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Cost-Benefit Analysis: Cashew Nut Processing Project Appraisal in Cambodia[1]

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Abstract

The global demand for cashew kernels has increased in recent years, particularly in high- and middle-income economies, due to rising international demand for nutritious food. Vietnam supplies 50 per cent of cashews sold on international markets. However, Vietnam is dependent on sourcing raw cashew nuts (RCN) from other countries to fulfil export obligations. Cambodia currently exports more than 70 per cent of its RCN to Vietnam. It is estimated that Cambodia could earn an extra US$30 to 40 million from its cashew nut industry if it developed a domestic processing industry. The objectives of this research are to answer two main questions: first, is it profitable to establish a cashew nut processing plant in Cambodia; and second, if so, what are the main opportunities and constraints? Cost-benefit analysis is employed to calculate the return from developing a small-scale cashew nut processing facility in Cambodia, based on standard Net Present Value and Benefit Cost Ratio measures, over a 20-year time horizon. Based on the most likely set of assumptions, the results show a clear positive return being made from such an investment, with the project taking just two and a half years to reach its break-even point. Cambodia has several advantages for investment in the cashew nut processing industry, including high-quality RCN and high kernel yields, and tax exemptions for Small and Medium Enterprises. However, investors need to consider that the returns are sensitive to any decreasing price paid for cashew kernels. Additional challenges for investors include competition from Vietnam for the Cambodian RCN, the lack of skilled labour, and high electricity costs in Cambodia. In conclusion, though, despite these challenges, it is considered to be financially viable to invest in small-scale cashew nut processing in Cambodia.

***Key words*:** Cost benefit analysis, Cambodia, cashew, small-scale processing

Introduction

Demand for cashew kernels has increased in recent years due to increasing demand for nutritious food in high- and middle-income economies (INC, 2019). Cashew kernels are consumed in three main

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forms: snacks, confectionary, and in bakery products as a substitute for other edible tree nuts such as almonds, walnuts and pistachios (Azam-Ali & Judge, 2001; Dendena & Corsi, 2014).

Vietnam and India were the first and second countries, respectively, to export processed cashew nuts to world markets, due to their huge processing capacities (Dendena & Corsi, 2014; Fitzpatrick, 2011). However, due to the lack of domestic production of RCN (raw cashew nuts) in these countries, they are both reliant on importing RCN from other countries, including Cambodia (DCCD, 2019; Fitzpatrick, 2017; Hean, 2018; IFC, 2010; MARD, 2019).

Cambodia produces about 100,000 MT of RCN per annum (IFC, 2010; MAFF, 2017a), with the majority being exported to Vietnam and India due to Cambodia's lack of cashew nut processing capacity, skilled labour and financial resources (Hean, 2018; IFC, 2010; MAFF, 2017a). Many studies assert that Cambodia has the potential to establish domestic cashew processing facilities that could earn US$30 million to US$40 million per annum (Goletti & Sovith, 2016; IFC, 2010; MAFF, 2017a).

The study poses two central research questions: is it profitable to establish a cashew nut processing plant in Cambodia; and if so, what are the main opportunities and constraints for developing a cashew nut processing industry in Cambodia?

To analyse the investment opportunity for cashew nut processing plants in Cambodia, in this study cost-benefit analysis (CBA) is conducted over a 20-year investment horizon to calculate the potential benefits from such an investment project. Standard return on investment criteria are calculated (Campbell & Brown, 2007). To incorporate risk, sensitivity analysis is used to determine whether changes in key assumptions result in changes in the satisfaction of project profitability criteria. The primary audience for this research is private sector agribusinesses that are interested in the investment opportunity for small-scale cashew nut processing in Cambodia.

The Cashew Nut Market

Global demand for cashew kernels

The global consumption of cashew nuts (in the form of cashew kernels) is increasing (see Table 1). The International Nut and Dried Fruit Council Foundation (INC) states that the estimated world consumption of cashew nuts (import data on cashew kernel basis) increased from about 599,000 MT in 2012 to about 792,000 MT in 2016, a rise of approximately 32 per cent. In 2016, India was the country with the largest cashew kernel consumption, accounting for 38 per cent of global consumption, followed by the United States (18 per cent) and Germany (5 per cent) (INC, 2019). Consumption per capita was largest in the Netherlands, with 1 kg/year, followed by Australia at 0.68 kg/year, New Zealand at 0.60 kg/year, Israel at 0.49 kg/year and the United States at 0.45 kg/year. In 2019, the World Bank (2019) forecast that the demand for cashew kernels would reach 1,100,000 MT by 2020, an increase of about 39 per cent compared to 2016. Therefore, there is a large and growing market opportunity for processed cashew nuts.

It is estimated that 60 per cent of processed cashew nuts are consumed in the form of snacks (mostly roasted and salted), while the remaining 40 per cent is substituted for peanuts and almonds in confectionary and bakery products (Azam-Ali & Judge, 2001). Cashew kernels can therefore be used as both a final and intermediate product for human consumption.

The most important factor driving increased cashew kernel consumption is the nutritional properties of the nut such as: its high lipid content, which reduces lower-density lipoprotein (LDL) cholesterol levels and coronary heart disease risks (Hu, Manson & Willett, 2001); protein varying from 19 per cent

Table 1. Estimated world cashew consumption (Kernel Basis)

	2012			2013			2014			2015			2016	
	Consumption (MT)	Cons. Per capita (KG/year)	Est'd Cons. Per capita (kg/year)2	Consumption (MT)	Cons. Per capita (KG/year)	Est'd Cons. Per capita (kg/year)2	Consumption (MT)	Cons. Per capita (KG/year)	Est'd Cons. Per capita (kg/year)2	Consumption (MT)	Cons. Per capita (KG/year)	Est'd Cons. Per capita (kg/year)2	Consumption (MT)	Cons. Per capita (KG/year)	Est'd Cons. Per capita (kg/year)2
India	289,677	0.245	0.5	230,278	0.182	0.36	224,384	0.177	0.36	257,190	0.203	0.406	301,719	0.228	0.456
USA	109,448	0.354	1.073	130,477	0.422	1.279	128,342	0.402	1.219	141,119	0.439	1.329	143,256	0.445	1.347
Germany	26,177	0.32	1.281	25,591	0.313	1.252	23,016	0.283	1.133	23,810	0.295	1.18	35,930	0.439	1.097
Netherlands	12,366	0.744	0.93	23,005	1.385	1.731	20,796	1.24	1.55	23,536	1.391	1.738	17,236	1.015	1.268
UK	12,381	0.199	0.603	9,636	0.155	0.469	16,052	0.251	0.759	19,854	0.307	0.93	16,772	0.255	0.773
Australia	15,491	0.695	1.389	15,763	0.707	1.414	16,572	0.715	1.43	15,893	0.663	1.326	16,471	0.683	1.365
Canada	11,808	0.346	0.692	11,958	0.35	0.701	12,156	0.344	0.689	11,812	0.329	0.657	14,267	0.393	0.786
France	8,416	0.134	0.535	8,698	0.138	0.553	10,027	0.151	0.606	10,418	0.162	0.647	8,649	0.134	0.535
Japan	7,580	0.059	0.108	8,146	0.064	0.116	11,523	0.091	0.166	11,235	0.089	0.161	8,040	0.063	0.114
Saudi Arabia	6,203	0.225	0.682	5,310	0.193	0.584	7,977	0.272	0.823	8,541	0.271	0.821	7,854	0.243	0.737
Italy	5,410	0.089	0.596	4,744	0.078	0.523	7,000	0.117	0.783	6,745	0.113	0.752	7,060	0.119	0.792
Thailand	5,920	0.088	0.131	6,010	0.089	0.133	8,164	0.121	0.181	8,290	0.122	0.182	6,213	0.09	0.129
Russian Fed.	10,094	0.071	0.284	10,060	0.071	0.283	12,161	0.086	0.345	3,604	0.025	0.1	5,830	0.04	0.162
Israel	4,041	0.53	1.06	2,840	0.373	0.745	4,490	0.561	1.121	4,349	0.539	1.079	4,001	0.488	0.977
China	51,043	0.038	0.116	51,350	0.038	0.116	52,159	0.038	0.115	49,925	0.036	0.109	3,998	0.003	0.008
Korea Rep.	1,150	0.023	0.071	2,676	0.054	0.164	3,920	0.078	0.236	3,085	0.061	0.186	3,964	0.078	0.237
Spain	4,383	0.095	0.381	4,935	0.107	0.428	4,511	0.096	0.382	5,303	0.115	0.46	3,498	0.075	0.302
Malaysia	2,120	0.075	0.15	1,323	0.047	0.094	2,013	0.067	0.133	2,297	0.076	0.151	2,971	0.095	0.191
New Zealand	2,389	0.547	1.094	2,651	0.607	1.214	2,884	0.635	1.27	3,006	0.664	1.328	2,811	0.603	1.206
Sweden	1,301	0.139	0.555	2,213	0.236	0.944	2,090	0.217	0.869	2,080	0.213	0.851	2,739	0.278	1.114
WORLD TOTAL	599,034	0.087		601,642	0.087		716,682	0.1		724,556	0.099		792,323	0.106	

Source: INC (2019)

(Venkatachalam & Sathe, 2006) to up to 36 per cent (Aremu et al., 2006); and various minerals required for bone formation (Akinhanmi, Atasie & Akintokun, 2008; Aremu et al., 2006). The second factor underlying rising demand for cashews is the increased popularity of nutritional foods in high-income economies (such as Australia, the United States and the European Union) and middle-income economies (such as China, India, and South Africa). Demand in high-income economies increased from 16 per cent in 2014 to 17 per cent in 2016, while the demand in middle-income economies rose from 15 per cent in 2014 to 22 per cent in 2016 (INC, 2017, 2019). Based on a gross national income (GNI) per capita classification (Atlas method) by The World Bank Group (2016), GNI per capita was classified into four thresholds: low-income, lower-middle income, upper-middle income and high-income economies (Table 2).

