Data Collection Survey on Development of Agricultural Value Chain in Cambodia

Final Report

November 2022

JAPAN INTERNATIONAL COOPERATION AGENCY

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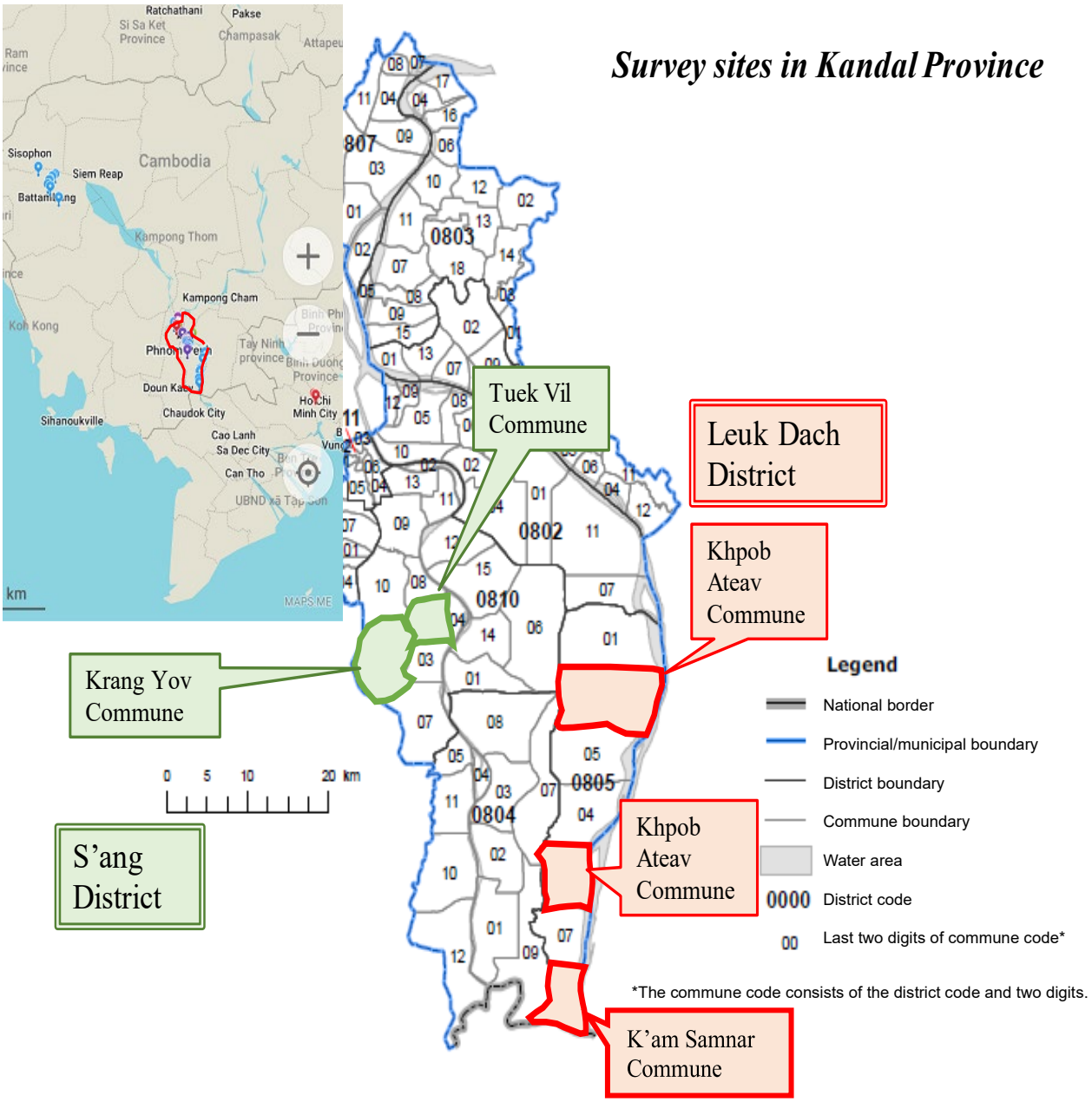
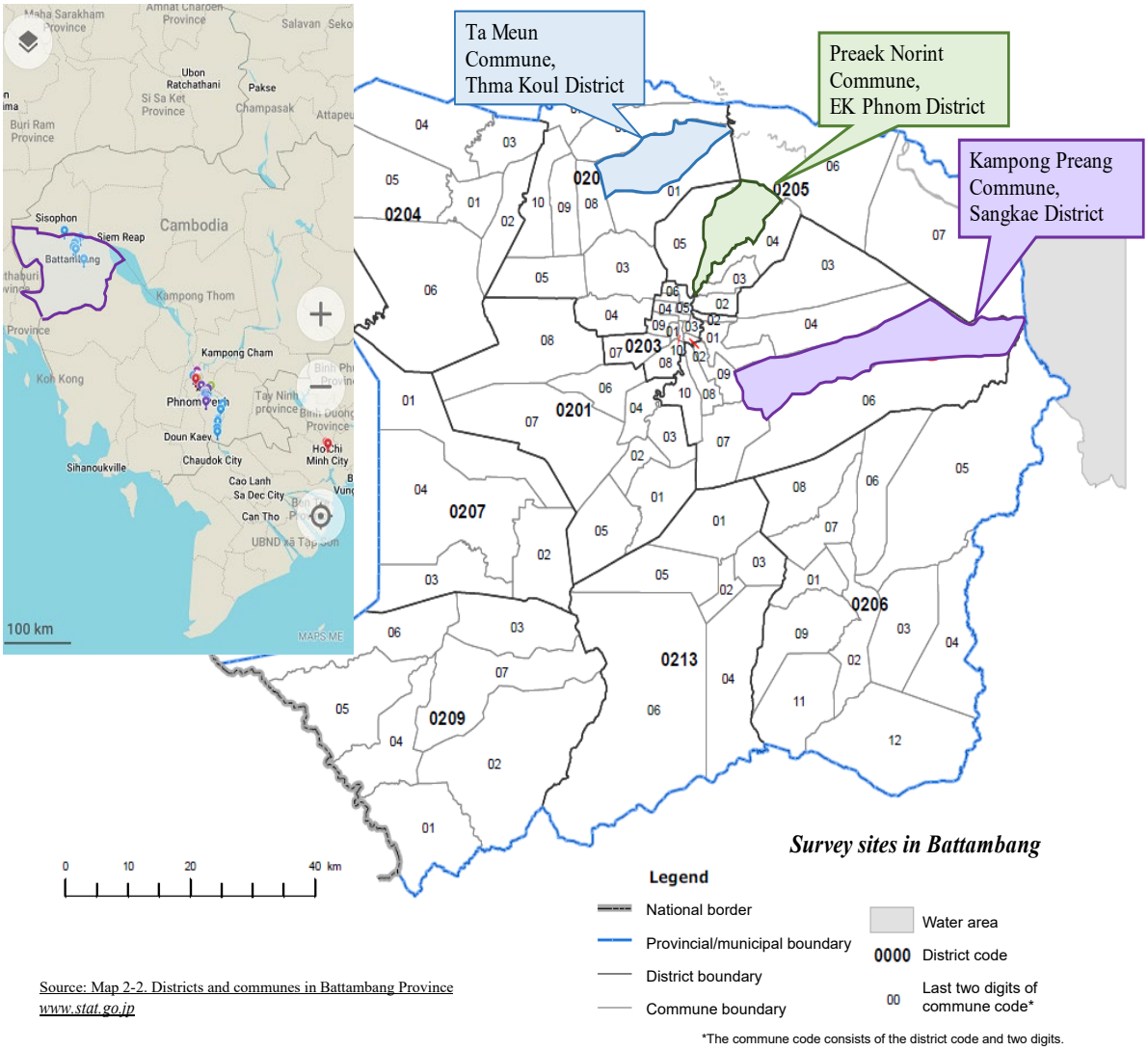
Map of Survey Locations (Chapter 2 Agricultural Value Chain)

