

An assessment of the supply chain management for agricultural products in Cambodia

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Abstract: The primary objective of this research is to examine the supply chain management of cashew nuts, mangoes, and cassava in Cambodia. The findings indicate that Cambodian farmers predominantly rely on traditional methods for crop cultivation. A significant issue is their lack of adequate knowledge regarding the assessment and utilization of land quality, which results in both the quantity and quality of their crop yields falling short of acceptable standards. Consequently, this deficiency adversely affects the market prices of their produce. To address this knowledge gap, it is essential for relevant institutions, particularly the Ministry of Agriculture, Forestry and Fisheries, to offer training programs that focus on modern agricultural techniques aimed at enhancing both the quantity and quality of crop production. Additionally, the study highlights the absence of an institution dedicated to analyzing land types and quality in Cambodia. Moreover, the establishment of an effective irrigation system is crucial for the successful growth of crops.

Keywords: *Agricultural products, Cashew nuts, Cassava, Mangoes, Supply chain management.*

1. Introduction

Cashew production data in Cambodia is somewhat scarce. The General Directorate of Agriculture (GDA) reports that the country generates approximately 55,000 tons of cashew nuts annually from a cultivated area of 76,000 hectares, resulting in an average yield of 720 kg per hectare. However, a field study conducted by Agrifoof Consulting International (ACI) in March 2015 indicated that the total production volume exceeded 100,000 tons. According to the most recent figures from the GDA, cashew nut production in Cambodia rose to 104,268 metric tons in the 2016/2017 period, cultivated across 79,487 hectares, which translates to a yield of 1.31 metric tons per hectare. The overall area dedicated to cashew cultivation reached 97,614 hectares. Furthermore, HEKS/EPER, a Swiss non-governmental organization, estimated that approximately 244,568 tons of cashew nuts were produced in 2021, positioning Cambodia as the fifth largest producer globally (Svi et al., 2021).

The Cambodian cashew sector has experienced significant growth over the past ten years, particularly in the provinces of Kampong Cham and Kampong Thom. This expansion has been largely influenced by the declining prospects of the rubber industry and a rising global demand for cashew nuts. In the last five years, the M21 and M23 varieties have emerged as the most cultivated among Cambodian cashew farmers. These "M" varieties are favored by international buyers due to their larger kernel size and higher yields compared to local varieties. However, the majority of Cambodian cashew producers are smallholder farmers managing only a few hectares of orchards. They typically utilize minimal technology and often refrain from using chemical inputs, such as fertilizers and pesticides, during cultivation. Furthermore, these farmers generally lack the necessary skills, knowledge, and technical expertise to establish a high-value organic cashew supply chain. It is also important to highlight that there has been insufficient training and support aimed at enhancing the sector's development and upgrading the value chain. Although the International Finance Corporation (IFC) and GIZ initiated several pilot projects for organic certification in Kampong Thom from 2008 to 2011, these efforts concluded without any substantial follow-up (Chaya et al., 2024). Cambodia has experienced a

rise in the production of raw cashew nuts; however, it lacks any commercial-scale processing facilities. Approximately 95% of the harvested nuts are exported to Vietnam for processing, with additional exports to Thailand, China, and India. Farmers typically sell their raw cashew nuts to small traders, who then pass them on to larger traders before they reach international buyers, resulting in a lack of quality control throughout the process. This disorganization within the cashew nut supply chain in Cambodia permits the value-added processing to occur in other nations. The country's soil and agroecological conditions are highly conducive to cashew cultivation, presenting an opportunity for farmers to achieve greater returns on their land and for investors to set up processing plants for cashew nut exports. By enhancing its position in the cashew industry, Cambodia could transition from merely being a leading producer to becoming one of the foremost global exporters of organic cashew nuts. To realize this potential, investments in processing facilities, organic certification, and training in agricultural and technical skills are essential, alongside a robust research framework (Piset et al., 2021).

Cassava cultivation in Cambodia was primarily intended for personal use until recent decades. The rising demand from neighboring Thailand and Vietnam has led to a significant expansion of cassava plantations, making it the second largest agricultural crop in the country. Despite challenges posed by climate change, annual harvests of cassava roots range from 10 to 14 million metric tons. As reported by the UNDP, this production level positions Cambodia as the fourth largest cassava producer in Asia and the tenth largest globally. Contributing approximately 2% to 3% of the national GDP, cassava is vital in rural areas, providing food, employment, household income, and aiding in poverty reduction. In 2020, the Royal Government of Cambodia introduced a national policy aimed at enhancing cassava production and exports while fostering the development of the agro-industrial sector. The provinces bordering Thailand and Vietnam, particularly Battambang, Pailin, Banteay Meanchey, Kampong Cham, and Kratie, are key areas for cassava cultivation. Cambodian cassava exports include fresh tubers and dried chips, with fresh tubers primarily sent to Vietnam and dried chips mainly exported to Thailand, Vietnam, and China. In 2018, the total export value of cassava reached approximately \$12.6 million (Beban & Gironde, 2023). The production and global trade of fresh tropical fruit are anticipated to rise over the next ten years. Developing nations are the primary producers, accounting for 98 percent of the total fresh tropical fruit supply worldwide. In contrast, developed countries are the largest consumers, importing 80 percent of the international trade in these fruits. Mangoes represent the most significant share, comprising 75 percent of the total fresh tropical fruit market, followed by pineapple, papaya, and avocado (de la Luz Cadiz-Gurrea et al., 2020).