Table 2. Different levels of classification based on GNI

Threshold	GNI per capita in July 2016
Low-income	Below US$ 1,025
Lower-middle income	US$ 1,026 – 4,035
Upper-middle income	US$ 4,036 - 12,475
High-income	Above US$ 12,476

Source: The World Bank Group (2016)

From the same report, Cambodia's GNI per capita was US$ 1,070, which classifies it as a lower-middle income economy. Though it can therefore be assumed that cashew consumption in Cambodia also increased in 2016 along with other middle-income economies, there are no data available on total cashew kernel consumption in the country. In 2018, GNI per capita in Cambodia increased by almost 30 per cent, to US$ 1,380 per capita.

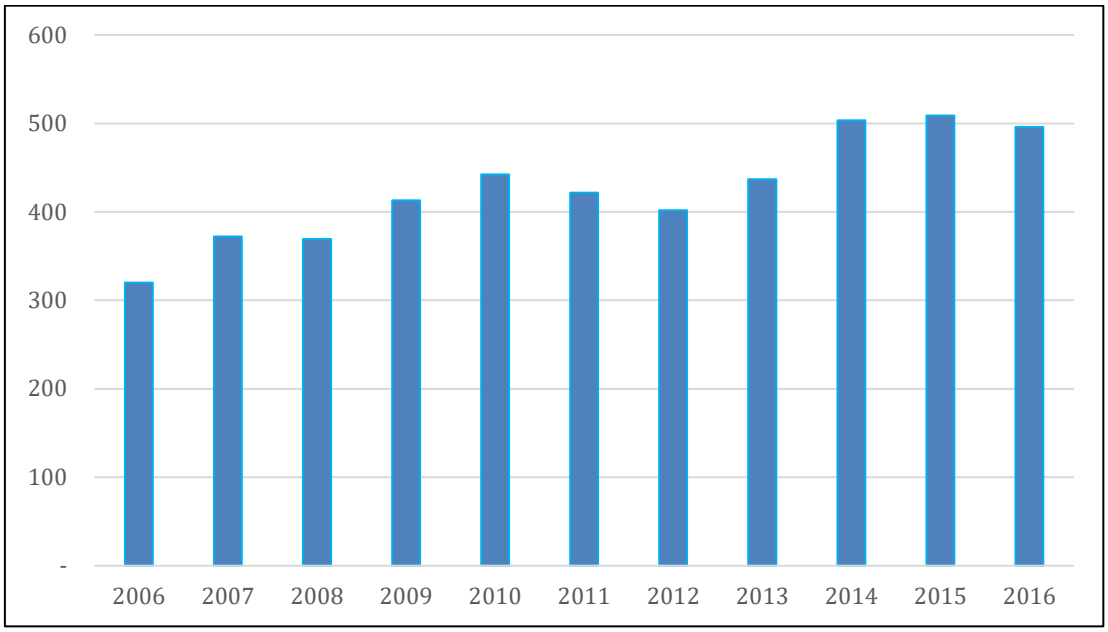
Global supply of cashew kernels

In recent years, the export of processed cashew nuts (cashew kernel basis) has increased in both quantity and value (Fitzpatrick, 2017; INC, 2019). Global exports of cashew kernels increased from 320,000 MT in 2006 to 496,000 MT in 2016, or by about 55 per cent (see Figure 1). In 2016, cashew exports (kernel basis) from Vietnam and India were 279,000 MT and 85,000 MT which accounted for 56 per cent and 17 per cent, respectively, of world cashew exports (INC, 2019) (see Figure 2). Vietnam and India are now the first and second largest exporters of processed cashew nuts (INC, 2019) due to their large processing capacities (DCCD, 2019; Fitzpatrick, 2011; MARD, 2019).

The export value of processed cashew nuts has also increased in recent years by some 350 per cent; from about US$2.3 billion in 2007/08 to US$8 billion in 2017/18 (INC, 2019). This was partly due to the increase in export volumes of processed cashew nuts to world markets, but also to increasing prices for cashew kernels (Fitzpatrick, 2017; INC, 2019). From 2007 to 2017, the price of cashew kernels doubled to about US$4.5/kg. In addition, the price of cashew kernels is forecast to continue to rise above US$5/lb (about US$11/kg) (The World Bank, 2019). Increasing prices due to strong demand will likely prove a further incentive for investment.

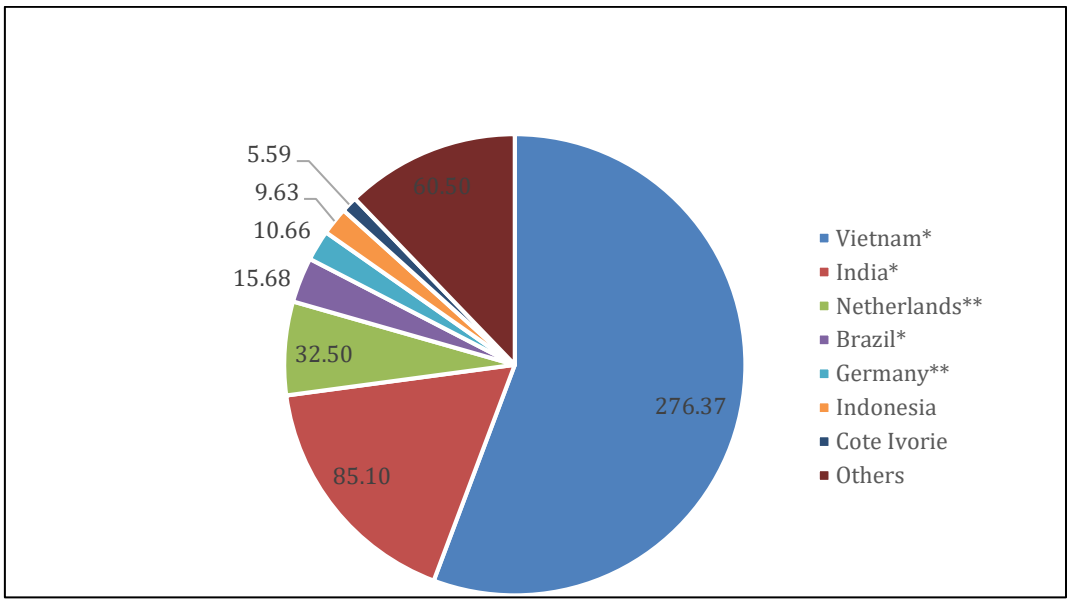
Vietnam is the leading country in processing cashew nuts, and exporting processed cashews, due to its huge processing capacities. The cashew nut processing industry in Vietnam has improved significantly, since its inception in 1990, due to the advancement of cashew nut processing automation technology.

Figure 1. World cashew exports (shelled), 2006 - 2016 (in thousand MT)



Source: (INC, 2019)

Figure 2. 2016 World cashew exports in shelled nuts (000 MT) by country



Source: (INC, 2019) (* processing country, **transit country)

Today, the country has about 1,000 processing plants that have a combined processing capacity of more than 1,300,000 MT of RCN per year (CashewInfo.com, n.a; MARD, 2019). Additionally, 50 per cent of these processing plants are large or medium processors that have obtained certificates in GMP, ISO and Hazard Analysis Critical Control Point (HACCP) (CashewInfo.com n.a). These certificates help Vietnamese cashew processors to gain trust from international consumers. However, as mentioned previously, to fulfil its processing capacity, Vietnamese processors import about 1,000,000 MT of RCN annually from other countries, including Cambodia (Fitzpatrick, 2017; Hean, 2018; MAFF, 2017a).

Like Vietnam, India has a huge cashew nut processing capacity due to its availability of skilled labour. The country has a processing capacity of 1.640,000 MT of RCN per annum, with 3,900 processing plants throughout the country (DCCD, 2019), making India the world's largest cashew nut processor. The cost of traditional cashew processing by manual labour was 288.56 Rupees (US$4.85)/kg, while the cost of cashew processing by machine was only 202.80 Rupees (US$3.40)/kg (Verma, Nag & Patil, 2014). The industry provides job opportunities to around half a million people, 95 per cent of whom are women (Anon, 2010). India imports about 50 per cent of its RCN supply from other countries, including Cambodia, to meet its processing capacity (DCCD, 2019; Hean, 2018).

Key factors in cashew nut processing

Cashew nut processing aims to extract the whole cashew kernel from RCN with as little damage as possible (Azam-Ali & Judge, 2001). There are three important factors determining successful cashew nut processing.

First, the quality of the cashew kernels is among the most important factors in the processing business. This quality aspect is important because cashews are considered to be a luxurious product (IFC, 2010), as they are consumed mostly as a source of healthy food in high- and middle-income economies (INC, 2017, 2019). 'Quality' here refers to the safety, reliability, durability and acceptability of a product to consumers (Nair, 1995). HACCP is one of the main food quality control standards that is applicable to small-scale cashew nut processing (Dillon & Griffith, 1995).