Map of Survey Locations (Chapter 3 Distribution, Use, and Regulation of Pesticides)



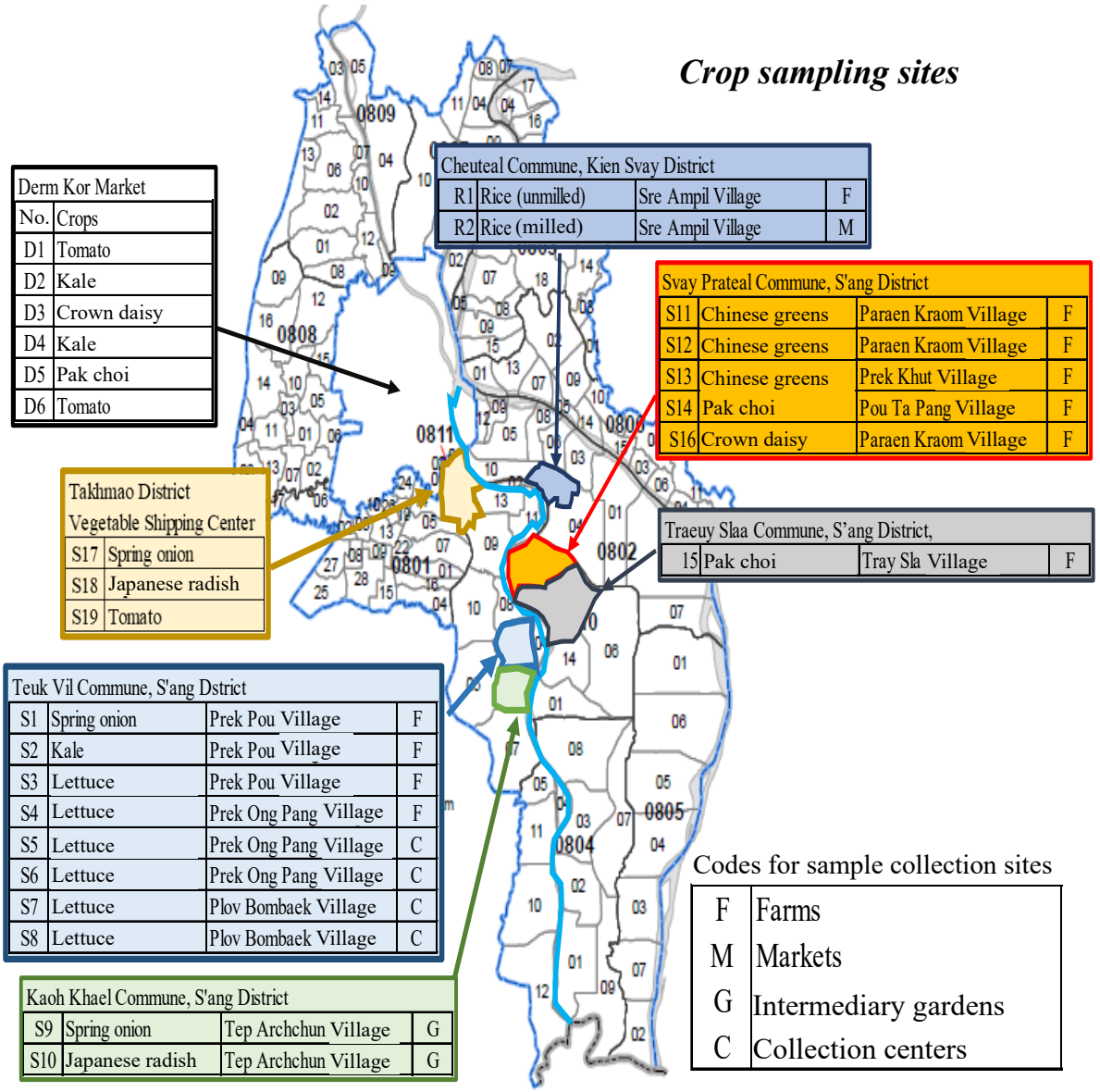
Source: Map 10. Administrative areas in Kandal Province by district
www.stat.go.jp

Areas Subject to Farmer Survey (Kandal Province)



Source: Map 2-2. Districts and communes in Battambang Province
www.stat.go.jp

Areas Subject to Farmer Survey (Battambang Province)



Source: Map 10. Administrative areas in Kandal Province by district
www.stat.go.jp

Sites Subject to Crop Sampling

Photographs (Chapter 3 Distribution, Use, and Regulation of Pesticides)

	**January 21, 2020** **Leuk Daek District, Kandal Province** It was found that most of the pesticides sold by the retailers subject to the survey carry labels written in Khmer and that the majority of these pesticides were imported through formal channels. This photo shows a store located relatively close to the central part of the Leuk Daek District in Kandal Province. Many stores display pesticides in glass showcases in an organized manner.
	**January 29, 2020** **EK Phnom District, Battambang Province** The above observation was also found to apply in the areas surveyed in Battambang Province. In principle, the stores sold pesticides and foods in separate areas. The majority of the pesticides carry labels written in Khmer. Pesticide products imported through illegal channels are rarely found.
	**January 29, 2020** **EK Phnom District, Battambang Province** At many stores, foods and drinks can be found right next to pesticide packages. The constant handling of pesticide products on a daily basis results in a loss of safety consciousness, so seminars on pesticide safety need to be held periodically.

	**January 22, 2020** **K'am Samnar Commune, Leuk Daek District, Kandal Province** The closer you get to the international border, the more you can find foreign pesticides being sold and used. Located in the southern part of Kandal Province, the K'am Samnar Commune neighbors An Giang Province in Vietnam, so there is a relatively free flow of people and goods for personal use. The photo on the left shows Dithane (Manzeb) from Vietnam, while the photo on the right shows a spent container of Vietnamese Hit Top (Azoxystrobin, Hexaconazole and Tebuconazole) that was found in front of a rice-farmer's home.
	**January 22, 2020** **K'am Samnar Commune, Leuk Daek District, Kandal Province** This is a checkpoint gate located at the Chau Doc crossing between the K'am Samnar Commune in Cambodia and Ving Xuong in Vietnam. Staff monitor the traffic here, but they do not perform any checks. Due to its close proximity to An Giang, farmers from the K'am Samnar Commune often visit An Giang to purchase pesticides. Farmers from the K'am Samnar Commune speak basic Vietnamese, but they cannot speak it fluently. The Vietnamese Dong is often used in this area.

