily, 2021). Additionally, Cambodia and China signed a Free Trade Agreement on 5 October 2020 (GIZ, 2020). This will give good opportunities for Cambodian agricultural products to access China markets. From these agreements, Cambodia hopes to increase the export of fresh mango to China in the future.

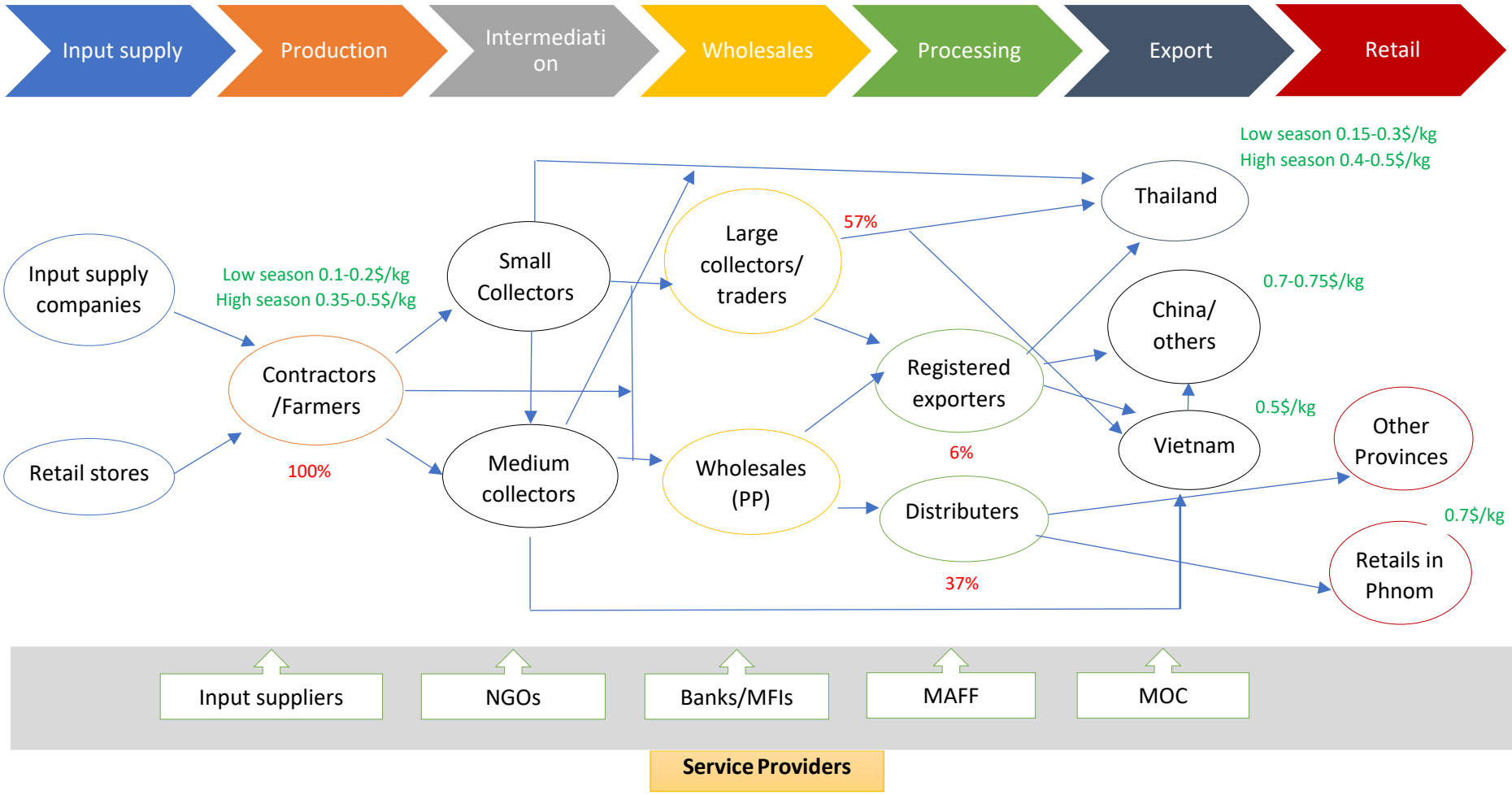
Mapping of the Value Chain

The value chain actors

Input supply

Inputs required for mango production include fertilizer, fungicide, insecticide, chemicals for inducing flowering, fuel, and labour (see Figure 2). Those inputs are mostly available in districts, provincial towns, and Phnom Penh. Farmers tend to buy those inputs from shops located near their residence but when they cannot find the products that they want, they go to provincial towns or to Phnom Penh.