Mango, a fruit that originated in India, is widely cultivated in Cambodia. The country boasts several varieties, including Keo Romeath, Keo Chin, Phomsen, and Kbal Domry. A new addition to the mango varieties is Irwin, which was imported from Taiwan by the Mong Reththy Group. The peak season for mango production in Cambodia occurs between April and May. Over the past decade, Keo Romeath has emerged as the predominant variety, cultivated for both local consumption and export. Notably, this variety can yield two additional harvests during the off-season, specifically from September to February. The first off-season harvest is typically collected from September to November, while the second occurs from late January to February. Despite the potential for mango production, only a limited number of companies are engaged in this sector, including PRL Co., Ltd, Kirirom Food Production (K.F.P) Co., Ltd, Khmer Mango, Narith Cambodian Fresh Mangoes, Khmer Natural Fruit Plantation, NIJIRINJIN Co., Ltd, Fruit Nirvana, Path Chamnan, L.K.S Cambodia Ltd, Karona Natural Fruits, Yeung Shi Group Co., Ltd, and Royal Trust Trading Co., Ltd (Sok et al., 2020).

Keo Romeath, capable of producing fruit three times a year, has gained significant popularity among Cambodians over the past decade as a preferred variety for both local and international markets. The traditional harvest season for Keo Romeath occurs from April to May. In addition to this primary harvest, two off-season harvests are conducted: the first from September to November and the second from late January to February. However, achieving off-season yields necessitates the application of plant hormones, a practice that remains relatively novel for many farmers. As a result, off-season harvesting is not feasible for the majority of them. Furthermore, a lack of agricultural knowledge has led to the excessive use of chemicals, raising concerns regarding food safety and labor health. The domestic mango market is poorly structured and lacks a representative body to ensure quality assurance. In

contrast, post-harvest technologies remain basic. Conversely, the export process to Vietnam is more organized, with farmers selling their products directly to Vietnamese buyers. Trade agreements are typically established prior to the harvest, with buyers often assuming responsibility for the mango tree harvesting. Lastly, processing and value-added activities for formal exports are managed in Vietnam, with a few companies engaged in mango processing, including products such as dried mango, green mango salads, fermented mango, and mango juice. The products in question are exclusively manufactured for the domestic market, and none are associated with a Cambodian brand. Since 2015, the mango industry in Cambodia has experienced significant growth. As reported by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in 2019, approximately 125,000 hectares are dedicated to mango cultivation, with 91,400 hectares actively producing, yielding up to 1.45 million tons of fruit each season. Mango production is categorized into two primary regions: the South, which includes Kampong Speu, Kampot, and Kampong Cham, and the North-West, comprising Siem Reap and Battambang, with farmland areas of about 50,000 and 7,600 hectares, respectively. Kampong Speu is the leading province for mango cultivation, with 39,500 hectares, representing 60.5% of Cambodia's total mango area, capable of producing around 790,000 tons of mangoes (Abbas, 2019). To enhance both the domestic market and export potential, the Royal Government of Cambodia (RGC) recognizes the need for improvements throughout the mango production and marketing processes to boost competitiveness in the international arena. A key priority is to meet the phytosanitary requirements outlined in the ASEAN Agreements on Export Fruit established in 2015. Furthermore, it is essential to develop fruit science capabilities in research and development and to engage both governmental and non-governmental organizations to support the industry, which is vital for achieving future success (Roëun & Hiev, 2022).

The primary aim of this study is to analyze the production value chain of cashew nuts, cassava, and mangoes in Cambodia, with a particular focus on the connection between Cambodia and Thailand as part of the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS). To achieve this objective, field research will be conducted involving various stakeholders, including farmers, contractors, contract harvesters, collectors, traders, and producers. The research will take place in Banteay Meanchey, a province adjacent to Thailand, over a two-month period from April to May 2021. The findings from this study are intended to enhance the production chain of cashew nuts, cassava, and mangoes, improve the quality of the fruit yield, and increase the overall value within the production value chain in Cambodia. Furthermore, the Royal Government of Cambodia may utilize these findings to formulate policies that support local farmers in boosting both the quantity and quality of their fruit yields, thereby enhancing export opportunities and generating additional income for all involved parties. Ultimately, this research has the potential to serve as a strategic policy framework aimed at alleviating poverty by increasing farmers' incomes through higher yields and superior quality produce. The key objectives of this research project include the development and assessment of crop management strategies that promote productive, profitable, and sustainable cultivation of high-quality cashew nuts, cassava, and mangoes. Additionally, the research seeks to establish a framework for improving management practices within the Cambodian cashew nut, cassava, and mango industries, focusing on both on-farm production and supply chain enhancements, as well as capacity building for Cambodian stakeholders in research, development, and extension systems to deliver targeted, practical outcomes for agribusiness and farmers.

2. Literature Review

Since the conclusion of the Civil War, Cambodia has embarked on a comprehensive reconstruction initiative. Initially, agriculture was recognized as the cornerstone and essential support of the nation's economy and the sustenance of its populace. This sector has played a crucial role in driving Cambodia's economic development, alleviating poverty, and improving living standards. In the early 1980s, agriculture alone employed 80 percent of the national workforce. By 2016, this sector contributed 26.3% to the overall GDP, while the industrial and service sectors accounted for 31.3% and 42.4%, respectively (Eliste & Zorya, 2015). Within the agricultural GDP, the crop sub-sector represented the largest portion at 60%, followed by fisheries at 22%, livestock at 11%, and forestry at 7% (Asian Development

Bank, 2021). In recent years, to foster economic growth and reduce dependence on a single sector, the country has created numerous job opportunities in industry, tourism, and construction. Nevertheless, agriculture will continue to play a vital role in Cambodia's economic advancement, poverty alleviation, and rural livelihoods for the foreseeable future (Asian Development Bank, 2014).