	**January 22, 2020** **K'am Samnar Commune, Leuk Daek District, Kandal Province** This photograph shows some farmers being interviewed. Information on the use of pesticides by farmers, including the commercial names of the pesticides as well as the timing and quantities of their application, was collected through a series of interviews. We also obtained information by collecting spent pesticide containers that had been dumped in rivers and other locations by farmers who are not well organized. This would also increase the degree of exposure to pesticides but, fortunately, we did not retrieve the containers at the same time as we conducted sampling for the analysis of residual pesticides.
	**January 21, 2020** **Leuk Daek District, Kandal Province** This is a net house located at the Khpob Ateav Cooperative. Such net houses were often found in Kandal and Battambang. Farmers from the Khpob Ateav Cooperative produce vegetables in net houses under a contract with a private firm situated in Phnom Penh. This business venture has only just started and, since pesticides have yet to be used, it seems to be a success. However, the intensive production of vegetables may induce replant failures due to potential imbalances in the soil nutrition.

	**January 29, 2020** **EK Phnom District, Battambang Province** Some farmers were found to practice low-input agriculture. The farmers used a variety of Thai floating rice contaminated with grass weeds. In neighboring areas, fresh fish farming was also practiced in combination with the use of leguminous plants to maintain soil fertility. However, the farmers seemed unable to run sustainable agriculture by proactively using these methods.
	**January 22, 2020** **K'am Samnar Commune, Leuk Daek District, Kandal Province** This is a demonstration of a pesticide spray nozzle device. Composed of five spray nozzles attached to a bamboo pole with a length of 2 m, this device appeared to be similar to the lily-type spray nozzle available on the Japanese market. The farmers explained that this device, characterized by the use of a bamboo pole, had been introduced from Vietnam recently. It allows farmers to spray pesticides while they traverse their paddy fields.
	**January 21, 2020** **Leuk Daek District, Kandal Province** Engine-driven knapsack sprayers are widely used in farm villages located in Cambodia. Almost no shoulder strap sprayers were found in the survey.

	**January 22, 2020** **Leuk Daek District, Kandal Province** Engine-driven knapsack sprayers are also used for the application of fertilizer. No farmers use basal fertilizer for rice production. This seems to be due to the limited use of slow-release nitrogen fertilizers.
	**January 30, 2020** **Sangkae District, Battambang Province** This is a tractor-mounted boom sprayer used at the Kampong Preang Agricultural Cooperative. The sprayer's thin tires get stuck in heavy clay farmland after flood irrigation, especially when the sprayer is loaded with pesticides, making it difficult to move the sprayer. Such sprayers were widely used in Battambang. The main challenges of this type of sprayer are apparently its drivability and mobility. The efficiency of application is also believed to be low.

Abbreviations

AC	Agricultural Cooperative
ADB	Asian Development Bank
AI	Active Ingredient
ASDP	Agricultural Strategic Development Plan
AVC	Agricultural Value Chain
AVIP	Agricultural Value Chain Infrastructure Improvement Project
CAVAC	Cambodia-Australia Agricultural Value Chain Program
CDRI	Cambodia Development Resource Institute
CEDAC	Centre d'Etude et de Développement Agricole Cambodgien
CF	Contract Farming
CIRD	Cambodian Institute for Research and Rural Development
CNSL	Cashew Nutshell Liquid
DACP	Department of Agricultural Cooperative Promotion
DAE	Department of Agricultural Extension
DAI	Department of Agro-Industry
DAL	Department of Agricultural Legislation
ELC	Economic Land Concession
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FORT	Foodborne Disease Outbreak Investigation and Response Team
FVC	Food Value Chain
GAP	Good Agricultural Practice
GC	Gas Chromatography
GDA	General Directorate of Agriculture
GDAHP	General Directorate of Animal Health and Production
GDP	Gross Domestic Product
GGP	Grant Assistance for Grassroots Human Security Project
GI	Geographical Indication
GIS	Geographic Information System
GMO	Genetically Modified Organism
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis & Critical Control Points
HCMC	Ho Chi Minh City
HPLC	High Performance Liquid Chromatography
ICT	Information and Communications Technology
IFAD	International Fund for Agricultural Development
IPM	Integrated Pest Management
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
ITC	Institut de Technologie du Cambodge (Institute of Technology of Cambodia)
IVY	International Volunteer Center of Yamagata
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MISTI	Ministry of Industry, Science, Technology and Innovation
MLIT	Ministry of Land, Infrastructure and Transport
MOC	Ministry of Commerce
MOE	Ministry of Environment
MOH	Ministry of Health
MOI	Ministry of Information
MOT	Ministry of Tourism
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources and Meteorology

MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
MRL	Maximum Residue Limit or Maximum Residue Level
NAL	National Agricultural Laboratory
NAV	Natural Agriculture Village (Cambodia)
NIS	National Institute of Statistics
PAN AP	Pesticide Action Network Asia and the Pacific
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PGS	Participatory Guarantee System
PPSPD	Plant Protection, Sanitary and Phytosanitary Department
QCAM	Project of Capacity Building for the Quality Standard Control of Agricultural Materials (Chemical Fertilizers and Pesticides)
R&D	Research and Development
RCN	Raw Cashew Nut
RUA	Royal University of Agriculture
SAC	Svay Rieng Agro-Products Cooperative
SAEDA	Sustainable Agriculture and Environment Development Association
SEARCA	Southeast Asian Regional Centre for Graduate Study and Research in Agriculture
SEC	Southern Economic Corridor
SOP	Standard Operating Procedure
SPS	Sanitary and Phytosanitary
TIT	Tokyo Institute of Technology
UPLB	University of the Philippines Los Baños
VC	Value Chain
VINACAS	Vietnam Cashew Association
WB	World Bank

Chapter 1 Overview of the Basic Data Collection Survey

1.1 Background and Purpose of Dispatching the Survey Team

In the Kingdom of Cambodia (hereinafter "Cambodia"), the agricultural sector accounts for 22% of GDP (WB, 2018) and plays an important role in economic growth. Under the national strategy that the country formulated in 2018 entitled "Rectangular Strategy Phase IV," agriculture is also positioned as one of the four priority areas of the Rectangular Strategy; namely "Comprehensive and Sustainable Development." Furthermore, the Industrial Development Plan (IDP) that was announced in 2015 aims to increase the export ratio of agricultural products to 12% by 2025 and to promote high value-added agricultural production.

Despite this, the Cambodian government does not have a clear and concrete strategy or action plan for building agricultural value chains (AVCs). Furthermore, due to geographic and climatic constraints, producers often produce similar commodities at the same time. As a result, the same types of agricultural products tend to be concentrated in the local markets at the time of shipment by farmers, thereby lowering the wholesale price and making it inevitable that these products will be sold wholesale to intermediate companies. This situation is partly attributable to administrative functions related to AVCs that are still under development, so they need to be strengthened. At present, a number of surveys related to value chains (VCs) have been conducted by various international cooperation organizations, and the bottleneck for each commodity is considered to have been clarified to some extent.

In this survey, therefore, the role of government and the analysis of issues related to AVCs are considered to be the main survey items and, based on the survey results, recommendations are made for the roles to be strengthened. In addition, JICA is considering whether to begin pursuing cooperation by undertaking the technical cooperation project entitled "Project for Capacity Building for Pesticide Residue Analysis in Agricultural Procedure" and a project for selecting individual experts as "agricultural value chain improvement advisors" in 2020, so the survey results can be used in both of these new projects. With this in mind, information was collected to consider an effective approach for cooperating in the construction and strengthening of AVCs that the Cambodian government is promoting.

1.2 Survey Team Members and Schedule

1.2.1 Survey Team Members

The members of the Survey Team are as indicated below.