Second, the kernel outturn ratio (KOR) is a key indicator used to determine the value of RCN. KOR indicates the proportion of good cashew kernels after processing, with between 21 per cent to 31 per cent of total RCN resulting in cashew kernels (Ministry of Trade, Industry, Regional Integration and Employment of the Gambia, n.d.) due to various factors such as the variety of cashew trees, growing conditions and post-harvest management (IFC, 2010). A high KOR means a high yield from the RCN, which leads to more valuable processed cashew kernels.

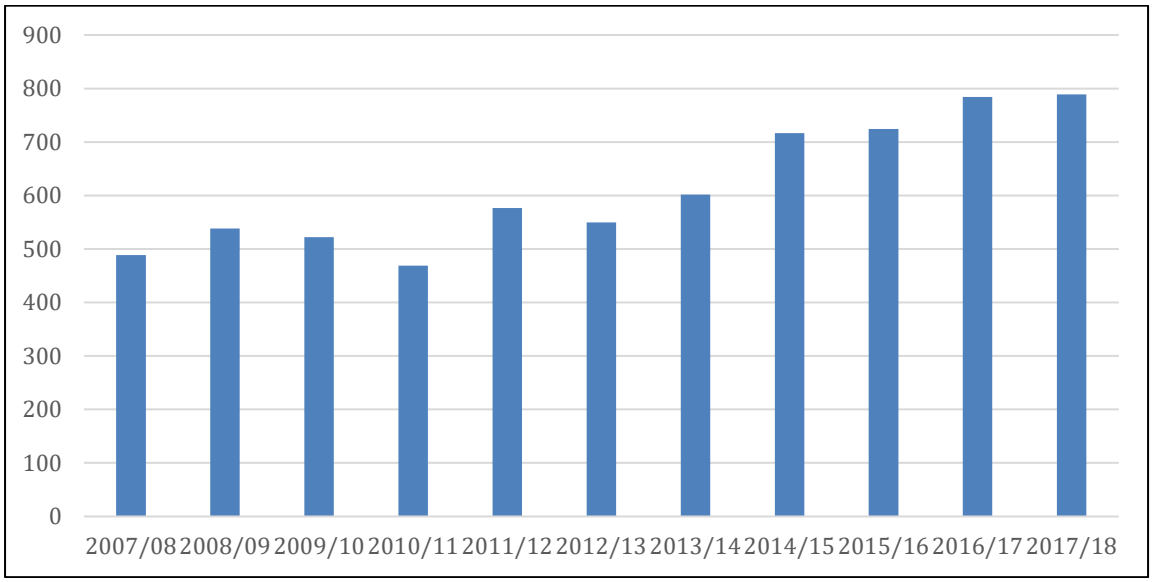
Finally, the ratio between whole and split kernels after cashew nut processing is the most important economic feature governing success in the processing business. According to Azam-Ali & Judge (2001), the ratio between whole kernels and split kernels after processing varies between 55 per cent to 85 per cent of actual output, according to processing methods and factory management. The standard satisfactory ratio for whole kernels is 65 per cent (Azam-Ali & Judge, 2001), although it has been argued that the ratio should be at least 80 per cent (after processing) to be considered a successful processing operation (Fitzpatrick, 2011).

Global production of raw cashew nuts (RCN)

In recent years, world RCN production (cashew kernel basis) has increased due to the increase in cultivated areas (FAOSTAT, 2019; INC, 2019). Over the last decade, global RCN production (cashew kernel basis) increased by about 30 per cent from 489,000 MT in 2007/08 to 789,000 MT in 2017/18 (see Figure 3).

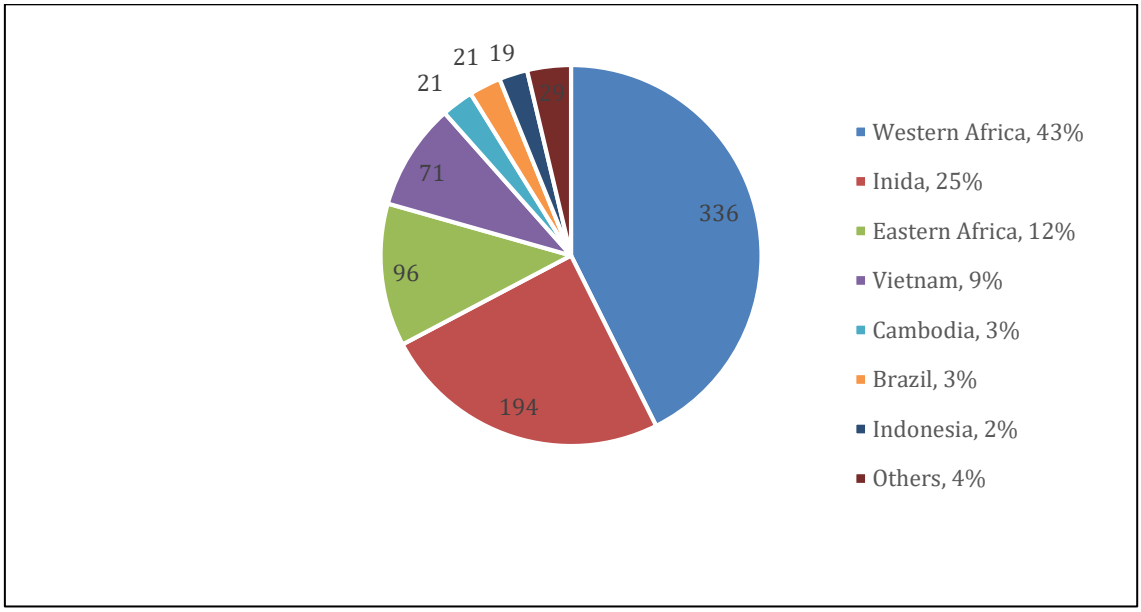
In 2017/18, RCN production in India, Cote d'Ivoire and Vietnam accounted for, respectively, 25 per cent, 20 per cent and 9 per cent of total global production which makes these countries the top three RCN producers in the world (see Figure 4). Cambodia's share of global RCN production is 3 per cent (INC 2019). Global cultivated area for RCN also increased from about 3 million ha in 2000 to 6 million ha in 2017 (FAOSTAT, 2019).

Figure 3. World RCN production in kernel basis 2007-2018 (thousand MT)



Source: (INC, 2019)

Figure 4. 2017-2018 global RCN production in kernel basis (thousand MT)



Source: (INC, 2019)

Most RCN producers (including Cambodia) are located in the northern hemisphere, which is responsible for 80 per cent of world RCN production. This skewed geographic distribution may have a negative impact on prices of RCN due to uneven supply, as most producers are harvesting RCN at the same time. In Table 3, the red colour represents the main harvesting period in each main producing country, while the yellow colour represents the less intensive times before or after the main harvesting period which may come into play due to other reasons, such as early rain or drought.

Table 1. Seasonal RCN harvesting by region

Region	Country	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern Hemisphere	Nigeria												
	Benin												
	Ghana												
	Cote D'Ivoire												
	Burkina Faso												
	Mali												
	Congo												
	Guinea												
	India												
	Vietnam												
	Cambodia												
	Guinea Bissau												
	Gambia												
	Senegal												
Southern Hemisphere	Indonesia												
	Brazil												
	Tanzania												
	Kenya												
	Mozambique												

Source: Ministry of Trade, Industry, Regional Integration and Employment of the Gambia (n.d.)

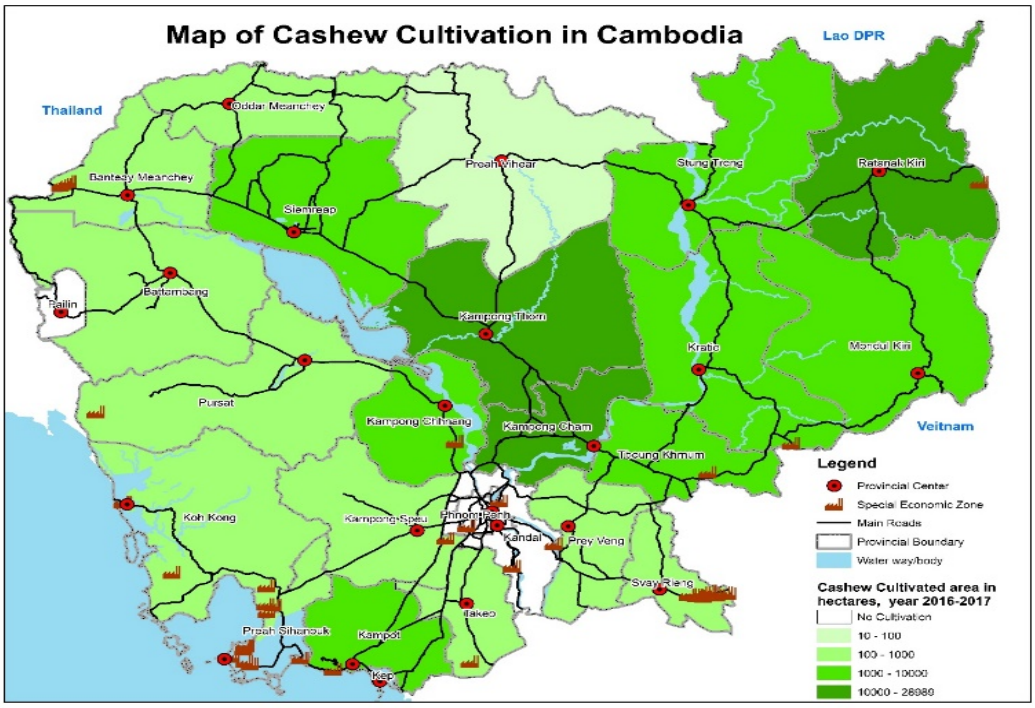
Cashew Nut Value Chain Analysis in Cambodia

RCN production

Cashew trees have been grown throughout Cambodia (see Figure 5) and, over the past decade, production has increased in terms of both total RCN production and cultivated area due to greater availability of agricultural land (Census of Agriculture, 2013, 2015; Hean, 2018; IFC, 2010; MAFF, 2017a). It is estimated that RCN production in Cambodia increased by about 40 per cent between 2010 and 2016/17, from 60,000 MT before 2010 (IFC, 2010) to about 107,000 MT in 2016/17 (Hean, 2018). Cultivated area for cashew trees in Cambodia also increased by 60 per cent, from 60,000 ha in 2013 (Census of Agriculture, 2013, 2015) to 97,000 ha in 2017 (Hean, 2018). According to the Ministry of Agriculture, Forestry and Fisheries (MAFF), in 2017 Cambodia produced an estimated 140,000 MT of RCN from about 140,000 ha of cultivated area, and that RCN production continued to increase in 2018 due to greater land availability (Khmer Times, 2018b). At present, the largest RCN producing province in Cambodia, Kompong Thom, accounts for about 29 per cent of the country's total RCN production and cultivated area (Hean, 2018) (see Appendix Table A.1).