Figure 2. Mapping of the Cambodia Keo Romeat mango value chain



Sources: Hickey (2019), Emily (2021), MoC (2021)

People living near the Thai and Vietnamese borders sometimes buy those products from Vietnamese or Thai retail shops.

Farmers and contractors

These are the mango producers. Farmers are responsible for growing mango trees, taking care of them until they can be harvested and sold. Keo Romeat mangoes can be harvested in two seasons, on-season from April to May and off-season from October to March. Some farmers don't want to take risks in the production, they lease their mango trees to contractors for management.

Contractors are playing more important roles in mango production as more farmers lease their mango trees to contractors. The contracts can be done annually or tri-annually. The contractors will control all production, flower manipulation, and harvesting. Contractors pay farmers a fee based on the number of trees and the ages of the trees. The price ranges from $US3-20 per tree depending on the tree's age from 3 to 15 years old. On average, one contractor can manage 5,000-6,000 trees. Some contractors have personal farms and tend contracted mango trees as well. Most contractors try to focus on the off-seasons for their profits.

Contractors sell mangoes to collectors or large traders for export. The price of mangoes in the on-season is cheaper than in the off-season. The average farmgate price during the on-season in 2015 was $US0.33-0.43/Kg for grade 1, $US0.20/Kg for grade 2, and $US0.18-0.50/Kg for ungraded. In comparison, the average farmgate price during the off-season in 2015 was $US0.38-0.55/Kg, $US0.20-0.33/Kg, and $US0.35-0.58/Kg for grade 1, grade 2, and ungraded respectively. However, the price fluctuates greatly. For example, mango price in February 2021 plunged to $US0.17/Kg and was only $US0.04/Kg for unpacked mangoes (Emily, 2021).

Collectors/traders/exporters

Mangoes are generally sorted into two grades: large mangoes (3-4 fruits/Kg), well coloured and no infection from diseases and insects are considered grade 1, while smaller fruits (5-6 fruits/Kg) with small defects are grade 2. For export, mangoes are packed in 25kg plastic crates and for local supply they are packed in plastic bags. Generally, collectors approach growers and visit the farms when the mangoes are ready to harvest. When they are agreed, collectors will manage all harvesting and packaging activities including harvesting labour depending on the negotiation between collectors and contractors. Collectors sell mangoes to larger collectors or traders. Large collectors are collectors who can collect more than 7,000 tonnes of mangoes a year and they usually have trucks to transport mangoes to Cambodian borders for exports.

Wholesalers

The biggest wholesalers are located in Phnom Penh, called Damkor and Neak Meas markets. The wholesalers source mangoes from all provinces in the country. Then, mangoes are distributed to retailers in the city and in other provinces. Wholesalers also export mangoes to other countries. During the off-season from September to December, they exported 50 tonnes/day to Thailand, 20 tonnes/day to Vietnam, and 18 tonnes/day to China indirectly. Mangoes for export were sorted into two grades, grade 1 (2-3 fruit/kg) and grade 2 (4-5 fruit/kg). The price for grade 1 in 2015 was $US0.40-0.50/kg to Thailand, $US0.50/kg to Vietnam, and $US0.70-0.75/kg to China.

Service providers

There are a number of service providers facilitating the mango value chain in Cambodia. The Ministry of Agriculture, Forestry, and Fisheries (MAFF) is a government institute at the national level that is responsible for preparing regulations, strategic plans, and policies to support agriculture development in the country. At the provincial level, MAFF's staff work closely with producers by providing technical training, extension services, and other activities to support agricultural communities. Currently, there is no specific policy for mango development in Cambodia but the Master Plan mentioned previously highlighted some activities focused on the mango industry ranging from production, processing, and marketing and trade (Goletti & Sin, 2016). MAFF has successfully reached an agreement on phytosanitary requirements with China for exporting fresh mangoes from Cambodia to China (GIZ, 2020). This is an achievement for Cambodian mango marketing and trade promotion. However, Hickey (2019) found that most growers learned techniques of flower manipulation for off-season mangoes from traders, not from agricultural experts. This can stress the mango trees due to overproduction and sometimes lead to failure to induce flowers. This shows the limitation of the implementation of the agricultural extension policy since 2015 which focuses on improving farmer's knowledge, skill, and technology to improve mango production (GIZ, 2020).