Table 1-1 Members of the Survey Team

Position	Name	Organization
Team Leader	Shunichi Nakada	Senior Advisor (Agriculture Policy), Economic Development Department, JICA
Cooperation Planning	Makoto Norimatsu	Team 1, Agricultural and Rural Development Group 1, Economic Development Department, JICA
Support for Agricultural Value Chain Establishment	Hiromichi Hara	ALMEC Corporation
Distribution, Use, and Regulation of Pesticides	Yasuhiko Muramatsu	CTI Engineering International Co., Ltd.

1.2.2 Study Schedule

The schedule of the survey is as indicated below.

Table 1-2 Study Schedule

Phase	Period
Preparations in Japan	Mid-December 2019
First field survey (preliminary information collection)	Mid-December 2019
Documentation in Japan	Late December 2019 to early January 2020
Second field survey (implementation of survey)	Early January to late February 2020
Documentation in Japan	Late February to early March 2020

1.3 Main Interviewees

1.3.1 Interviewees Questioned about Agricultural Value Chains

Table 1-3 Main Interviewees Questioned about AVCs

(Organization Names and Positions Are Accurate as of the Dates of the Respective Interviews)

Organization	Position	Name
General Directorate of Agriculture (GDA), Ministry of Agriculture, Forestry and Fisheries (MAFF)	Deputy Director General	Mak Soeun
Department of Agro-Industry (DAI), MAFF	Director	Kong Pheach
	Deputy Director	Hour Bopha
	Deputy Chief, Agribusiness Office	Em Huy
	Chief, Processing Management Office	Phonn Reno
	Chief, Office of Agro-Industrial Development	Om Sovannak
	Vice Chief, Processing Management Office	Phann Hour
	Chief of LAPF	Chuon Mony Roth
Department of Industrial Crops, GDA, MAFF	Director	Khann Samban
Plant Protection, Sanitary and Phytosanitary Department (PPSPD), GDA, MAFF	Deputy Director	Chun Hy
General Department of SME and Handicraft, Ministry of Industry and Handicraft (MIH)	Director General	Hort Pheng
	Deputy Director General	Lor Sathya
Institute of Standards of Cambodia (ISC), MIH	Deputy Director General	In Sambo
	Director	Seng Chhang
Industrial Laboratory Center of Cambodia (ILCC), ISC, MIH	Director	Srey Siyorn
Department of Technical Science and Technology, MIH	Director	Ouch Many
Department of Accommodation, Food & Beverage Management, Ministry of Tourism (MIT)	Director	Kim Sereiroath
Department of Macroeconomic and Fiscal Policy, Ministry of Economy and Finance (MEF)	Chief of Research Division	Lao Poliveth
Green Gold/Natural Agricultural Village (NAV)	Director	Seng Nhel
Cambodian Institute for Research and Rural Development (CIRD)	Founder and Director	Prak Sereyvath
HEKS/EPER	Country Director	Sivouthan Norng
Fuchs Gruppe	Country Director	Richard Bahlke
Sela Pepper	General Manager	Soeng Sopha

Maly San Group	Assistant to Director	Pov Thuon
	Vegetable Seed Sales Manager	Soy Than
Santana	Factory Manager	Nhem Sokoan
Svay Rieng Agro-Products Cooperative (SAC)	Director of SAC	Mao Sitha
	Director of Governing Board	Reach Serey
	Accountant	Phoub Piseth
Neak Meas Wholesale Market	Manager of Vegetable Section	SAY Sin
AEON (Cambodia) Co., Ltd	Food Line Senior Merchandizing Manager	Ikumi Uehata
SPEC BioLaboratory, inc.	CIO	Atsushi Kobayashi
International Volunteers of Yamagata (IVY)	Country Director	Ayumi Matsuura
Nippon Express (Cambodia) Co., Ltd.	General Manager	Masahito Ishikawa
Konoike Asia (Cambodia) Co., Ltd.	Managing Director	Yohei Takabayashi
Yusen Logistics (Cambodia) Co., Ltd.	Director	Yoshikazu Sano
Top Planning Japan Co., Ltd.	Cambodia Representative	Takayuki Imahashi

1.3.2 Interviewees Questioned about the Distribution, Use, and Regulation of Pesticides

Table 1-4 Main Interviewees Questioned about the Distribution, Use, and Regulation of Pesticides (Organization Names and Positions Are Accurate as of the Dates of the Respective Interviews)

Organization	Position	Name
MAFF	Secretary of State	Mam Amnot
GDA, MAFF	Director General	Ngin Chhay
Department of Agricultural Legislation (DAL), MAFF	Director	Phum Ra
	Deputy Director	Kan Kompheak
	Office Chief	EM Pisey
	Vice Chief	Thong Soklin
	Vice Chief	Vinin Marineth
National Agricultural Laboratory (NAL), GDA, MAFF	Director	Neou Ratana
	Deputy Director	Phev Chin Theng
	Administration Office Chief	Lorn Socheata
	Technician	Hun Rithy
	Technician	Khoun Kanha
	Vice Chief of Residue	Neau Chanmonny
	Technician	Nguon Nirdey
	Chief	Tean Sithan
	Vice Chief of Residue	Thao Seaklay
Plant Protection, Sanitary and Phytosanitary Department (PPSPD), GDA, MAFF	Director	Ker Monthivuth
	Deputy Director	HENG Chhun Hy
	GAP Officer	TRAY Bunthan
	GAP Officer	Prak Sopheavina
	Admin Officer/PPSPSD	Yoeurn Chanvanyi

Organization	Position	Name
Department of Agricultural Extension (DAE), GDA, MAFF	Director	Mao Minea
	Chief of ICT Office	Heng Choulong
		Meach Sary
Department of Agricultural Cooperative Promotion (DACP), GDA, MAFF	Director	Chea Saintdona
	Deputy Director	Vong Phalla
	Chief of Registration Promotion Officers	Kong Pyseth
Directorate-General of CAMCONTROL, Department of Laboratory, Ministry of Commerce (MOC)	Director	Sin Sieth
ISC, MIH	Deputy Director General	In Sambo
Kandal Provincial Department of Agriculture, Forestry and Fisheries (PDAFF)	Deputy Director	Hor Sophal
	DACP	Ang Vanna
	Agronomy Division	Pan Khemarin
	Extension Director	Kim Rin
	Adviser for ASPIRE	He Sokunty
	PDAL	En Chanyarith
Battambang, PDAFF	Deputy Director	In Sovanmony
	Chief	Ros Ratha
	Chief	Kea Chhun
	Agronomy Production Staff	CHIM Dararoth
Leuk Daek District Office	District Office Chief of Agriculture, Forestry and Fisheries	Tun Somnang
	Deputy Director	Somm Phalla
Thmar Kaul Agriculture District Office	Chief	NU Sambath
EK Phnom Agriculture District Office	Chief	CHAP Sothea
	Agriculture Officer	SORN Pov
Sangkae Agriculture District Office	Vice Chief	PHAT Sophoeun
Sangkae District	Extension Officer	PECH Sokhon
	Chief	CHHEB Chantha
International Rice Research Institute (IRRI)	Senior Scientist in Entomology	Buyung Hadi
	Researcher	Rica Joy Flor
Centre d'Etude et de Développement Agricole Cambodgien (CEDAC)	Technical Support Officer	Sin Angkeasath
Swisscontact	Sector Coordinator, Mekong Inclusive Growth and Innovation Programme	Neha Shrestha
Cambodia Harvest II	Private Sector Development Specialist	Seng Thuy
Cambodia-Australia Agricultural Value Chain Program (CAVAC)	Irrigation & Water Management Manager	AB Koster
	Production & Diversification Coordinator (RICE)	Sourn Sophoan
	Intervention Manager (Rice)	Ear Sothy
Royal University of Agriculture	Director, Division of Research and Extension	Borarin Buntong
	Plant Pathology and Extension Specialist	Tho Kim Eang
	Deputy Director	Tong Socheath