Agriculture, while not a singular solution to future growth and the alleviation of rural poverty, plays an essential role in addressing these challenges. In 2016, the nation announced its transition from a least developed country to a lower-middle-income status, with aspirations to achieve high middle-income status by 2030. To realize sustainable growth and ensure the continued relevance and competitiveness of this vital sector, it is imperative to shift from a "production-only" approach to one that emphasizes value-added creation. Additionally, enhancing labor productivity, increasing mechanization, and expanding arable land are critical factors for boosting crop yields and adding value to Cambodia's economy (World Bank, 2017). Nevertheless, the journey toward establishing a sustainable agricultural sector in Cambodia is fraught with obstacles. The high cost and inadequate regulation of farm inputs have led to the proliferation of low-quality and counterfeit products, such as fertilizers, resulting in diminished crop yields and resource wastage. Convincing farmers to adopt high-yield seed varieties over traditional ones remains a challenge, despite progress made by the Ministry of Agriculture, Forest, and Fisheries (MAFF). Access to seeds is hindered by a supply shortage that currently meets only 20 percent of demand, coupled with elevated prices. Furthermore, credit represents one of the most significant expenses for farmers, particularly smallholders who often depend on the informal credit market. The expediency of accessing informal lenders, compared to formal institutions like Microfinance Institutions (MFIs), forces farmers to accept loans with exorbitant interest rates, averaging around 5 percent per month. Additionally, the high cost of transporting goods to market is exacerbated by inadequate infrastructure, and there is a notable lack of formal market information.

The ongoing migration of labor away from agriculture has significantly impacted the sector's ability to expand and has raised doubts about the development of a sustainable agricultural framework. In 2020, Cambodia's population was estimated at approximately 16.7 million, with nearly 80% residing in rural regions. The labor force in Cambodia comprises about 8.5 million individuals, representing around 56% of the total population, with women accounting for approximately 50% of this workforce. While the country experiences minimal unemployment, underemployment is notably high among urban youth. Agriculture remains the primary sector for employment, surpassing both industry and services. However, as the service and industrial sectors continue to expand and offer new and varied job opportunities, the proportion of employment in agriculture is declining rapidly. Research indicates that families receiving remittances are more likely to invest in agricultural machinery, suggesting that increased migration enables more farming families to afford mechanization. A significant number of rural Cambodians are relocating to urban centers in search of higher-paying jobs, particularly in the garment and footwear industries, construction, and the service sector, including hospitality and tourism. Additionally, many have sought employment opportunities abroad. These economic developments have contributed to a decrease in the percentage of the population engaged in agricultural work (Bansok et al., 2011).

Cambodian policymakers recognize the ongoing transition in agriculture from traditional practices to a modern framework that incorporates organized linkages among input suppliers, farmers, processors, logistics agents, distributors, traders, and retailers. Crop production plays a vital role within these value chains, aiming to sustainably generate value for consumers. At present, the agricultural value chains in Cambodia are underdeveloped. A significant challenge lies in identifying and prioritizing strategic crop-based value chains for the Cambodian Master Plan (CMP). The modernization and diversification of the crop sector towards higher value-added products depend heavily on technological advancements. This necessitates substantial investments in research, extension services, and education. It is essential to mobilize resources from the private sector, international agencies, and global research and academic institutions to supplement the limited resources available to the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Royal Government of Cambodia (RGC). The key challenge remains ensuring that farmers and agro-enterprises can access and implement technology to enhance the value of crop production (Siphana et al, 2011). Despite the ongoing changes in agricultural land, it is

anticipated that within the next 15 to 20 years, the predominant demographic of farmers in Cambodia will remain smallholders, with average landholdings of less than 5 hectares. However, survey data reveals a trend towards land consolidation, resulting in an increase in the proportion of medium and large farms. When managed effectively, these larger farms can significantly enhance farmers' potential to achieve higher incomes and create incentives for investment and the adoption of technologies that could improve returns on both land and labor. A key challenge lies in facilitating the transition to more efficient, larger-scale farms while simultaneously addressing the needs of rural households that may experience adverse effects from this transformation (Diepart & Thuon, 2022).

The value chain approach encompasses not only the production phase but also various stages from input suppliers to end consumers. The choice of crops, along with the necessary investments and policies to foster their growth, necessitates an examination of postharvest systems, processing, logistics, trade, and marketing. This approach is bolstered by future growth factors such as urbanization, globalization, food safety standards, competitiveness, structural transformation, labor migration, and mechanization. Integration within the value chain can manifest in various forms of horizontal and vertical coordination, including contract farming. A pivotal aspect is that by integrating into the value chain, smallholder farmers and agro-enterprises can enhance their competitiveness, increase value addition, and mitigate risks (Bellù, 2013). Cambodia ranks among the top five exporters of high-quality fresh mangoes globally. According to a report from the Ministry of Agriculture, Forestry, and Fisheries in 2005, the Cambodian mango sector has witnessed significant growth. By the 2014/15 period, the area dedicated to mango cultivation was estimated at approximately 56,251 hectares, a notable increase from around 24,000 hectares in 2010. The primary production regions are the South and the North-Western Provinces, with the South focusing on Kampong Speu, Kompot, and Kampong Cham, which collectively account for about 50,000 hectares. The North-Western Provinces, including Siem Reap and Battambang, have an estimated planting area of 7,600 hectares. Notably, Kampong Speu stands out as the leading mango producer, yielding approximately 790,000 tons annually from a planting area of 39,500 hectares, representing 60.5% of the total mango cultivation area (Sanderson, 2024).