The Ministry of Commerce is responsible for facilitating trade-related activities and finding new markets for exports. Banks and microfinance institutes (MFIs) providing financial services in terms of loans to actors in the chain while input suppliers advise on chemical use in mango production. Non-governmental organizations (NGOs) play a part in providing training to farmers.

Product, information and financial flows

Product flow

Producers have two choices about selling mangoes. Firstly, they can sell directly to international traders, who are mostly Vietnamese. In this case, the arrangement is made early in the season with an agreement on supplying paper bags for covering the fruit to protect it from insects, plus labour for covering and harvesting. Traders want high quality fruits therefore they work directly with producers. Secondly, producers can sell mangoes to collectors who approach them during the harvest season. The price is negotiated after the collectors visit the farms. There are different scales of collectors, small, medium, and large. After collectors agree to buy the mangoes, they harvest and sell directly to international traders at the borders (Thai or Vietnamese) or sell their mangoes on to larger collectors or wholesalers. Large collectors also sell mangoes to Thai and Vietnamese traders at the borders after aggregating supply from many small collectors. At the wholesale sites, some mangoes are distributed to retail shops in Phnom Penh and to other provinces in Cambodia. This channel accounted for about 37 per cent of total production in 2020. Some traders are also registered exporters, and they export mangoes to Thailand, Vietnam, China, the Philippines, Singapore, Korea, and some European countries. Although there is no clear data about the volume of exports to each country, it is expected that the neighbouring countries of Vietnam and Thailand import most of the Cambodian mangoes because about 90 per cent of total exports (about 57 per cent of total production) is done unofficially. Only about 6 per cent of total production is officially exported as Cambodian product to international markets (GDA, 2021).

Information flow

In the case of the mango value chain, Thai and Vietnamese traders are the main source of information related to markets. Those traders collect all information from import countries, price and quantity demanded are then set, and the information is shared with the main collectors who source mangoes for them. Collectors are the main source of information for producers. However, collectors usually do not share all information because they want to get more profits from producers. Hickey (2019) found

that while producers were concerned about the price of mangoes, most collectors know that the price of mangoes will increase with increasing opportunities to access new export markets, but this information is not shared with producers. Moreover, contractors and growers never share information other than leasing agreements.

Because mangoes cannot keep for a long time on the trees, growers need to harvest them when they are ready. As Cambodia depends mostly on neighbouring countries for selling mangoes and there are no large processing factories in the country, farmers have no choice but to sell their mangoes when they are ready, usually at cheap prices.

Financial flows

Growers lease their mango trees to contractors with prices between $US3-20 per tree depending on the tree's age. Then the contractors buy all the inputs from retailers such as fertilizer, fuel, and chemicals to apply on the trees. If the crop is not contracted, when the fruits are ready to harvest, collectors approach producers to buy mangoes with an agreed price from $US0.35-0.50/kg or cheaper based on seasons (Hickey, 2019). Collectors can resell the fruit to larger collectors or to international traders and profit from their set of services. Vietnamese and Thai traders receive the most profit after processing and reexport to other countries.

Performance Assessment of the Chain

A whole-of-chain framework, developed by Aramyan et al. (2006), is adopted to assess the performance of the Keo Romeat mango value chain in Cambodia. This framework was designed to evaluate the performance of the supply chain of agriculture products and can be applied both at the institution level and supply chain level (Aramyan et al., 2007). Aramyan's framework assesses the chain performance in four main categories - efficiency, flexibility, responsiveness, and food quality. Efficiency focuses on the evaluation of resource utilisation while flexibility measures the level of responses of the chain to changing situations such as the environment and demand. Responsiveness looks into the time of product supplies and food quality evaluates both products and process quality such as product safety and health, sensory properties and shelf-life, and product reliability and convenience (Aramyan et al., 2007).