Organization	Position	Name
Establishment of Environmental Conservation Platform of Tonle Sap Lake	Tokyo Institute of Technology	Chihiro Yoshimura
	Coordinator	Aiko Yamashita
Corteva Agriscience/DuPont (Cambodia) Company Ltd.	Country Manager	Tuot Saravuth
Loc Troi Group/An Giang (Cambodia) Plant Protection Company Limited	Director	Do Trung Truc
	Vice Director	Yanh Chantha
Agrotech Vita Co., Ltd.	Senior Marketing Executive, Agro-Marketing and Technical	Heng Soklaing
Angkor Green Investment and Development Co., Ltd.	General Manager	Hur Thinearng
	Regional Manager (Kandal)	Ros Samphors
Forward		Bun Bak Chheng
SGS	Sales & Marketing Executive	Chanteaphea Chhrien
Bureau Veritas (Cambodia) Ltd.	Operation Team Leader, International Trade Division	Chantha Thorn
Intertek Testing Services (C) Co., Ltd.	Celeb Brett Manager	Atheriddh Hok
	Senior Business Development Executive, Marketing and Corporate Communications	Chan Vichka An
	Laboratory Manager, Softline Laboratory	Ramon V. Macaraig Jr.
SPEC BioLaboratory, inc.	CIO	Atsushi Kobayashi
X-Lab Co., Ltd.	Managing Director	Chann Rithy
	Sales Director	Im Sinath
DKSH (Cambodia) Ltd.	Manager, Business Development Technology	Sena Len
Dynamic Scientific	Sales Representative	Try Chorvy
	Product Manager	Khom Bona
	Product Manager	Thuon Daravuth
Acta Bio Co., Ltd.	Food Safety Specialist	Davin Uy

Chapter 2 Agricultural Value Chains

2.1 National Policies and Development Plans

2.1.1 Overall Policies Relating to Agricultural Value Chains

The above-mentioned "Rectangular Strategy Phase IV" is one of Cambodia's overall policies, and the "Economic Diversification" part of this policy contains the following description: "The creation of high added value in the global VC system and the transformation of the agricultural sector into an intensive sector with high productivity and commercialized production." Meanwhile, the "Private Sector and Job Development" part of this policy addresses the development of small and medium-sized enterprises (SMEs), the promotion of competition, and the creation of employment, which is interpreted as including the development of a private sector in association with AVC development.

Furthermore, the Agricultural Strategic Development Plan (ASDP; 2019–2023) of the Ministry of Agriculture, Forestry and Fisheries (MAFF) emphasizes the promotion of ACs, the strengthening of food safety, the promotion of cashews, peppers, and horticultural crops, and the promotion of contract farming (CF). The Industrial Development Policy (2015–2025) announced by the Ministry of Economy and Finance (MEF) in 2015 sets a goal of increasing the proportion of processed agricultural products in total exports from Cambodia to 12% by 2025.

2.1.2 Japanese Cooperation in Establishing Agricultural Value Chains

In accordance with the Cambodian government policies described above, the Japanese government has provided various forms of support for the establishment of AVCs. Table 2-1 below lists some representative examples of Japan-funded support projects aimed at establishing AVCs.

Table 2-1 Japanese Cooperation in Establishing AVCs in Cambodia

Cooperating organization	Name of project	Details
JICA (technical cooperation project)	Capacity Building for the Quality Standard Control of Agricultural Materials (Chemical Fertilizers and Pesticides)	Food safety in Cambodia has been threatened by Cambodian farmers using chemical fertilizers and pesticides that have been illegally imported from neighboring countries, such as Vietnam and Thailand. To counter this threat, activities such as improving the capacity of laboratories involved in the analysis of fertilizers and pesticides as

	(2009–2012)	well as promoting the drafting of rules concerning registration and post-registration work for fertilizers and pesticides were conducted in an attempt to promote the appropriate use and quality control for chemical fertilizers and pesticides.
JICA (preparatory survey for BOP business cooperation promotion)	Happy Handwash Project in Cambodia (Mar. 2013–Feb. 2015)	To improve the hygiene situation in Cambodia, hygiene education on the use of alcohol-based hand sanitizers and their dissemination was conducted at two national hospitals in Phnom Penh as well as two local health centers. In addition, on-site investigations, including the trial sale of liquid hand soap, were conducted to establish a business model for disseminating soaps and alcohol-based sanitizers in Cambodia. At the same time, a more effective method of improving sanitary conditions was devised.
JICA (technical cooperation project)	Project for Establishing Business Oriented Agricultural Cooperative Models (2014–2019)	To strengthen the operational capacity of ACs in Cambodia, the following measures were implemented in the four target provinces: 1) strengthening of the capacity of the Department of Agricultural Cooperative Promotion (DACP) of MAFF and the provincial agricultural bureaus to promote ACs; 2) strengthening of the organization and business implementation system for ACs; 3) introduction and operation of pilot businesses in model ACs; and 4) strengthening of AC business networks that include private enterprises and other business partners.
JICA (support for overseas business expansion of private enterprises)	Feasibility Survey for Sericulture Promotion through Silk Farming and Sericin Extraction Technology Transfer (Nov. 2016–Dec. 2017)	To establish a business for the production and sale of high-grade silk soap from silkworm cocoons with the aim of taking advantage of the UV protection provided by the sericin that the cocoons contain, a pilot factory was built on the site of the Royal University of Agriculture (RUA). At this factory, the utility and versatility of the product was verified, a manual on processing and quality management for silk protein was prepared, and information on the utility and usage method for silk protein was disseminated.
	Feasibility Survey for the Establishment and Implementation of Food Safety Standards, and the Development of Inspection Business through the Public-Private Partnership in Cambodia (May 2018–May 2019)	The aim of this project was to verify a system for providing consumers with safe foods by providing support for the establishment of food safety standards by relevant ministries and agencies while also promoting the development of a safe inspection business by the private sector. The business model that private enterprises developed to provide an inspection service for the government was demonstrated, and the foundation for disseminating the inspection business model was built in collaboration with the relevant ministries and agencies.