The "grey" export trade of primarily green Keo Romeat mangoes presents significant challenges in quantification, as there are no official statistics available regarding the volumes crossing the border. According to observations made at border crossings, the ACIAR project HORT/2014/020 estimated that Cambodia exported approximately 135,000 tons of mangoes to Vietnam and Thailand during the 2015/16 period. The prices offered to growers are considered fair, ranging from 1,500 to 2,000 riels (approximately AUD 0.50) per kilogram. Nevertheless, growers face price volatility and relinquish control over the fruit once it departs from their farms and enters the domain of exporters and traders (Hickey, 2019). The Royal Government of Cambodia (RGC) aims to enhance both domestic and export opportunities for mangoes. Achieving this objective necessitates comprehensive improvements throughout the entire production and market continuum, allowing Cambodia to compete on an international scale. A key factor in this endeavor is fulfilling phytosanitary standards as stipulated in the ASEAN agreements concerning export fruit crops by 2015. Success in this area hinges on strengthening the capacity for fruit science within research, development, and extension sectors of both governmental and non-governmental organizations. Over the past four years, this ACIAR project has played a pivotal role in research and development to tackle some of these challenges. Expanding the agricultural development agenda from annual crops, such as rice and vegetables, to include research on perennial tree fruit crops requires substantial investment in enhancing the capabilities of research, development, and extension (RD&E) institutions. Investing in advanced technology during the initial phases of developing a perennial tree crop like mango can yield significant benefits in subsequent years of fruit production. The lack of trained and experienced researchers and advisors in the field of fruit crops has posed a challenge to the growth of the local mango industry. For the RGOC to achieve its goal of increasing fresh mango exports, considerable enhancements are essential across all aspects of production and supply chain management, enabling the Cambodian mango industry to compete effectively with other mango-exporting nations.

The success of these objectives hinges on enhancing the capacity for fruit science within both governmental and non-governmental research, development, and extension agencies. Additionally, it is

imperative to involve the Royal University of Agriculture and regionally-based universities in integrating fruit research into their scientific curricula. A comprehensive survey carried out by Cambodian partners from CARDI, GDA, and RUA as part of the SRA HORT/2012/018 provided valuable insights for the team, illustrating how a production systems approach to research can effectively complement traditional disciplinary research methods. Participants faced challenges in grasping the significance of various stages in plant phenology, which are crucial for determining the timing and nature of interventions that yield the most substantial effects. This understanding will remain a central strategy in building capacity in Cambodia. The lack of modern plant and soil testing services in the country has hindered the selection of appropriate sites for mango cultivation and the formulation of suitable nutrition programs. Furthermore, essential ancillary services for implementing Good Agricultural Practices (GAP), such as pesticide residue testing laboratories, are nonexistent in Cambodia, necessitating the shipment of fruit samples to Bangkok or Singapore for analysis. For instance, pesticide residue tests for this project were submitted to SGS in Phnom Penh, but the actual fruit samples had to be transported to the SGS laboratory in Bangkok for testing (BLAiR & BLAiR, 2014).

The initial fruit samples processed by SGS in Cambodia marked a significant milestone. Although a government testing laboratory is capable of analyzing fruit residues, it lacks the necessary standards for the primary pesticides relevant to fruit production and pertinent to the project. Furthermore, there are no established standards for leaf nutrient levels in varieties such as Keo Romeat when it comes to soil and leaf testing. The Australian mango production season begins in late August in Darwin and concludes around late February, with fruit sourced from northern New South Wales or Gin Gin in Western Australia. This variation in the harvest period is influenced by both the type of mango and its geographical distribution. Within a specific production area, the Kensington Pride variety is typically harvested first, followed by R2E2, B74 (CalypsoR), and Honey Gold. The duration of the harvest window within each region or property may last only five to seven weeks, contingent upon the climatic conditions of that particular season. Additionally, the phenomenon of biennial bearing in mature mango trees significantly affects the industry's capacity to provide a consistent supply of products in both developed and fluctuating markets (Goletti & Sovith, 2016). As the size of properties expands and the volume of fruit produced in a region increases, managing the processing and transportation of large quantities of fruit while ensuring stringent quality control becomes increasingly challenging for management and logistics. This challenge is particularly pronounced as larger orchards aim to enter export markets. Implementing techniques to either advance or delay fruit maturity on a property could effectively extend the harvest period, thereby enhancing efficiency in harvesting and packaging, as well as increasing profitability. The ACIAR component of the program in Australia focused on a combination of strategic approaches, such as identifying and refining methods to utilize the highly conserved Flowering Locus T (FT gene), adaptive strategies that involve recognizing current growth regulators that either inhibit or promote the activity of the FT gene, and developmental efforts aimed at integrating all components into commercial practice. The results of this research on the FT gene are expected to yield commercial advantages for Cambodian varieties, particularly the Keo Chen, which currently does not respond to existing manipulation techniques (Robins, 2014).