Efficiency

Production cost and profit

Production cost and profit vary according to the price of mangoes and the method of sale. If farmers lease their mango tree to contractors, farmers have low risks with price fluctuations but they may not get much return. Contractors' costs and profit are dependent on the price of leasing per tree, input and labour costs and the price of mangoes. If the lease fee is $US15/tree and one hectare has 260 trees (Hickey, 2019), contractors will pay $US3,900/ha plus input and labour costs which are about $US1,000/ha (pers. com. Cambodian mango farmer). Therefore, with an average yield of 15.4 tonnes/ha (MAFF, 2021), contractors need to receive a farm gate price of at least $US0.31/kg as the threshold to break even. So the price of mangoes is the main driver of profit for contractors.

Others actors in the chain receive profit for their activities but the profit for Cambodian participants is low. Cambodian contractors receive about $US12/tonne, but Vietnamese wholesalers and traders receive about $US50/tonne and $US20/tonne respectively (Table 3). This shows that most of the value received for Cambodian mangoes accrues to Vietnamese importers.

Table 3. Average price of mangoes from Cambodia to Vietnam in 2015

	Unit	Producers	collectors	Vietnamese wholesalers	Traders in Vietnam	Vietnam customers
Mango price	VND/Kg	4,500	6,500	15,000	17,500	19,000
	KHR/Kg	900	1,300	3,000	3,500	3,800
Transportation cost	VND/Kg		100	200	100	
Labour cost	VND/Kg		30	400	0	
Other fees	VND/Kg		30	100		0
Net profit	VND/Kg		240	1,000	400	
	KHR/Kg		48 ($US12/t)	200 ($US50/t)	80 ($US20/t)	

Source: Department of Agricultural Cooperative Promotion (2015)

Productivity

Table 4 shows that according to official FAOSTAT figures, mango productivity in Cambodia is 13.5 tonnes/ha, higher than other ASEAN countries especially Indonesia, Thailand, and the Philippines which are the major producers in the region. Further, more recent data shows yield has risen to an average of 15.4 tonnes/ha (MAFF, 2021). This indicates the potential advantage of mango production in Cambodia over other countries in the region.

Table 4. Mango yield of ASEAN countries in 2019

Countries	Yield (tonnes/ha)
Cambodia	13.5
Indonesia	13.1
Lao PDR	8.3
Malaysia	9.5
Myanmar	5.6
Philippines	3.8
Thailand	7.7
Timor-Leste	9.1
Viet Nam	11.3

Source: FAOSTAT (2021)

A study that investigated the opportunity cost of producing some crops locally comparing to the cost of importing those crops shows that Cambodian farmers can produce some crops cheaper than importing them. Those crops were paddy rice, cashew nut, maize, among others (Goletti & Sin, 2016). Although mangoes were not included in that study, the fact that Thailand and Vietnam imported Cambodian mangoes to supply their processing factories means that mango farmers in Cambodia have a comparative advantage in producing mangoes over farmers in those countries.

Flexibility

Losses

Losses in mango production can be caused by climate change, and poor farm management and post-harvest activities.

Climate change is one of the major factors that cause mango production losses in Cambodia. Too much rain and long droughts during flowering may have negative effects on mango fruit setting and the quality of the fruits. The Kampong Speu Mangoes Association's president estimated that heavy rain followed by a prolonged drought in 2019 decreased mango yield in the region by nearly 50 per cent (Heng, 2019).

Som (2019) found that the quality and quantity of Cambodian mangoes were affected by a range of factors. Firstly, if fruit-protection covers were not used, some 5 per cent of fruit suffered defects from pests and 50 per cent of fruit have dark skin which can decrease fruit color quality. Secondly, harvesting too early affects the degree of sweetness and harvesting too late could decrease the shelf life of mangoes. Finally, packing in big plastic bags and stacking them on top of each other during transport also adversely affected the quality of mangoes (Som, 2019).