Due to the increasing availability of agricultural land, in 2017 MAFF signed a MoU with the Vietnam Cashew Association (Vinacas) to produce 1,000,000 MT of RCN in Cambodia for export to Vietnam by 2028, through growing 500,000 ha of cashew trees in Cambodia. Vietnam's vision is turning its south-

Figure 5. Map showing cashew nut production in each province in Cambodia



Source: (Data from Hean, 2018)

east neighbours (Cambodia and Laos) into its main RCN suppliers in the future (Customsnews, 2017; Khmer Times, 2018a). While the MoU is good news for the market for Cambodian RCN, it may represent competition for local cashew nut processors in purchasing Cambodian RCN.

Export of Cambodian RCN

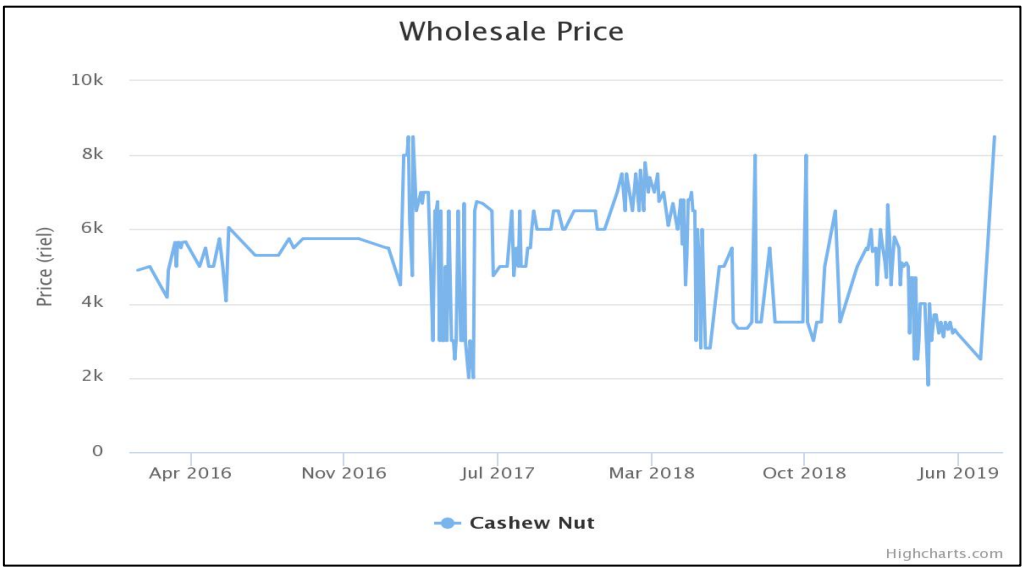
Cambodia exports the majority of its RCN to Vietnam (Goletti & Sovith, 2016; Hean, 2018; IFC, 2010; MAFF, 2017a). In 2015, Cambodia exported about 103,000 MT of RCN to Vietnam, almost all of total Cambodian RCN production (Hean, 2018). In 2015, the export value of Cambodian RCN to Vietnam was US$133 million (MAFF, 2017a). Cambodia was the fifth largest RCN supplier to Vietnam (Customsnews, 2017).

Prices of Cambodian RCN and kernels

According to data from the Agricultural Marketing Office (AMO/MAFF, 2019), the wholesale price of RCN in Cambodia fluctuates frequently, between 4,000 riels (US$0.98) and 6,000 riels (US$1.47)/kg. The lowest price is about 2,000 riels (US$0.49)/kg, while in rare cases the highest price reaches about 8,000 riels (US$1.96)/kg (AMO/MAFF, 2019) (see Figure 6).

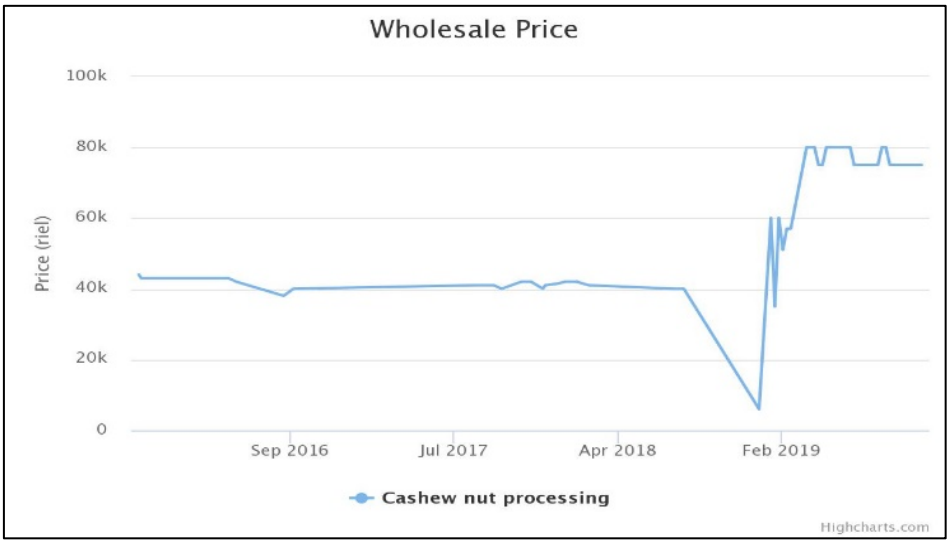
According to AMO/MAFF (2019), the wholesale price of processed cashew nuts in Cambodia was nearly 41,000 riels/kg (about US$10) until mid-2018, and the price increased to almost double that after February 2019 (see Figure 7). Internationally, a cashew processing association in Kampong Thom is reported to have sold processed cashews to markets in Japan and South Korea at prices between US$15 and US$17/kg (Khmer Times, 2017) due to the good flavour of Cambodian cashew kernels (MAFF, 2019) and these prices were 50 per cent greater than domestic prices. This processing association also estimated that the demand for processed cashew in both markets is about 100 MT

Figure 6. Wholesale price of RCN in Cambodia 2016-2019 (riel per kg)



Source: (AMO/MAFF, 2019)

Figure 7. Wholesale price of cashew kernels in Cambodia 2016-2019 (riel per kg)



Source: (AMO/MAFF, 2019)

per year, illustrating the market opportunities for Cambodian processed cashews (Khmer Times, 2017).

Current cashew nut processing in Cambodia

The export of almost all RCN production means that Cambodia loses potential economic benefits from cashew nut value addition. Many reports claim that Cambodia has the potential to establish its own cashew nut processing plants and could derive an extra US$30-40 million from cashew nut value addition (Goletti & Sovith, 2016; IFC, 2010; MAFF, 2017a).

The cashew nut processing industry in Cambodia remains small due to a lack of skilled labour (IFC, 2010) and a lack of capital to buy RCN as stock for processing (Hean, 2018; Khmer Times, 2017). It has

been claimed that cashew nut processing in Cambodia ranges from between 1 per cent to 30 per cent of total RCN production (Khmer Times, 2018b, 2019). MAFF predicts that only 30 per cent of RCN production is processed locally, of which 20 per cent is for export of processed cashews to international markets, and 10 per cent is for local consumption (Khmer Times, 2019). The cashew processing association in Kampong Thom claimed that the association exported about 15 MT to Japan and South Korea in 2017, while another private cashew nut processor reported that he bought about 300 MT of RCN for processing and exporting to markets in Netherland, India, China and Vietnam (Khmer Times, 2017). It is estimated that the average KOR of Cambodian RCN is 27 per cent, which is higher than that of Vietnam (24 per cent) and India (26 per cent) (Ministry of Trade, Industry, Regional Integration and Employment of the Gambia, n.d.; IFC, 2010). Theoretically, the relatively higher RCN in Cambodia represents a comparative advantage over Vietnam and India.

The cashew nut processing industry in Cambodia faces several main challenges such as competition for shelling from Vietnam (the biggest cashew nut processor), lack of skilled labour, a high interest rate, lack of market information, high transportation cost due to physical infrastructure problems, and low capacity in research and development (Hean, 2018; IFC, 2010; MAFF 2017). These primary challenges hinder the competitiveness of the Cambodian processing industry.

An overview of the cashew nut value chain in Cambodia is shown in Figure 8.