Cambodia's agricultural sector is undergoing significant transformation, propelled by factors such as economic growth, urbanization, increasing global food demand, climate change, and fiscal responsibility. This evolution brings forth a variety of challenges and opportunities for the existing production and distribution framework. Consequently, this study aims to tackle these challenges while identifying strategies, policies, investments, and mechanisms necessary to foster the development of a sustainable agricultural supply chain.

3. Methodology

A survey has been conducted to investigate the supply chain of mango, cassava, and cashew nut in Cambodia, aligning with the research objectives. The questionnaire comprises both closed-ended and open-ended questions. Respondents were chosen based on their position within the production chain of each crop, specifically focusing on early agricultural outputs of mango, cassava, and cashew nut. The

participant pool includes farmers, contractors, contract harvesters, collectors, traders, and producers, selected randomly from various provinces and cities, including Kompong Speu (Cassava), Battambang (Mango), and Kompong Thom and Preah Vihear (Cashew nut). The questionnaires are structured according to the roles of the respondents and divided into three sections. The initial section aims to gather demographic information, such as crop types, cultivation areas, quantities of outputs harvested, purchased, or produced, and the selling or buying prices per kilogram or ton. To further explore the supply chain management of cashew nuts, this research specifically surveys two provinces, Kompong Thom and Preah Vihear, targeting four groups: collectors, traders, processors, and exporters.



Figure 1.
Supply chain diagram of cashew nut.

The survey concerning mangoes is conducted exclusively in Battambang city. The intended participants for the questionnaire include contractors, collectors, traders, and exporters.



Figure 2.
Supply chain diagram of mango.

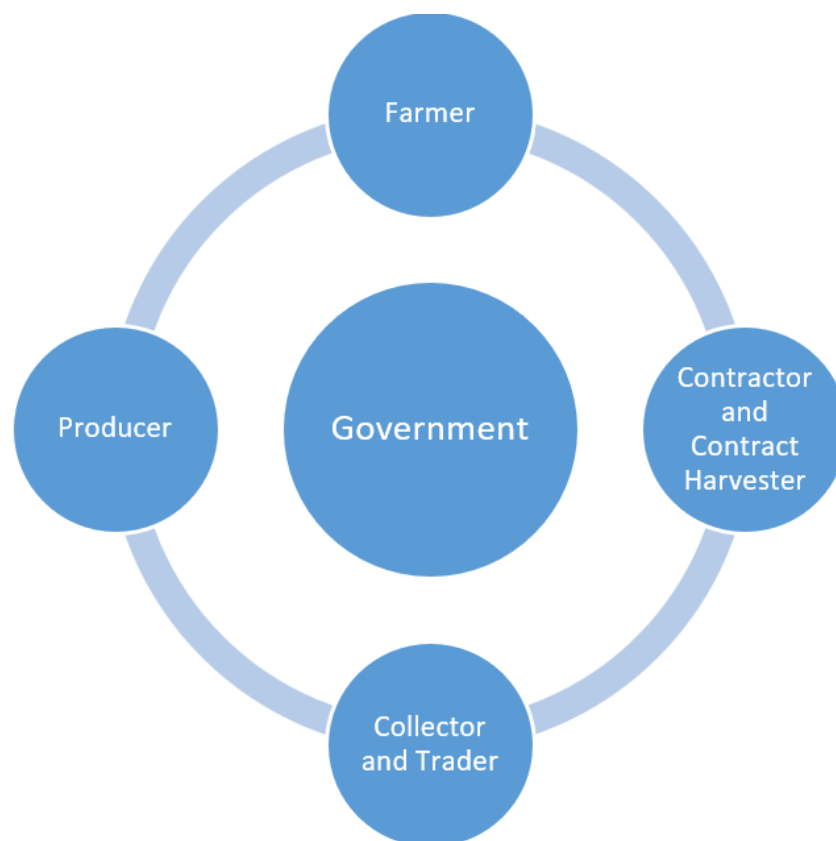


Figure 3.
Supply chain diagram.

Aoral Farm, located in the Kompong Spue province, has been chosen as a case study to examine the cassava production and export process. Furthermore, inquiries have been directed to three key stakeholders involved in the supply chains of mango, cassava, and cashew nut. These inquiries pertain to the challenges faced from the planting phase through to harvesting, as well as the buying and selling of agricultural products and their export to both domestic and international markets. In addition to gathering information from these stakeholders, the study will also conduct interviews with policymakers, including representatives from the Ministry of Agriculture, Forestry and Fishery (MAFF), the Ministry of Commerce (MoC), and other pertinent ministries and organizations, with a particular emphasis on the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS).

4. Research Findings

4.1. Cashew Nuts

Cashew nut collectors serve as domestic purchasers located within the production villages or communes. They acquire the cashew nuts harvested by local farmers, playing an essential role in these communities, particularly during the harvest season. Typically, these collectors buy and resell cashew nuts to traders on a daily basis. On average, a collector can gather between 9 to 10 metric tons each day, with the nuts being resold either on the same day or the following day. Transactions and payments are usually conducted over-the-counter, allowing for immediate capital return, which reduces the challenges associated with capital demand and minimizes the need for borrowing working capital. In certain instances, trading may involve advance payments, where collectors receive funds upfront in exchange for a commitment to deliver a specified quantity of cashew nuts. In such cases, collectors may also provide advance payments to farmers to ensure a steady supply. Generally, collectors do not store the

nuts for extended periods, making investment in warehousing unnecessary. Annually, a collector can typically gather and resell approximately 640 to 690 metric tons. The purchasing process is predominantly conducted over-the-counter, with collectors selling the cashew nuts to traders who have the capacity to store larger quantities. Cashew nut traders act as intermediary buyers, acquiring nuts from collectors, while some farmers with transportation means may sell their products directly to these traders. The traders purchase all varieties of cashew nuts, with the M23 variety being the most prevalent and widely cultivated by farmers in Kompong Thom and Preah Vihear.