	Project on High-Quality Seeds and Grafting and Seedling Technology for High-Value-Added Vegetables and Productivity Enhancement (Jan. 2019–Mar. 2020)	To establish a domestic vegetable VC in Cambodia, this survey was conducted with the aim of achieving stable vegetable production by passing on techniques such as grafting and seedling raising for the cultivation of demanding vegetable varieties and the prevention of diseases. In addition, measures such as the following were conducted: verification of the effects of developing grafts and seedlings suited to local conditions and test cultivations by utilizing the relevant know-how; the development of a manual detailing processes ranging from the raising of seedlings through to production; the provision of technical guidance to model producers; and the implementation of dissemination seminars.
	SDGs Business Model Formulation Survey with the Private Sector for Establishing a Value Chain and Securing High Added Value for Cashew Nuts in Cambodia (Aug. 2019–Sept. 2020)	To establish a cashew VC in Cambodia, the following issues needed to be reviewed: the distribution of raw cashews; the establishment of domestic processing techniques; and the construction of a mass-production system. In this survey, the varieties of cashews and the condition of seedlings were checked to address the production side of VC, while the sales destination and existing business methods were checked to address the distribution side. In addition, the actual condition of the processing factories was ascertained, and the current state of quality and hygiene management was investigated.
Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan	Japan-Cambodia Food Value Chain Bilateral Dialogue (First: Dec. 2015, Second: Jan. 2017, Third: Jan. 2018, Fourth: Nov. 2018, Fifth: Dec. 2019)	Under the framework of the Public-Private Council for Promoting Global Food Value Chain (GFVC), which was established in 2014 by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan to promote the establishment of food value chains (FVCs) through the overseas expansion of the Japanese food industry, bilateral political dialogues and investigations of GFVCs established in overseas countries are conducted. In terms of bilateral relations with Cambodia, the first of five bilateral dialogues was held in 2015. Political dialogues are also held on matters such as the establishment of FVCs by MAFFs of both countries, while investment forums and other discussions are hosted as well.
	Food Value Chain Establishment Project for 2016 (Bilateral Business Development Support Consignment Project in Asia): Practical Survey on Agricultural Process Management (GAP) in Cambodia	To facilitate exports of agricultural products within ASEAN, it is necessary to manage product quality and ensure product safety in accordance with ASEAN GAP (Agricultural Production Process Management) certification or each country's National GAP certification. In Cambodia, however, efforts to implement ASEAN GAP have been delayed. Therefore, in order to promote a Cambodian version of GAP certification (Cam GAP) based on ASEAN GAP, an investigation was conducted to assess the progress made in efforts to

	(2016–21017)	implement ASEAN GAP and Cam GAP as well as issues concerning Cam GAP certification. In addition, activities such as a test production in an actual farm field where the concept of Cam GAP had been incorporated were conducted.
	Overseas Agriculture and Trade Investment Environment Survey Analysis Consignment Project for 2017: Work conducted by the secretariat of the Public-Private Council for Promoting Global Food Value Chain, political dialogues with Southeast Asian countries, etc. (2017–2018)	To formulate an ASEAN GAP or National GAP certification system and promote its dissemination, support was provided for the establishment of a Cam GAP certification system by utilizing the food safety assurance system employed in Japan and the relevant know-how. To promote FVC through a public-private partnership, the participation of private enterprises is essential. Therefore, for the Cam GAP certification system that had been tested the previous year, MAFF and various private enterprises cooperated in conducting a demonstrative investigation of the certification process at the field level, including the development of human resources for conducting examinations.

Source: Prepared by JICA Survey Team based on applicable reference materials.

2.2 Analysis of Agricultural Value Chains

In consultation with concerned parties from MAFF and JICA, vegetables, peppers, and cashews were selected as the target commodities for this survey. In the following sections, the establishment of AVCs for these three commodities is analyzed.

2.2.1 Vegetables

(1) Basic information

Table 2-2 below shows the estimated vegetable production, consumption, imports, etc., for Cambodia.

Table 2-2 Estimated Vegetable Consumption and Imports in 2018

Item	Value	Unit
Population	16,245,729	Persons
No. of tourists	6,200,000	Persons
Per-capita consumption	250	Grams/day
Total consumption by domestic population (i)	1,482,381.7	Tons/year
Total consumption by tourist population (ii)	1,550	Tons/year
Total consumption [(iii) ≈ (i) + (ii)][1]	1,481,981.7	—
Total production	639,513	Tons/year
Total imports	844,418.7	Tons/year
Total imports per day	2,313.5	Tons/day

Source: ADB (2019)

[1] These values are rough estimates, so they may not be consistent with detailed calculations.

Figure 2-1 below shows trends in the domestic production, domestic supply[2], import volume, export volume, and domestic stock for vegetables from 2003 to 2017[3]. During this period, production increased by about 14.6% and domestic supply increased by about 15.0%. In contrast, the export volume as of 2017 had fallen to about half that of 2003, while the import volume as of 2010 had greatly increased compared to that of 2003. This trend is believed to have been caused by the fact that, although the demand for vegetables increased in line with the country's growing population and production volume increased accordingly, supply could not keep up with demand so dependency on imports grew. According to Table 2-2 above, the estimated import volume in 2018 was 0.844 million tons, accounting for 56.9% of total vegetable consumption.

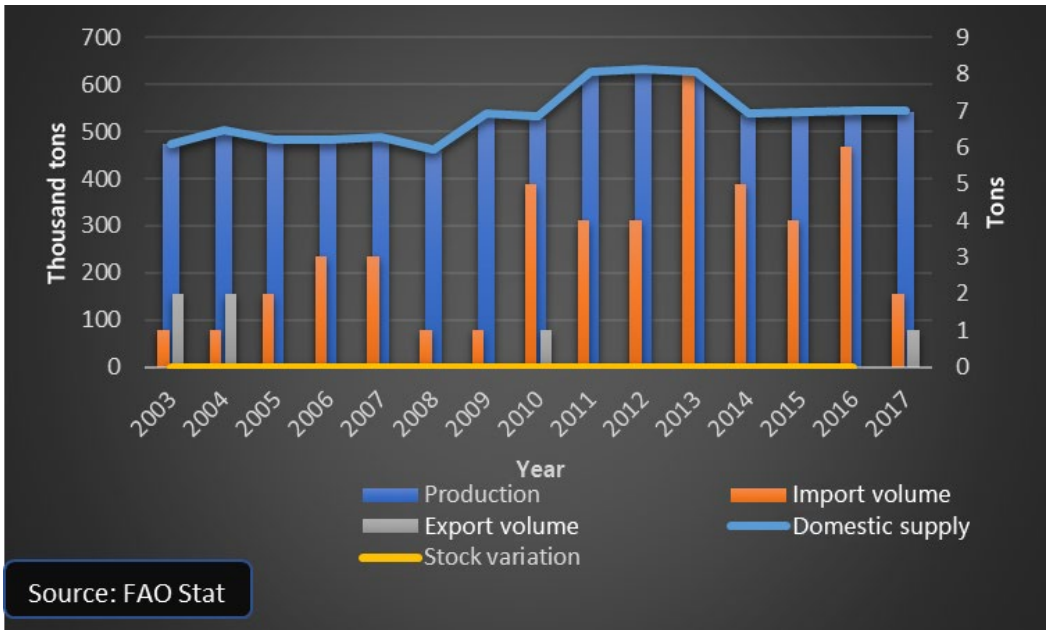


Figure 2-1 Trends in Domestic Production, Exports, and Imports for Vegetables (2003–2013)

Figure 2-2 below shows trends in the population of Cambodia during the same period[4] as well as changes in domestic per capita vegetable consumption[5]. Although the country's population has been increasing, annual per capita vegetable consumption has remained almost flat at around 30 kg, except for during the

[2] According to the definition provided by FAO, domestic supply volume was calculated as follows: "Production + Imports - Exports + Changes in stocks (decrease or increase) = Supply for domestic utilization."

[3] The data source used for the 2003–2013 period differs from that used for the 2014–2017 period. The former is based on the FAO's "New Food Balances" (http://www.fao.org/faostat/en/#data/FBS) while the latter is based on "Food Balances" (http://www.fao.org/faostat/en/#data/FBSH).

[4] For details on Cambodia's population trends, refer to the following URL: https://ecodb.net/exec/trans_country.php?type=WEO&d=LP&c1=KH&c2=JP (accessed March 4, 2020)

[5] As with Figure 2-1, the data source used for the 2003–2013 period differs from that used for the 2014–2017 period. For details, refer to the footnote for Figure 2-1.