The Potential for a Domestic Cashew Processing Industry

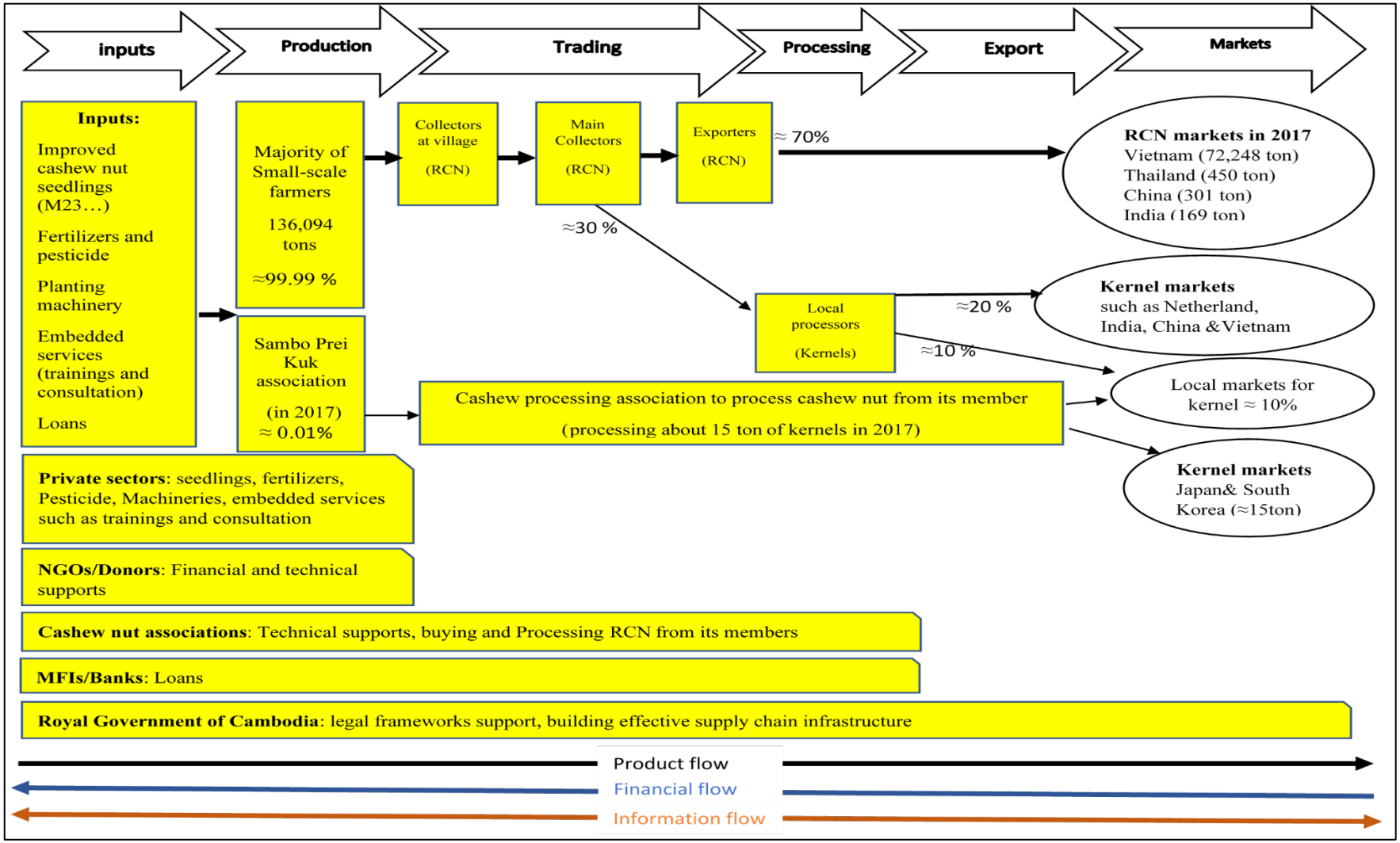
Given the discussion above about the potential market opportunities for cashew kernel exports from Cambodia, and the substantial price differentials between RCN and kernels, this study analyses a proposed 20-year investment project of a cashew nut processing plant in Cambodia. The processing plant has been proposed by a private company, the Mekong Tech Group. It is designed to contain small-scale automatic cashew nut processing machinery (Mekong Tech Group, 2019) due to the lack of skilled labour in the country for shelling (IFC, 2010) and health issues related to exposure to too much cashew nut shell liquid (CNSL) during the shelling process (Azam-Ali & Judge, 2001). The installation capacity of the processing plant is 3.2 MT of RCN per day, equal to 960 MT per year (for 300 working days per annum). Based on the KOR of Cambodian RCN of 27 per cent, it is assumed that the proposed plant can process about 860 kg of kernels per day, or almost 260 MT per annum.

Kampong Thom province is the location selected for the project due to its RCN producing capacity and central location in Cambodia. In 2016-17 RCN production in Kampong Thom was about 30,266 MT (Hean, 2018), which is about one third of total RCN production in Cambodia. The RCN demand for the project is 960 MT per annum; about 3 per cent of RCN production in the province and about 1 per cent of total RCN production in Cambodia.

RCN as a primary input material

The project is assumed to buy the total demand (960 MT) during the harvest season to store for year-round processing, because the price of RCN is predicted to be low then (see above; Ministry of Trade, Industry, Regional Integration and Employment of the Gambia, n.d.; MAFF, 2018). According to agriculture market information, the wholesale price of RCN in Cambodia fluctuated frequently between US$1 and US$1.5 per kg, with rare cases of US$2 at the highest point (AMO/MAFF, 2019). The price of RCN, including transportation, is assumed to be US$1.5 per kg.

Figure 8. Cashew nut value chain map in Cambodia



Adapted from: (Goletti & Sovith, 2016; Hean, 2018; IDP 2015-2025, 2015; IFC, 2010; Khmer Times, 2017, 2018b, 2018c, 2019; MAFF, 2017a)

Manufacturing process

According to (Mekong Tech Group, 2019), there are seven steps in cashew nut processing. First, dried RCN are sorted into various sizes through sorting machines (400 kg per hour). The five sizes of sorted RCN that are deemed suitable for automatic shelling machines are A+, A, B, C, and D (see Appendix Table A.2). Second, the sorted RCN are steamed in a cashew nut cooking machine to soften their shells (400 kg per batch). Third, the steamed RCN that are suitable for automatic shelling machines are shelled. The automatic shelling capacity is 200 kg per hour per line. The broken rate is less than 6 per cent, with the rate of uncut RCN also low. Uncut and unsuitable-size steamed RCN are shelled manually. At the fourth and fifth stages, the shelled cashew kernels are dried and humidified prior to peeling. Sixth, the dried and humidified shelled cashew kernels are peeled with a peeling machine. The peeling capacity is 300 kg/hour, and the ratio of white whole kernels (unbroken rate) ranges between 75 per cent and 90 per cent. Finally, peeled cashew kernels are graded for markets into various categories according to their size and colour. The grades of cashew kernels are: white whole cashew kernels (such as W240, W320 and W450), and other grades (such as SP, LP and WS) (Mekong Tech Group, 2019).

Installation processing capacity and capacity utilization

The installation processing capacity of the project is 3.2 MT per day, or 960 MT per annum (Mekong Tech Group 2019). Capacity utilisation is defined as "a ratio of the actual level of output to a sustainable maximum level of output, or capacity" (Corrado & Mattey, 1997, p. 152). The assumption of capacity utilisation for the project is 80 per cent for year 1, then 85 per cent, 90 per cent and 95 per cent for years 2, 3, and year 4 onward, respectively.

The ratio of whole and split kernels ranges between 75 per cent to 90 per cent, according to Mekong Tech Group (2019). In this project, the assumption is 75 per cent whole kernel and 25 per cent split kernels. Another assumption is that the wholesale prices of whole and split kernels are US$10 (AMO/MAFF, 2019) and US$6 per kg, respectively (see Table 4).

Table 4. Output capacity and capacity utilization

Description	Year 1	Year 2	Year 3	Year 4 onward
RCN as installation processing capacity (cashew with shell basis in MT)	960	960	960	960
KOR (Kernel Outturn Ratio) @ 27 per cent (cashew kernel basis in MT)	259	259	259	259
Capacity utilization (per cent)	80	85	90	95
Actual production (cashew kernel basis in MT)	207	220	233	246
Ratio for white whole kernels (75 per cent) (cashew kernel basis in MT)	155	165	175	184
Ratio for broken kernels (25 per cent) (cashew kernel basis in MT)	52	55	58	61
Price of RCN (including transportation)				US$ 1.5 per kg
Wholesale price of white whole kernels				US$ 10 per kg
Wholesale price of split kernels				US$ 6 per kg

Source: (AMO/MAFF, 2019; Ministry of Trade, Industry, Regional Integration and Employment of the Gambia, n.d.; IFC, 2010; Mekong Tech Group, 2019) and author's own assumptions

Investment or capital cost of the project

Following Campbell and Brown (2007), investment or capital cost is divided into two forms: fixed investment and working capital. Fixed investment refers to all the capital goods (such as land, buildings, and machinery), as well as initial training in human resources. Unlike fixed investment, working capital refers to stocks of goods used to offset possible interruptions (such as raw materials, spare parts and fuel) that are crucial for the starting point and ensuring on-going processing operations.

Though fixed investment costs are usually incurred at the commencement of a project, some types of capital goods in the fixed investment category (in this case warehouse construction, cashew nut processing machineries, diesel generators, and transportation vehicles) have different lifespans. Therefore, replacement investment (of fixed investments) will exist at various stages of a project. All investments or capital costs should be recorded in the actual year of expenditure (Campbell & Brown, 2007). The straight-line method will be employed in the calculation of depreciation costs of warehouse construction, cashew nut processing machinery, diesel generators and transportation vehicles. Based on the assumptions made, the total for investment, or capital cost, of the project is US$507,603 (see Table 5).