Traders frequently assess the cleanliness, color, and size of cashew nuts to establish quality standards and pricing. Typically, during the two-month harvesting season, a trader can acquire approximately 30 to 60 metric tons of cashew nuts daily, amounting to an annual total of 3,750 to 4,200 metric tons. The nature of the trading business necessitates substantial capital, as traders must accumulate a sufficient stock of cashew nuts prior to exporting them to buyers in Vietnam or Thailand. Consequently, obtaining a bank loan is often essential. The purchasing process may occur over-the-counter, or in certain instances, payment is made in advance to collectors for a specified quantity of cashew nuts. Similarly, the nuts are subsequently delivered to buyers in Vietnam or Thailand. Traders typically receive payment over-the-counter; however, there are occasions when payment is finalized within a week following the delivery of the nuts. The transportation of the collected cashew nuts to Vietnamese and Thai buyers is generally carried out using trucks with a capacity of 20 metric tons. Deliveries are made regularly once the truck is filled with an adequate quantity of cashew nuts, and the nuts are dispatched promptly, as prolonged storage poses significant risks.

Processing and grading activities are not conducted at the farm level. Nevertheless, in Kompong Thom, there exist two community cashew nut processing centers: the Sombo Prey Kuk Tourism Community Cashew Nuts Processing Center, situated in Chey, Kampong Svay, and the Santuk Mountain Agricultural Cooperative Cashew Processing Unit, located in Kor Koh, Santuk. The Sombo Prey Kuk center, funded by ADB/JFPR, was established in 2013 by the Kampong Thom Provincial Department of Tourism with the objective of promoting products from economically disadvantaged individuals. This initiative has provided the community with a warehouse and a facility for shelling cashew nuts. Additionally, the project has offered financial assistance through revolving funds, enabling farmers to obtain start-up capital for operating a community-owned shelling center. Currently, the community comprises a total of 384 members, of which only 34 have organized into cashew nut production groups. Each member of these groups is tasked with supplying cashew nuts to the processing center.

Historically, the Sre Khmer Organization provided technical training to farmers prior to the arrival of the JFPR. However, the absence of financial support has hindered the community's ability to sustain the shelling center as a collective enterprise, compelling them to lease the facility to a private owner for \$50 per month. Consequently, since 2016, the shelling center has been under private management. On average, this private processor is capable of processing approximately 50 metric tons annually. Each metric ton of raw cashew nuts yields about 200–300 kilograms of finished product. The processing of one metric ton typically requires up to three days: one day for shelling and two days for cleaning. The processed nuts are either packaged for sale in Siem Reap and Phnom Penh or sold directly to tourists. The retail price for tourists can reach up to \$20 per kilogram, while wholesale prices for shops are set at \$16 per kilogram.

Established in 2011 with the assistance of Kampong Thom-PDA, the Santuk Mountain Agricultural Cooperative Cashew Processing Unit comprises 125 members who collectively manage 379 hectares of farmland. The community has benefited from technical guidance provided by the “Harvest II Project,” which focused on crop conservation, tree nursery production, and market access for their products. Historically, the unit functioned as a collector, acquiring cashew nuts from its members and selling them to traders in the provincial town. However, limited profits and insufficient capital for large-scale storage hindered the unit's ability to sustain its business operations. Despite these challenges, the unit continues to engage in a modest processing venture, supplying finished products to the market in Phnom Penh. Currently, due to capital constraints, the unit can only stock and process approximately two to three metric tons of cashew nuts. Given the limited capacity and demand, the unit typically purchases raw

cashew nuts at the end of the harvesting season at significantly reduced prices. For instance, in 2019, Famrgate reported that the price of cashew nuts during the early harvesting season (February to March) was 6,000 riels per kilogram, while prices dropped to 4,500 riels per kilogram in the middle of the season (April-May) and further to 3,000 riels per kilogram by the end of the season (May-June). The unit aims to expand its operations when additional capital becomes available. Furthermore, there is currently a commercial cashew processing factory owned by Santana Agro Product Co., Ltd. located in Preah Vihear, which commenced operations in 2018 and has the capacity to process up to 20,000 metric tons annually. The majority of the final products are packaged and exported to China, with a smaller portion supplied to the domestic market.

Santana Agricultural Products Co., Ltd. intends to broaden its market reach into Europe, driven by demand from buyers interested in acquiring Cambodian cashews from the company. Presently, Santana has secured a contract to deliver 5,000 tons of cashews annually to the European market; however, in 2020, the company was only able to supply 2,000 tons. In comparison to the Chinese market, the European market currently has a lower demand for cashews, accompanied by distinct quality requirements and types of cashews. For Santana, adhering to the quality standards necessary for the Chinese export market is comparatively more manageable than those for the European market. Based on Santana's experience thus far, the M-23 variety yields the highest quality processed cashew nut product, characterized by its large size and white color, which are preferred in the European market. Conversely, the Chinese market has a preference for smaller-sized cashews. To meet production needs, Santana sources AC cashew nuts from traders in Preah Vihear, Siem Reap, Kompong Thong, and Kompong Cham. The company offers a purchase price that is 100 Riel per kilogram higher than the prevailing market price, although suppliers are responsible for delivering the cashews to the factory. The current pricing in the agricultural import and export market is influenced by the price of cashew nuts in Vietnam. As of 2020, Santana has collaborated with the provincial agricultural department to forge business partnerships with eight Autonomous Communities within the province, focusing on the exchange of knowledge in cashew production and contract farming.