2011–2013 period. In other words, although per capita consumption has not changed significantly, it is estimated that overall demand will continue to increase due to the rapid population growth.

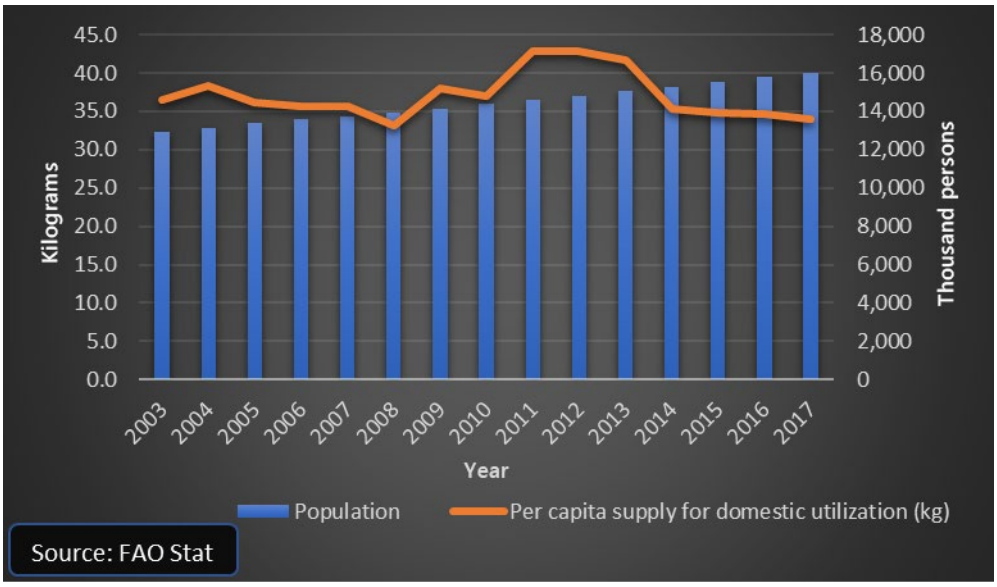


Figure 2-2 Trends in Population and Domestic Per-capita Vegetable Consumption (2003–2013)

Next, VC for Cambodian vegetables is discussed. For the purpose of analysis, the term "general vegetables" is used in this section to refer to non-organic vegetables and vegetables that are grown without using reduced amounts of pesticides, distributed through the conventional distribution system, and then sold at ordinary local markets and stores, while the term "low-pesticide vegetables" is used to refer to organic vegetables and vegetables that are grown using reduced amounts of pesticides. It is also assumed that most of the vegetables consumed in Cambodia are the former and that the amount of the latter is very small.

First, VC for general vegetables is analyzed. One of the main characteristics of this VC is that 60% of the vegetables delivered to wholesale markets are delivered from importers, which is higher than the share of domestic vegetables[6]. However, unified safety and quality standards for both imported and domestic foods have not yet been created. Therefore, when vegetables are distributed through wholesale markets, it is difficult to negotiate and set prices in accordance with the food quality and to trust information on the place of origin (domestic or imported) indicated on the labels of agricultural products in local markets or told orally by the retailer because labeling regulations are not functioning properly. In addition to these issues, there has

[6] Dependence on imports from Vietnam and Thailand is particularly high. The "Investigation Report on the Production, Distribution and Investment Environment in ASEAN Economic Community," published by the Daiwa Institute of Research (2017), points out that the value of imports from these countries accounted for 60% of total vegetable imports in 2015.

been a lack of traceability. In other words, it is impossible for anyone to guarantee who has produced a product and where it reached the market. Consequently, with the current VCs for general vegetables in Cambodia, it has not been possible to satisfy market needs, which include growing consumer awareness of food safety and quality, in recent years[7].