Table 5. Investment or capital cost of cashew nut processing in Cambodia ($US)

No	Description	Amount
1	Fixed investment cost	457,470
2	Working capital	50,133
	Grand total for investment/capital cost	507,603
	Bank loan (about 50 per cent of investment/capital cost)	250,000

Source: (Mekong Tech Group, 2019; NBC, 2018) and own assumption

Fixed investment costs and depreciation

In the project, the fixed investment consists of warehouse construction, a set of cashew nut processing machinery, a diesel generator, a vehicle (3-MT truck), initial training for staff related to cashew nut processing, registration of the company and fees for utilities connection (see Table 6). The total for this fixed investment cost is US$ 457,470 in year 0.

Table 6. List of fixed investment costs ($US)

No	Description	No	Price per unit	Cost
1	Warehouse construction (2000 m2)	1	240,000	240,000
2	Cashew nut processing machinery (set)	1	173,350	173,350
3	Diesel generator	1	10,000	10,000
4	Vehicle (3-ton truck)	1	30,000	30,000
5	Initial training for staff	1	2,000	2,000
6	Registration of the company	1	795	795
7	Fee for utilities connection	1	1,325	1,325
	Total fixed investment cost			457,470

***Land*:** The size of the land is about 5000 m^2, of which 2000 m^2 is used for building the warehouse to house the processing machinery, and the remaining 3000 m^2 is used as space to dry the RCN. The land is already owned by the company.

***Warehouse construction*:** a warehouse (2000 m^2) will be constructed to house processing machinery and store-dried RCN. The warehouse is made from an iron frame with zinc sheets for the roof. An estimation of construction costs is about US$240,000. The lifespan of the warehouse is assumed to be 20 years, with the salvage value of the warehouse being zero.

Cashew nut processing machinery (set): A set of cashew nut processing machinery is bought from Vietnam. The cost of the cashew processing machinery is about US$173,350. The lifespan of the processing machinery is expected to be 10 years, with the salvage value assumed to be zero.

***Diesel generator*:** As electricity supply in Cambodia is inadequate (especially during the dry season), the project will buy a diesel generator. The generator costs about US$10,000 and consumes 22 L of diesel per hour. Assumed generator usage is 8 hours per day for 100 days a year. The lifespan of the generator is 10 years, and the salvage value is zero.

Vehicle (3-MT truck): A new truck is bought for the project, and costs US$30,000. The lifespan of the truck is 10 years and the salvage value for the truck is zero.

***Initial training for staff*:** Initial training on cashew nut processing is organised for staff. This is a 5-day training session that mainly focuses on machinery management, and shelling and peeling techniques. The estimated cost for this training is about US$2,000.

***Registration of the company*:** In Cambodia, it necessary to register prior to starting a business. The registration process takes approximately 86 days, and costs about US$975 (MAFF, 2017a).

***Utility connections*:** It is necessary to connect the processing plant to water and electricity. The total fee for utility connections is about US$1,325: about US$663 for electricity (EDC, 2019) and another US$662 for water. Fees for electricity and water consumption are US$0.18 per kw/hr and US$ 0.37 per m^3, respectively.

Depreciation cost of warehouse, processing machineries, generator, and transportation: The straight-line method is employed to calculate the depreciation cost of the fixed investment items within the 20-year period of analysis (Table 7).

Table 7. Calculating depreciation using the Straight-Line Method ($US)

List of items	Initial cost	Lifespan (years)	Annual Depreciation (per cent)	Annual Depreciation Allowance
Warehouse (2000 m2)	240,000	20	5 per cent	12,000
Cashew nut processing machinery (set)	173,350	10	10 per cent	17,335
Diesel generator	10,000	10	10 per cent	1,000
Transportation (3-ton truck)	30,000	10	10 per cent	3,000
Total	453,350			33,335

Source: (Mekong Tech Group, 2019) and author's own assumptions

Working capital

The working capital for the project is shown in Table 8. Total working capital is $US50,133.

***RCN stock*:** To avoid interruptions caused by shortage of RCN, the cashew nut processing plant buys 32 MT of RCN as stock. The total cost is US$48,000.

Table 8. List for working capital for cashew nut processing project (US$)

No	Description	No.	Price per Unit	Cost
1	Raw cashew nut for stock (MT)	32	1,500	48,000
2	Diesel reserve for generator (1 barrel=159 liters)	1	133	133
3	Spare parts for machinery	1	2,000	2,000
	Total for working capital			50,133

Source: author's own assumptions

***Diesel reserve for generator*:** The processing plant buys a barrel (159 litres) of diesel as a reserve for the generator. This costs US$133 per barrel (PTTCambodia, 2019).

***Spare parts for machinery*:** It is assumed that the project spends US$2,000 on spare parts.

Operational cost

The annual operational cost to run the project is $US 1,538,343 (Table 9).

Table 9. List of operating costs

Operating cost	No.	Price per unit (US$)	Cost (US$)
Raw cashew nut (MT/year) (3.2 MT per day for 300 days)	960	1,500	1,440,000
Salary for processing supervisor and QC (Person/Year)	1	6,000	6,000
Salary for workers (Person/year)	20	1,800	36,000
Salary for driver (Person/year)	1	2,400	2,400
Salary for accountant (Person/year)	1	3,600	3,600
Water for machinery operation (m^3/year) ($5m^3$ per day)	1,500	0.37	555
Electrical consumption (kw/year) (80 kw/hour for 8 hours for 200 days)	128,000	0.18	23,040
Diesel for generator (L/year) (22 L/h for 100 days)	17,600	0.83	14,608
Gasoline for truck (L/year) (20 L/d for 300 days)	6,000	0.88	5,280
Miscellaneous assets	1	3,000	3,000
Maintenance	1	2,000	2,000

Patent for business operation	1	285	285
Employment injury scheme (occupational risk and healthcare)	1	1,575	1,575
TOTAL operating cost			1,538,343

Source: (MAFF, 2017a; Mekong Tech Group, 2019; NSSF, 2014) and author's own assumptions

***RCN as raw material input*:** RCN is the main raw material for the cashew nut processing plant. 960 MT of RCN will be bought during the harvest season and stored inside the warehouse for year-round processing. The price of RCN (including transportation) is assumed to be US$1,500 per MT, with the total cost of RCN being US$1,440,000 per annum.

***Labour*:** The processing plant employs 23 full-time employees in four different roles: one processing supervisor, one accountant, 20 workers, and one driver (see Table 9). The processing supervisor's main role is overseeing the processing plant, to ensure the quality of the product. Workers perform several tasks such as drying RCN, shelling and peeling RCN, and loading cashew kernels. The driver's main role is to deliver cashew kernels to customers. Salaries are shown in Table 10.

Table 2. Labour requirements and costs of the cashew processing plant ($US)

No	Position	Number	Cost per unit	Annual
	Salary for processing supervisor and QC (Person/year)	1	6,000	6,000
2	Workers (Persons/year)	20	1,800	36,000
3	Truck driver (Person/year)	1	2,400	2,400
4	Salary for accountant (Person/year)	1	3,600	3,600
	Total	22		48,000

Source: Author's own assumptions

***Electricity and water expenditure*:** According to the Mekong Tech Group (2019), the cashew nut processing machinery utilizes 5m^3 of water and 80 kw hours of electricity per day. It is assumed that the fee for water is US$0.37 per m^3 and the fee for electricity is US$0.18 per kw/hr. The total cost of annual water usage is US$555 per annum. As the electricity supply in Cambodia often experiences cuts, the assumption for electricity consumption is 200 days out of 300 days of total operation. The total annual cost for electricity for 200 days is US$23,040. The processing plant is assumed to use a diesel generator for the other 100 days of its operation, which costs US$14,608.

***Miscellaneous assets*:** Some other assets like plastic buckets and chairs are required for daily processing activities. The assumed cost of these miscellaneous assets is US$3,000 per year.

Maintenance: This cost refers to fixing processing machinery. The assumed cost of maintenance is US$2,000 per annum.

***Patent for business operation*:** The patent tax is an annual tax for business operations. The fee for patents is US$285 (GDT, 2019; MAFF, 2017a).

Employment injury scheme (occupational risk and healthcare): By law, there are two types of employment injury scheme to ensure worker safety: the occupational risk scheme and healthcare scheme. It is the responsibility of employers to cover these schemes for their employees. The occupational risk scheme is 0.8 per cent of employees' wages (MAFF, 2017a; NSSF, 2014), while the healthcare scheme is 3 per cent of employees' wages (NSSF, 2014). Total annual payment for the employment injury scheme is US$ 1,575 (see Table 11).

Table 3. Employment Injury scheme (occupational risk and healthcare schemes) ($US)

Position	No.	Occupational risk scheme		Healthcare scheme		Grand-total per annum
		fee/person/ month	Total fee per annum	fee/person/ month	Total fee per annum	
Processing supervisor and QC	1	2.36	28.32	7.66	91.92	120.24
Workers	20	1.23	14.76	3.99	47.88	1,252.8
Driver	1	1.62	19.44	5.26	63.12	82.56
Accountant	1	2.36	28.32	7.66	91.92	120.24
Grand total						1,575

Source: (MAFF, 2017a; NSSF, 2014)

All the key variables required for the appraisal are shown below in Table 13.