While the majority of Cambodian cashew nuts are destined for export markets, Santana Agricultural Products Co., Ltd. stands out as the sole company engaged in the formal export of Cambodian cashew nuts directly to importing nations. Besides Santana, private processors utilizing the Prey Kuk cashew nut shelling center in Sambo have the capability to export directly to the European market, albeit this market remains limited and niche. In the realm of informal exports, cashew consolidators and traders assume the role of exporters by gathering cashews from producers and supplying these raw cashews to buyers in Vietnam and Thailand, where they are processed. The processed nuts are then packaged and exported as cashew nuts from these countries. Consequently, a significant portion of Cambodian cashews is exported through this informal channel.

4.2. *Mango*

In Battambang, the role of contractors is becoming increasingly significant, as a growing number of farmers are entrusting their trees to these professionals for management. Contractors typically oversee production, flower operations, and harvesting, with each managing between three to six farms, encompassing 450 to 1,500 trees. The compensation for contractors generally amounts to \$17 per year for each tree that is six to seven years old, with contracts being renewable annually or every three years. Mango production occurs primarily in two distinct seasons: the high season from April to May and the low season from October to January. Effective management of flowers during the off-season is crucial for maintaining business profitability. However, discussions with contractors indicate that various technologies have been employed in this process. Given the substantial profits associated with off-season production, contractors are inclined to focus predominantly on cultivating off-season fruits. It appears that they have acquired technological knowledge from Thai or Vietnamese entrepreneurs, yet they largely lack an understanding of the phenological cycle of mangoes and the methods to achieve optimal production. There are indications that they may be exerting excessive pressure on the trees, resulting in overproduction and inadequate nutrition, which could be partly attributed to unsuccessful flowering

attempts. Considering the contractor's pivotal role and their interactions with other key stakeholders in the supply chain, they may become a central point for potential interventions.

Wholesalers in Battambang, located in Boeung Chhouk Wholesale Market and the smaller Thmei Wholesale Market, operate on a relatively modest scale, handling approximately 550 kg of mangoes per day. Consequently, they procure mangoes from a wholesaler in Phnom Penh, specifically Neak Meas, rather than sourcing them locally, as Battambang exports mangoes directly to Thailand. Mangoes are categorized into two grades: Grade 1 mangoes are larger, with 3 to 4 fruits per kilogram, exhibiting vibrant color and being free from pests and diseases. In contrast, Grade 2 mangoes are typically smaller, with 5 to 6 fruits per kilogram, allowing for minor imperfections. Exports of mangoes are packaged in 25 kg plastic boxes, while local market products are often placed in plastic bags. Khmer merchants usually purchase produce after inspecting the farms, taking responsibility for collection and packaging. The transportation cost for mangoes (3–4 tons) to the Thai border is approximately 125 USD per trip, whereas trucking costs for 8 tons amount to about 225 USD per trip. At Lime Gate/Border-3, large collectors and traders sell directly to Thai traders, with high season volumes reaching 130–220 tons per day and low season volumes ranging from 25–50 tons per day, alongside numerous small collectors and traders. Similar conditions are observed at other border ports. Exported agricultural products cater to both the fresh produce market and the processing sector. Off-season production is primarily utilized by the Thai processing sector, priced at 700 riel per kg or \$0.17 per kg, while fresh produce sales during the off-season range from 1300 to 1500 riel per kg or \$0.36 per kg. These products originate from Cambodia and are supplied through collector networks in various provinces.

The primary challenges encountered during interviews with contractors and pickers revolve around the volatility of mango prices, the dynamics among supply chain participants, and the flow of information. Respondents tend to emphasize pricing issues more frequently when given the chance to discuss their concerns or prospects for the industry's future. Throughout the three-year period from 2018 to 2020, numerous contractors identified the fluctuating price of mangoes as a significant concern, while a smaller subset of pickers viewed the rising prices as an opportunity linked to the expanding export market. This suggests that any increase in prices has not been effectively communicated to producers. Contractors are motivated to manage the leased mango orchards sustainably, as their ability to renew leases hinges on the owner's perception of their management practices. Typically, leases range from one to three years, and contractors must renew them to navigate their operational environment, achieve a return on investment, and foster relationships within the supply chain. Rental agreements vary by farm, with the age of the trees being a critical factor in determining rental rates. Contractors who have established trust with landlords often benefit from lower rents. The significance of the relationship between the owner and contractor is challenging to assess in other contexts; for instance, familiarity does not guarantee extended lease terms or managerial support from the owner. Contractors tend to sell their produce to the collector offering the highest price, resulting in infrequent sales to the same harvester, which complicates the establishment of trust and predictability in the market. Furthermore, the exchange of information between contractors and collectors is generally restricted to pricing and harvest schedules, with consignees dictating these terms and contractors responding based on their capacity to comply, leading to a scarcity of long-term contracts.