Price

The producer price index of mangoes in Cambodia is shown in Table 5. This shows that the annual average price is increasing over time. However, it does not show the variability in price through the year. For example, most farmers expect to get better returns during off-season production because the mango price is generally higher than during the on-season. ADB (2018) found that traders were able to offer $US 0.20-0.25/kg more in the off-season than the price in on-season for premium products. Thus, off-season production seems to be the driver for producers in the chain.

Table 5. Annual producer price index for mangoes in Cambodia

Year	Producer Price Index
2015	99.18
2016	100.93
2017	103.85
2018	106.92

Source: FAOSTAT (2021)

Product quality

Keo Romeat mangoes are green outside and golden yellow inside. When it is ripe, the skin becomes yellow with deep yellow flesh, and it has an aroma with a good balance of sweetness (GIZ, 2020). Keo Romeat mangoes can be consumed both green and ripe. The Keo Romeat variety has become popular for export markets especially for Thai and Vietnamese traders (Hickey, 2019). Also, since the first shipment of Keo Romeat mangoes to Korea in January 2020, Cambodian mangoes have become popular among Korean consumers which encouraged Korean investors to invest in the mango industry in Cambodia for export (O'callaghan, 2020).

Responsiveness

The chain has medium responsiveness. Keo Romeat mangoes can be produced both on-season (March to May) and off-season (September to February) (GIZ, 2020). In general, Keo Romeat mangoes can supply the market for about nine months, but off-season production is still low and there is no fruit supply between June and August. At the exporting level, Keo Romeat mangoes have fairly good

responsiveness for exporting to neighboring countries because it takes only a short time to deliver. However, exporting long distances is challenging as it requires proper storage and transport facilities.

Challenges Facing the Mango Value Chain

As Hickey (2019) noted, contractors depend on off-season production for their profits, but off-season production based on using hormones to induce flowering is still new for most growers. They learned those techniques from Thai or Vietnamese traders who mostly do not know about the development of mango trees and their nutrition requirements. This might cause stress to the trees because of overproduction (Hickey, 2019). Moreover, farmers frequently use excessive amounts of chemicals on mango trees which may have negative effects on food safety and workers' health (Goletti & Sin, 2016). Additionally, climate change also had impacts on fruit setting and fruit quality of off-season mangoes (Som, 2019).

The price of mangoes is highly variable. Most Cambodian mangoes are exported unofficially to Vietnam and Thailand. Cambodian farmers usually get lower prices than formal market international prices because the price is controlled by Vietnamese and Thai traders and the mangoes may be reexported to other countries (Abbas et al., 2019). This is a kind of oligopsony market for Cambodian farmers where collusion is often evident among those traders. Also, because standard processing facilities are not available in Cambodia, almost all mangoes are exported in raw form to Thailand and Vietnam where processing activities such as grading, cleaning, waxing, packing, treatment, and processing into other forms of products are done before exporting to other countries. Cambodia does not receive any of this value-addition for exported mangoes and job opportunities from mango processing are lost.

Information exchange between actors in the chain is limited. Collectors are the main source of market information, but they communicate with each other only on the price and the date of harvesting, while future demand, mango quality requirements, and other standards were not shared. Growers and contractors have never shared information about their practices, except the lease price. Contractors use their own experience and information about input applications from suppliers, not from experts in the operation of mango farms. Each actor is making decisions independently without considering the long terms benefits of the whole chain.

High interest rates are an obstacle for actors in the value chain to expand their business. MAFF (2021) reported that getting loans that have high interest rates is a factor that contributed to high production costs among actors in the value chain such as processors, collectors, and growers.

Potential Interventions and Support

Improve value chain coordination both horizontally and vertically

Improving horizontal coordination refers to improved cooperation between mango producers. One way of creating the potential of more bargaining power for producers, especially smallholder farmers, is to combine them into larger groups or cooperatives. Farmers should voluntarily form their groups with clear goals and specializing in mango production. The production should have a specific standard for operation such as good agriculture practice, organic or other standards to ensure both quality and quantity of mangoes. When the group can manage the quantity and quality, the group can have more power to negotiate with buyers.

Forming groups can give many benefits to smallholder farmers such as improving product quality, minimizing transaction costs, increasing their power in the supply chain, and sharing risks. It may also

help to improve the access to other resources such as financing, training, information, and other services (Smith, Dyer & Wandschneider, 2020). However, making those groups strong enough to manage and operate themselves, requires regular support from all related stakeholders. While there are some groups that have been working well, for example the Kampot pepper association and the organic rice association in Prah Vihea province, there are many who are not.