Method of Analysis

Cost-Benefit Analysis (CBA) is used to assess whether an investment in a cashew nut processing plant in Cambodia would be profitable, using well-known and routinely applied decision-making criteria of net present value (NPV) and benefit/cost ratio (B/C ratio) (Campbell & Brown, 2007).

Sensitivity analysis is used to analyse risk and uncertainty in the CBA. Sensitivity analysis is "the simple process of establishing the extent to which the outcome of the CBA is sensitive to the assumed values of the inputs used in the analysis" (Campbell & Brown, 2007, p. 195). A list of changes of input values for sensitivity analysis used in the project appraisal are shown in Table 12.

Table 12. Four scenarios for sensitivity analysis

Scenario	Variables for sensitivity analysis
1	Effects of different prices (whole & split kernels) Vs ratio (whole & split kernels) on NPV@6 per cent
2	Effects of different prices (whole & split kernels) Vs KOR (24 per cent, 25 per cent, 26 per cent and 27 per cent) on NPV@6 per cent
3	Effects of different prices (whole & split kernels) Vs increase in salaries (5 per cent, 10 per cent, 15 per cent and 20 per cent) on NPV@6 per cent
4	Effects of different prices (whole & split kernels) Vs different prices of RCN (US$1, US$1.25, US$1.50,US$1.75 and US$2 per kg) on NPV@6 per cent

Table 4. Key variables for the projects (installation processing capacity 3.2 MT/day or 960 MT/year of RCN)

Table 1: Key Variables								
Investment or capital cost		**No**	**Price per un**	**Cost (USD)**	**Operating cost**	**No**	**Price per unit**	**Cost (USD)**
(i) Fixed investment					Raw cashew nut (3.2 MT per day for 300 days)	960	1,500	1,440,000
	Warehouse construction (2000 m2)	1	240,000	240,000	Salary for processing supervisor and QC (Person/Year)	1	6,000	6,000
	Cashew nut processing machineries (a set)	1	173,350	173,350	Salary for workers (Person/year)	20	1,800	36,000
	Diesel generator	1	10,000	10,000	Salary for driver (Person/year)	1	2,400	2,400
	Vehicle (3-ton truck)	1	30,000	30,000	Salary for accountant (Person/year)	1	3,600	3,600
	Initial training for staff	1	2,000	2,000	Water for machinery operation (m3/year) (5 m3 per day	1,500	0.37	555
	Registration for the company	1	795	795	Electrical consumption (kw/year) (80 kw/hour for 8 hou	128,000	0.18	23,040
	Fee for utilities connectivity	1	1,325	1,325	Diesel for generator (L/year) (22 L/h for 100 days)	17,600	0.83	14,608
Sub-total fixed investment				**457,470**	Gasoline for truck (L/year) (20 L/d for 300 days)	6,000	0.88	5,280
(ii) Working Capital					Misellaneous Assets	1	3,000	3,000
	Raw cashew nut for stock (MT)	32	1,500	48,000	Maintenance	1	2,000	2,000
	Diesel as a reserve for generator (1 barrel=159 L)	1	133	133	Patent for business operation	1	285	285
	Spare parts for machineries	1	2,000	2,000	Employment inury scheme (occupational risk and health	1	1,575	1,575
Sub-total Working Capital				**50,133**	**TOTAL for operating cost**			**1,538,343**
GRAND-TOTAL Investment/Capital Cost				**507,603**				
(iii) Salvage value			%	**Cost (USD)**				
	Warehouse (2000 m2)	1	0%	-				
	Cashew nut processing machineries (a set)	1	0%	-	**Annual Revenues**	**Unit**	**price per unit**	**Cost (USD)**
	Diesel generator	1	0%	-	Whole cashew kernel (cashew kernel basis in MT)	194.40	10,000	1,944,000
	Vehicle (3-ton truck)	1	0%	-	Splits cashew kernel (cashew kernel basis in MT)	64.80	6,000	388,800
	Total Salvage value			-	Cashew shell (in MT)	288	86	24,768
					Gross profit			2,357,568
Depreciation (Straight-line method)		Life (yrs)		Amount per year	VAT (10%)			235,757
	Warehouse (2000 m2)	20		12,000	**Annual profit before financing and incorporate tax reduction**			**2,121,811**
	Cashew nut processing machineries (a set)	10		17,335				
	Diesel generator	10		1,000	**Capacity Output**			
	Vehicle (3-ton truck)	10		3,000	Year	year 1	Year 2	Year 3+
				33,335	%	80%	85%	90%
					Outturn/KOR (%)	27%		
					Whole Kernel ratio (%)	75%		
					Split Kernel ratio (%)	25%		
					Price of whole kernel (USD/kg)	10		
					Price of split kernel (USD/kg)	6		
					Exhange rate (USD to Riel):	4075		

Table 14. Project Net Cash Flow, Years 0-10

Project Net Cash Flow											
ITEM/YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Investment/Capital costs											
Fixed Investment	(457,470.15)										(213,350.00)
Working Capital	(50,132.51)										
Total investment/Capital costs	(507,602.66)	-	-	-	-	-	-	-	-	-	(213,350.00)
Operating Costs		- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46	- 1,538,343.46
Revenues		1,697,448.96	1,803,539.52	1,909,630.08	2,015,720.64	2,015,720.64	2,015,720.64	2,015,720.64	2,015,720.64	2,015,720.64	2,015,720.64
Net Cash Flow (Before Financing & income Tax)	(507,602.66)	159,105.50	265,196.06	371,286.62	477,377.18	477,377.18	477,377.18	477,377.18	477,377.18	477,377.18	477,377.18

	6%	12%	18%	24%
NPV	4,286,201.59	2,465,809.56	1,522,065.95	980,085.76
B/C Ratio	1.23			

Findings and Discussion

Investment decision-making criteria

Using the data and assumptions shown in Table 13, it can clearly be seen that a positive return is made from the investment at the discount rate 6 per cent (Table 14). The NPV is a healthy $US 4.286 million and the BCR is 1.23:1.

The estimated processing cost for this investment is US$3.91/kg, which is about 13 per cent higher than that in India (US$3.40/kg). However, this cost is still cheaper than processing by hand in India, which is about US$4.85/kg (Verma, Nag & Patil, 2014). This means that investments in cashew nut processing in Cambodia have less of a comparative advantage than similar investments in India, but there may be offsetting reasons for such investments in Cambodia.

Sensitivity analysis

The results of the four scenarios relating to changes in the price of kernels, salary, and the price of RCN are shown in Tables 15-18.

NPV is sensitive to changes in the prices of kernels because decreasing prices, equal or below US$8 and US$6 for whole and split kernels, respectively, cause negative NPV for almost all scenarios (scenarios 2 to 3). There are only two exceptions to this, in which either the ratio between whole and split kernels is at 85 per cent and 15 per cent (scenario 1), or the price of RCN is at US$1 per kg (scenario 4).

From the data, quality is key, where quality is represented by the whole kernel (Table 14) and improving the outrun ration (Table 16). Greater quality gives subsequent consumers greater opportunities with the end product and from the analysis we can see that the firm would be wise to chase quality. It is clear, then, that increasing quality from 55/45 to 85/15 (whole v kernel) would generate around US$2.6 million increase in NPV, while increasing the kernel outrun ratio from 24 to 27 per cent generates between US$1.4 and US$2.4 million in additional NPV.

This then creates challenges for the start-up company. They will need to ensure that, along their supply and processing chain, efforts are focused on keeping the kernel together. The firm may be able to send price signals to their suppliers to enhance quality, and investing in quality control within the processing facility may provide greater returns.

From Table 17 we see that a 20 per cent increase in labour costs, effectively reduces NPV by around US$100,000. Therefore, labour costs are not really a binding constraint for investment. If the firm has the capacity to invest in quality gains, including via financial incentives for staff, everyone wins.

Finally, NPV is not sensitive to changes in prices of RCN (scenario 4) because changes in prices of RCN between US$1 to US$1.75 per kg do not make NPV negative. However, if prices of RCN reach US$2 per kg, which is a rare case (AMO/MAFF, 2019), this does cause a negative NPV negative.

Chasing quality (% whole v split and outturn ratio) will be important as the investment is sensitive to the price of the input - RCN. As the RCN price increases from $US1 to $US2, the NPV falls by $US9.6 million. However, this is a rare event. Normally, the price of RCN in Cambodia is cheap during the harvesting season because the majority of farmers need to sell to pay back their loans and they do not have storage facilities. Looking at the RCN harvesting season (Table 3), there is also strong competition

from other RCN producing countries. Therefore, it is rare that the price of RCN is $US2 per kg (roughly 8,000 riel/kg in Figure 6).