Cambodia's mango sector has experienced significant growth, largely driven by the regional export trade of the Keo Romeat variety. While this variety enjoys popularity in international markets, domestic consumption remains limited due to the strong preference among Khmer-speaking consumers for Keo Chen and other types. To ensure sustainable future growth, it is essential to diversify the varieties available. The robust business networks in neighboring countries such as Thailand, Vietnam, and China present valuable opportunities for the Cambodian mango industry. However, the ASEAN Trade Agreement (AEC) may influence product and food safety standards, potentially leading to an increase in formal trade. While these developments could enhance the overall industry, it is crucial for Cambodia to adapt swiftly to maintain its competitive edge. Insights gathered from interviews with contractors and mango harvesters in Battambang Province suggest that improvements in farm productivity and post-harvest management could significantly boost the industry's growth potential. Thailand and Vietnam represent vital and expanding markets for fresh mangoes from these provinces, necessitating

enhancements in farm management practices and information dissemination within the Cambodian mango sector. The contractors interviewed revealed a wide range of farm management techniques and sourcing practices, with inputs often derived from various suppliers and markets. Concerns have been raised regarding the reliance on supplier information and past experiences for chemical and fertilizer usage, as improper application of these inputs can lead to significant waste.

4.3. Cassava

Established in 2008, Aoral Farm stands as one of the largest private agricultural enterprises in both Asia and Cambodia. Strategically situated in the Aoral District of Kampong Speu Province, this fully developed agricultural operation encompasses approximately 10,000 hectares of cultivable land along with processing facilities. Notably, the farm serves as Cambodia's primary processor of cassava, producing natural tapioca starch under the registered name of HLH Agriculture (Cambodia) Co., Ltd. The starch produced is capable of being stored for up to two years, and the company's production facilities include a starch factory with a daily output of 120 tons. In collaboration with its joint venture, Aoral Farm can supply an impressive total of 100,000 tonnes of starch annually. The company exports its products to significant global markets, including the Netherlands, France, the United States, Italy, India, New Zealand, and Vietnam, while continuously seeking opportunities for market expansion. Furthermore, Aoral Farm has achieved ISO22000, HACCP, and FDA certifications for its tapioca starch, indicating a commitment to quality and safety. The operational framework of Aoral Farm adheres to sustainable practices, ensuring that the necessary raw materials are consistently available for processing throughout the year. The farm's extensive area is organized into 38 blocks, categorized into four primary sections: Aoral 1, 2, 3, and 4, which facilitates more efficient agricultural management without physically dividing the land.

The company is currently focused on broadening its international partner network. It possesses up to 10,000 hectares of land available for diverse agricultural investments, which can facilitate the cultivation of a variety of crops. Additionally, the company intends to set up new food ingredient processing facilities in Cambodia while also investing in logistics and warehousing capabilities. Furthermore, it remains receptive to collaboration with foreign agricultural investors interested in expanding their operations in Cambodia, whether through planting or engaging in upstream or downstream product manufacturing for both local and international markets. Lastly, the company is eager to explore distribution opportunities for its cassava products in foreign markets to enhance its global supply chain and is actively pursuing research and development initiatives aimed at improving the quality of its arable land.

The discussions held with officials from the Ministry of Agriculture, Forestry and Fisheries (MAFF), the Ministry of Commerce (MoC), and farmers concerning the cultivation of the three agricultural products under scrutiny—cashew nuts, mangoes, and cassava—have revealed three critical issues that require attention and resolution from relevant stakeholders, particularly policymakers. These issues encompass a decline in production volume, an escalation in production costs, and a reduction in output during both the harvest and post-harvest phases for each of the aforementioned products. Furthermore, there is a significant gap in training programs aimed at educating farmers on effective planning and storage techniques, which are essential for enhancing the value chain. Additionally, farmers face limited demand for their products, primarily due to quality deficiencies or an oversupply in the market. Lastly, the challenges encountered by farmers have been communicated to the appropriate authorities, yet the responses have been inadequate, with little to no solutions provided.

5. Conclusion and Policy Implication

The primary objective of this research is to examine the supply chain management of cashew nuts, mangoes, and cassava in Cambodia. The study focuses on two provinces, Kompong Thom and Preah Vihear, for the analysis of cashew nuts, while the supply chain of mangoes is investigated in the city of Battambang. Additionally, a case study of Aoral Farm in Kompong Spue province is included to explore the cassava product. Research questionnaires, comprising both open-ended and closed-ended questions, have been designed and distributed to respondents in the aforementioned provinces and city. The target

groups for this study include farmers, contractors, collectors, traders, processors, and exporters. Furthermore, interviews have been conducted with government officials from relevant ministries to gain insights into the supply chain management of these three agricultural products.

This research has revealed that Cambodian farmers continue to rely on traditional methods for crop cultivation. A significant issue is their lack of adequate knowledge regarding the assessment and utilization of land quality, which results in both the quantity and quality of crop yields falling short of acceptable standards. Consequently, this deficiency adversely affects the market prices of their produce. To address this knowledge gap, it is essential for relevant institutions, particularly the Ministry of Agriculture, Forestry and Fisheries, to offer training programs that focus on modern agricultural techniques aimed at enhancing both the quantity and quality of crop production. The study also indicates that Cambodia currently lacks an institution dedicated to the analysis of land types and quality. Additionally, the establishment of a robust irrigation system is crucial for the successful growth of crops. Therefore, investing in an effective irrigation infrastructure presents a significant opportunity to foster sustainable growth within the agricultural sector, which is a key component of Cambodia's economy. Lastly, securing appropriate market access for farmers to sell their crops is essential to provide them with the necessary assurance and motivation for their investments.

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