Improving vertical coordination means strengthening relationships between all actors in the chain. Growers want their farms to be managed sustainably while contractors need profits from leasing mango trees. Collectors and traders want both increased quantity and better quality of products. In this scenario, support from the government is important to build trust between those actors. Introducing one standard for the operation that all actors can recognize as a generic standard for the industry, such as good agriculture practice, would be a start. Moreover, contract farming between producers and buyers with coordination from the government can also improve trust between them.

Improving export capacity and diversify export markets

Finding other export markets, rather than only Thailand and Vietnam, could provide more value to the Cambodian mango industry through bilateral agreements or free trade agreements. However, non-tariff barriers such as SPS and other requirements need to be agreed upon between Cambodia and those countries. Moreover, public-private partnerships for standard processing facilities to meet importing country requirements are important considerations. If these standards cannot be met, value-addition for Cambodian mangoes cannot be achieved. Currently, Cambodia has implemented public-private partnership frameworks on infrastructure related to energy, airports, bridges and roads (Sar, Chea & Ung, 2020). The private sectors are responsible for designing, financing and implementing the projects while the government provides special conditions related to law, policies, tax reduction, and other aspects of the supporting environment. Public and private shared management for better utilization. In terms of mango industries, the government could provide special conditions for investors such as tax reduction, low interest loans and other legal supports.

Processors are concerned that the export of processed mangoes from Cambodia is more expensive than from other countries especially Thailand and Vietnam. Higher costs of electricity, transportation, and other imported material for processing make it difficult for the processors to compete with neighboring countries (CPSA, 2020)**.** Policies and regulations for supporting investment in mango processing facilities should be prioritized. This should also include a reduction in the energy price, transportation costs, and improving other infrastructure to reduce production costs. This will attract investors to invest in mango processing in the country, and help maintain the price of mango during the peak season.

Mango export information and services should be available to support investors or traders who want to export. This information and services must be free and easy to access. Moreover, cooperation between the government and Cambodian exporters to tackle export market barriers are necessary.

Considering diversifying mango varieties to supply markets

Currently, Cambodia depends on only one variety, Keo Romeat, for exporting. It represents about 80 per cent of total production during the on-season from March to May and nearly 100 per cent during the off-season from September to February (Hickey, 2019). There is no mango supply from Cambodia between June to August. Moreover, off-season production is not stable because it depends on the producer's knowledge of inducing flowering, and climate conditions (Som, 2019). Therefore, growing various mango varieties that can produce fruits for the whole year might be better in terms of reducing

price variability through the year and leading to a more responsive value chain (Chopra & Meindl, 2013).

Conclusion

Overall, the Cambodia Keo Romeat mango value chain still depends heavily on the neighboring country's markets, Vietnam and Thailand. Cambodia exported most mangoes to these two countries, mostly unofficially. The price of mangoes is controlled by Vietnamese and Thai traders because the products were bought at a cheap price for re-export to other countries. All mangoes are exported as a raw material that causes the loss of potential value-added revenues to the mango industry, fewer job opportunities, and a less profitable economy. Some challenges were identified along the supply chain. Producers have limited knowledge on fertilizer and chemical use especially the application of chemicals for flower manipulation which might have effects on tree production and health issues. Prices vary because of limited international market access as a result of lacking standard processing facilities. Information in the chain is not shared properly.

Improving the performance of the chain requires cooperation between all actors in the chain especially the coordination and support from the government. Some suggestions are made about forming grower cooperatives and making sure those groups function well regarding production capacities, knowledge sharing, market power, and getting support. Building trust between actors in the chain concerning production, quality, quantity, and price through creating one standard for all would also assist. Improvements in export capacity and diversification of export markets are necessary. Public-private partnerships are the key to success in many developing countries. The government creates a good enabling environment and therefore opportunities through bilateral agreements or free trade agreements with potential importing countries. The private sector then has the confidence to invest in modern processing facilities for exports. Diversifying more mango varieties for year-round supplies is an option to be considered for setting a responsiveness strategy.

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