Table 15. Scenario 3: effects of price of kernels and ratio of output on NPV@6% ($US million)

		Effects of ratio whole vs split kernel (per cent)			
Effects of wholesale prices (Whole vs split)	Whole/split	55/45	65/35	75/25	85/15
	7/3	(4.597)	(3.734)	(2.871)	(2.009)
	8/4	(2.440)	(1.577)	(0.715)	0.148
	9/5	(0.283)	0.579	1.442	2.305
	10/6	1.873	2.736	3.599	4.461
	11/7	4.030	4.893	5.755	6.618

(Assumption: NPV @6 per cent and KOR @27 per cent)

Table 16. Scenario 4: effects of price of kernels and KOR on NPV@6% ($US million)

		Effects of Kernel Outturn Ratio (KOR)			
Effects of wholesale prices (Whole vs split)	Whole/ split	24 per cent	25 per cent	26 per cent	27 per cent
	7/3	(4.309)	(3.830)	(3.351)	(2.871)
	8/4	(2.392)	(1.833)	(1.274)	(0.715)
	9/5	(0.475)	0.164	0.803	1.442
	10/6	1.442	2.161	2.880	3.599
	11/7	3.359	4.158	4.956	5.755

Assumption: (NPV @6 per cent and Ratio (W/S) @75 per cent&25 per cent)

Table 17. Scenario 5: effects of price of kernels and salary increase on NPV@6% ($US million)

		Effects of salary increase (per cent)				
Effects of wholesale prices (Whole vs split)	Whole/split	No increase	5 per cent	10 per cent	15 per cent	20 per cent
	7/3	(2.871)	(2.896)	(2.920)	(2.944)	(2.968)
	8/4	(0.715)	(0.739)	(0.763)	(0.787)	(0.811)
	9/5	1.442	1.418	1.394	1.370	1.346
	10/6	3.599	3.574	3.550	3.526	3.502
	11/7	5.755	5.731	5.707	5.683	5.659

Assumption: (NPV @6 per cent, KOR @27 per cent and Ratio (W/S) @ 75 per cent&25 per cent)

Table 18. Scenario 6: effects of price of kernels and RCN on NPV@6% ($US million)

		Effects of price of RCN (USD/kg)				
Effects of wholesale prices (Whole vs split)	Whole/split	1.00	1.25	1.50	1.75	2.00
	7/3	1.948	(0.462)	(2.871)	(5.281)	(7.691)
	8/4	4.105	1.695	(0.715)	(3.125)	(5.535)
	9/5	6.262	3.852	1.442	(0.968)	(3.378)
	10/6	8.418	6.008	3.599	1.188	(1.221)
	11/7	10.575	8.165	5.755	3.345	0.935

Assumption: (NPV @6 per cent, KOR @27 per cent and Ratio (W/S) @ 75 per cent&25 per cent)

Whether a private company would make such an investment also depends on financing and taxation issues, as well as the cost of land if not already owned.

Opportunities

To recap, there are three main reasons why it is worthwhile investigating the opportunity for investment in cashew nut processing businesses in Cambodia. First, Cambodian RCN is of high quality in terms of flavour, which leads to high demand in international markets, particularly in Japan (MAFF, 2019). The intrinsic high quality of Cambodian RCN is therefore a comparative advantage. Second, the KOR of Cambodian RCN is 27 per cent, which is high compared to competitors - 26 per cent for Indian RCN and 24 per cent for Vietnamese RCN (Ministry of Trade, Industry, Regional Integration and Employment of the Gambia, n.d.). KOR is among the most important economic factors influencing the profitability of cashew nut processing businesses (Azam-Ali & Judge, 2001). Finally, currently, Cambodia has an income tax exemption of up to the first five years of operation for SMEs who use local inputs (GDT, 2019). This represents a significant saving in operational costs for SMEs.

A discounted cash flow analysis based on these factors and most likely assumed values of other parameters indicates that investment in a small-scale cashew nut processing business in Cambodia would be profitable.

While there are direct benefits for a firm to establish a processing facility, there are associated flow-on and second round benefits that can occur. The firm described here employs an additional 23 people and these jobs provide people with opportunities. As there is economic reward from chasing quality (as defined above), any increased cost associated with higher prices to cashew suppliers and better trained staff would create additional benefits.

Challenges

However, there are a number of key challenges to consider before such an investment in cashew nut processing in Cambodia is made. In terms of the enabling environment, there are some key constraints which already exist. First, there is strong competition for buying RCN by Vietnam, because the Vietnam Cashew Association (Vinacas) signed a MoU with the Cambodian MAFF to export 1 million MT of RCN to Vietnam by 2028 (Customsnews, 2017; Khmer Times, 2018a). This may cause increasing prices of RCN. Second, a lack of skilled labour in the cashew nut processing field is another challenge for Cambodia (IFC, 2010). Although skills training is allowed for in the investment costs, such training needs to be ongoing. This may cause either high investment costs in training or low outputs. Finally, the electricity cost in Cambodia is high compared to Vietnam (IDP 2015-2025, 2015), and supply is unreliable. Again, these costs are allowed for in the calculations, but this situation makes it difficult for Cambodian cashew nut processors to compete with Vietnam.

Another set of challenges relates to the reconfigurations required in existing cashew value chains. At present, they are configured for exports of RCN to Vietnam. If significant domestic processing is undertaken, these chains will have to change the nature of their investments in meeting the optimal type of strategic fit. New capabilities will have to be developed, and new partnerships formed to service a new set of customers. Tools and strategies outlined in some of the value chain toolkits such as *M4P* (Anon., 2008; Department for International Development, 2008), and *ValueLinks* (Springer-Heinze, 2007) would be useful resources to assist in these implementation issues. Some of the issues related to value chain upgrading are discussed in Griffith et al. (2017).

The development of cashew producing facilities in Cambodia provides the cashew producers with greater future flexibility (see Figure 8). Now they have access to domestic and international consumers of their raw product. While this may be a good for producers, processors will face increasing competition to source raw material. The combination of an increased number of processors and enhanced processing capacity will tighten the market and may lead to higher prices. If producers have forward contracted and have not secured their supply, then prices may increase in the short run where firms are operating at a short-term loss if they are unable to pass costs along the supply chain.

Short-term price spikes for the raw material may also occur via a changing climate (weather volatility), pest incursions, or sudden loss of production area. Alternatively, adverse international market issues may lead to downward price shocks on the processors' output. These shocks may occur from: processors failing to meet their requirements including biosecurity protocols and product labelling or large-scale cashew investments in other countries, or other adverse shocks to supply chains either increasing supply or denying market access. Hence, any small-scale processor in Cambodia may need additional access to capital to assist in dealing with short-term price spikes.

Conclusion

In conclusion, global demand for cashew kernels has increased recently due to the rising demand for nutritious food in high- and middle-income countries. Vietnam and India are the main players in both RCN processing and cashew kernel exports in the global market. Cambodia is a large producer, but it exports the majority of its RCN to Vietnam due to lack of local processing facilities. Many studies advised that Cambodia could earn extra US$30million to US$40 million by establishing processing in the country. The main investment opportunities facing a small-scale cashew nut processing industry in Cambodia are the high KOR of Cambodian RCN, the high quality of cashew kernels (flavour), and the tax exemption for the first five years for SMEs. A BCA has shown that such an investment would be profitable, based on most likely assumptions for key parameter values. The estimated NPV of the investment project is sensitive to decreases in the prices of whole and split kernels; however, the price of cashew kernels is forecasted to rise. Changes in other inputs (such as increasing price of RCN and increasing salaries) have little effect on the NPV of the investment. Despite a number of key challenges to be overcome, it is concluded from this study that it would be financially viable to invest in small-scale cashew nut processing in Cambodia.

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Appendices

Appendix Table A.1. Cashew nut production in Cambodia by province, 2016-2017

Province Name	Cultivated area (ha)	Harvested area		Average yield (Ton/ha)	Production (Ton)
		Size (ha)	%		
Kampong Thom	28,989	27,515	95	1.10	30,266.5
Ratanakiri	27,289	19,984	73	0.87	17,409.0
Kampong Cham	14,097	10,234	73	1.87	19,151.8
Tbong Khmum	7,054	7,003	99	1.52	10,930.2
Steung Treng	4,583	3,865	84	1.50	5,797.5
Siem Reap	3,921	2,036	52	3.57	7,269.0
Kratie	2,387	2,387	100	1.00	2,387.0
Kampot	2,152	2,046	95	1.79	3,677.0
Kampong Chhnang	1,328	870	66	3.00	2,655.0
Mondulkiri	1,059	643	61	3.10	1,941.0
Koh Kong	946	610	64	0.50	301.7
Banteay Mean Chhey	776	426	55	2.07	882.0
Battambang	692	88	13	2.20	194.0
Oddor Mean Chhey	464	70	15	0.86	60.6
Preah Sihanouk	460	427	93	0.60	256.2
Svay Rieng	401	283	71	0.66	177.0
Takeo	354	354	100	1.00	354.0
Kampong Speu	334	334	100	1.00	334.0
Prey Veng	135	135	100	1.00	135.0
Pursat	105	89	85	1.87	167.0
Preah Vihear	76	76	100	1.00	76.0
Kep	11	11	100	1.20	13.2
97,613	**79,486**	**81%**	**1.31**	**104,435**	

Source: Data from General Department of Agriculture, MAFF (Hean, 2018)

Appendix Table A.2. American standard grading system for cashew kernels

Grade	Description
White whole	
W180 (super large)	120-180 kernels per Ib (266 to 395 per kg)
W210 (large)	200-210 kernels per Ib (395 to 465 per kg)
W240	230-240 kernels per Ib (485 to 530 per kg)
W280	270-280 kernels per Ib (575 to 620 per kg)
W320	300-320 kernels per Ib (660 to 706 per kg)
W450	400-450 kernels per Ib (880 to 990 per kg)
White pieces	
Butts	Kernels broken cleanly across the section of the nut
Splits	Kernels broken down the natural line of cleavage to form a cotyldon
Pieces	Broken kernels across the section but does not qualify for butts and splits
Small pieces	Above a specific size
Baby bits	Very small pieces of kernels that are white in colour
Scorched grades	
Wholes	Whole kernels that are scorched slightly during processing
Butts	Butts that are scorched during processing
Splits	Splits that are scorched during processing
Pieces	Pieces that are scorched during processing

Source: (Azam-Ali & Judge, 2001)