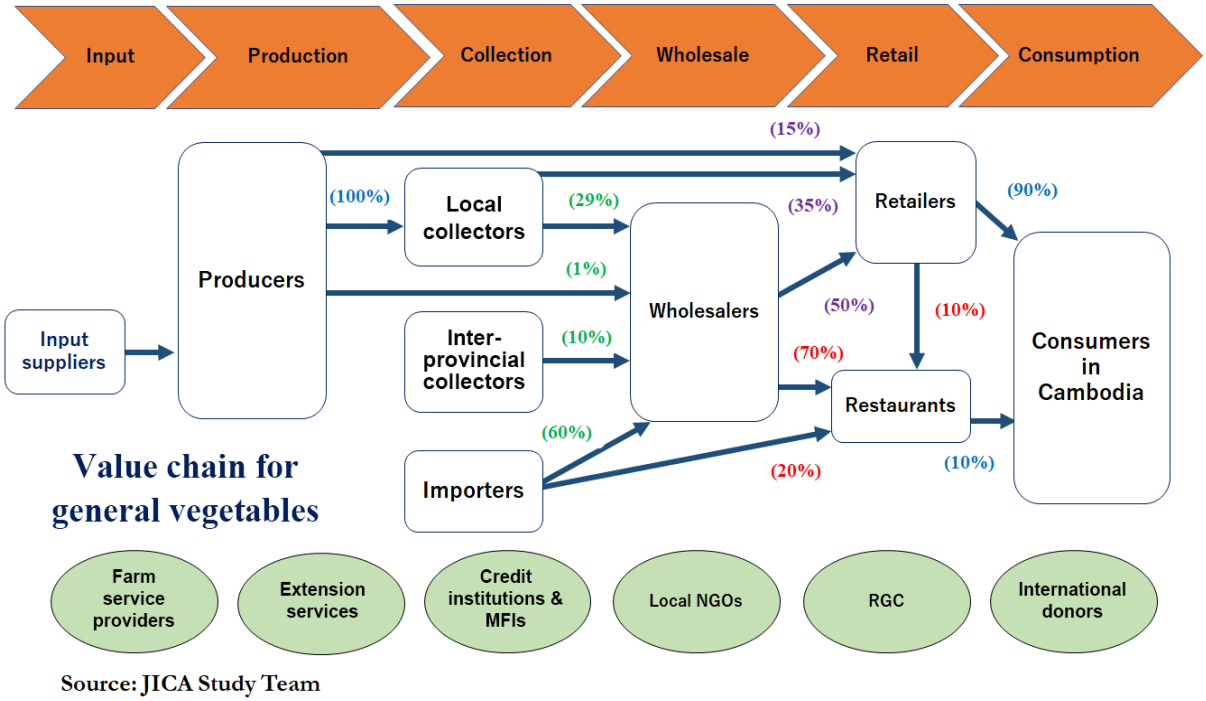


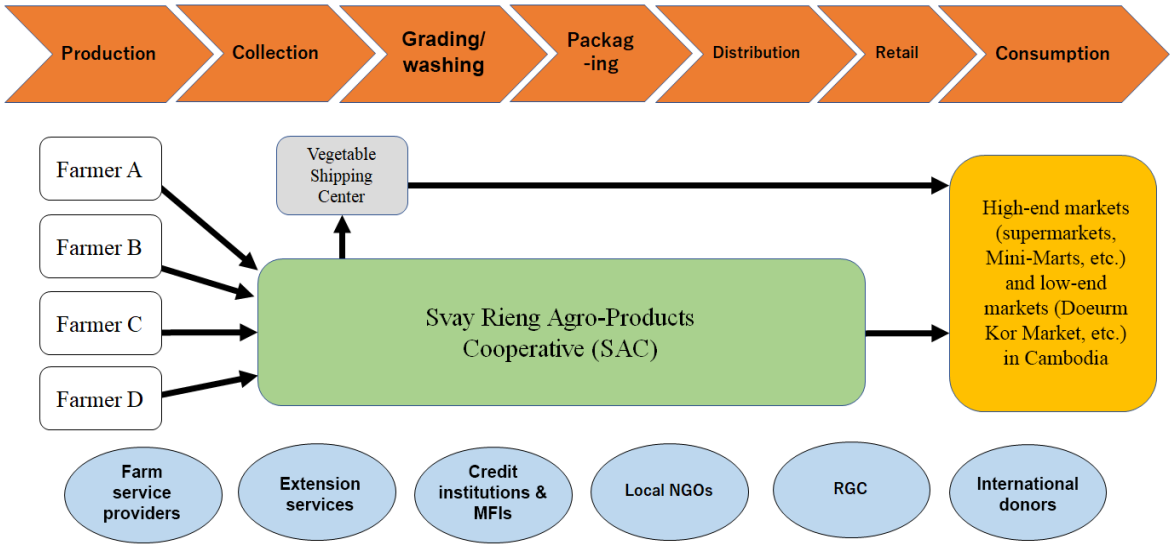
Figure 2-3 VC for General Vegetables[8]

While conventional VCs that pass through wholesale markets have structural issues that are difficult for private enterprises to overcome, some supermarkets and agricultural corporations for high-end customers have built their own VCs by utilizing contract farming (CF) in order to respond to the growing consumer need for agricultural products that are both high quality and safe (Figure 2-4 below). One example of this is the low-pesticide vegetables cultivated in Svay Rieng Province, and the actors involved in this VC are shown in Figure 2-4. With the growing consumer need for food safety in Cambodia as mentioned earlier, the Svay Rieng Agro-Products Cooperative (SAC) has been supplying low-pesticide vegetables continuously to

[7] For the past several years, Cambodian consumers, food processing companies, policymakers, and other stakeholders have become keenly aware of food safety and quality. For details, refer to the following URL: https://www.khmertimeskh.com/85845/food-safety-health-concern-cambodia/ (accessed March 4, 2020)

[8] As shown in Figure 2-1, a small volume of vegetables is exported from Cambodia, but the export channels have not been confirmed in this survey. Therefore, a description of these channels is not included in Figure 2-3. For details on exports, refer to the following URL: https://wits.worldbank.org/CountryProfile/en/Country/KHM/Year/2016/TradeFlow/Export/Partner/all/Product/06-15_Vegetable (accessed March 6, 2020)

supermarkets for high-end customers in Svay Rieng Province, including AEON in Phnom Penh[9]. With support from the International Volunteers of Yamagata (IVY)[10], SAC has continued supplying low-pesticide vegetables to high-end markets in Phnom Penh even after the completion of IVY project. This is due to the following factors: 1) continuous strengthening of management throughout the duration of the project and maintenance of a robust operational system; 2) possession of infrastructure such as collection/shipping sites and refrigerated trucks; and 3) strict observation of quality standards on both the producer side and the product collection side.



Source: JICA Study Team

Figure 2-4 VC for Low-Pesticide Vegetables (Svay Rieng Province)

(2) Production (agricultural materials, production infrastructure, etc.)

ADB (2016) points out that, of the various materials used in agriculture, there is a particular need to improve the prices, quality, and lineup of vegetable seeds. First of all, the prices of these seeds are relatively high. In addition, some vegetable seeds are currently easy to obtain (e.g., those for tomatoes and cabbages), while others are not. Therefore, measures should be taken to increase or diversify the lineup of seeds that have high market demand (e.g., water morning glory and cucumbers). In terms of the availability of

[9] As one of the Japanese government's Grassroots Technical Assistance Projects, "Poverty Reduction in Rural Area through Establishment of Sustainable Management of Svay Rieng Agro-Products Cooperative (SAC) Phases I to III" was implemented with support from IVY (Japanese NGO) between 2013 and 2016. In this project, SAC's management system was strengthened and a collection/shipping platform was constructed. Even after the project was completed, member farmers continued delivering low-pesticide vegetables to a casino and other facilities located in Phnom Penh and near the border between and Svay Rieng Province and Vietnam.

[10] IVY had implemented a series of projects aimed at establishing and strengthening farmers groups for women (e.g., vegetable VC development), including "Support for the Establishment of Village Women's Unions" (1999–2003) and "Project for the Development of Supply and Distribution Systems for Vegetables" (2009–2012), between 1999 and 2016 in Svay Rieng Province. For details, refer to the following URL: http://ivyivy.org/act/cambodia/ (accessed March 14, 2020)

agricultural materials, many of the seeds, pesticides, and fertilizers that are currently distributed in Cambodia are imported products that lack any guarantee of quality and safety, thereby restricting the availability of inexpensive high-quality agricultural materials. According to an interview conducted by the Survey Team in S'ang District, Kandal Province, the Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) has supported the distribution of pesticides and fertilizers to farmers as countermeasures for such issues.

Production support is provided to farmers by both the public and private sectors. The survey revealed that, in addition to the technical support provided to farmers by MAFF[11], the Royal University of Agriculture (RUA) has issued instructions on measures aimed at reducing the adverse influence that noxious insects have on vegetable production while the private enterprise Natural Agricultural Village (NAV) has provided its contract farmers with knowledge on how to grow low-pesticide vegetables and transport their harvests as well as instructions on how to manage and inspect their soil and produce organic fertilizers and natural insecticides.

Photo 2-1 Phnom Penh City: Natural Agricultural Village (NAV)

In line with the growing consumer awareness of food safety, NAV as of 2019 had contracts with over 400 farmers and was supplying low-pesticide vegetables mainly to supermarkets in Phnom Penh.

[11] According to ADB (2016), the Department of Agricultural Extension (DAE) of MAFF provides farmers with relevant information and technical guidance directly while also arranging business matching seminars between farmers and other actors (e.g., processing companies, distributors). It has been argued, however, that farmers do not always take advantage of the opportunities provided by DAE even though most of them are aware of the latter's activities.

Photo 2-2 Fertilizer Found in S'ang District, Kandal Province

This fertilizer was made in Thailand and then provided to farmers with the assistance of PDAFF. Although the farmers use this product daily in their production activities, they occasionally use domestically made fertilizers and pesticides. The interviewed farmers had contracts with NAV and were engaged in the cultivation of vegetables using appropriate amounts of fertilizers and pesticides in accordance with the company's standard.

One of the key issues facing Cambodia in relation to horticultural agriculture is the need to diversify the product lineup and extend shipping times. Given the increased income of Cambodians and the influx of foreign tourists in recent years, the number and variety of restaurants in Phnom Penh and other major cities have rapidly increased[12]. To meet the needs of residents and tourists alike, there is a need to improve food safety and quality while also increasing or diversifying the range of raw materials, including vegetables. From this perspective, it now seems possible to produce the main commodities at the prescribed quality levels or higher due to improvements in technical standards, but diversifying vegetable production is not necessarily easy. The main reasons for this are as follows: little progress has been made in developing various commodities and varieties; only a limited range of agricultural materials are available, as mentioned earlier; and insufficient knowledge concerning the use of agricultural materials and cultivation techniques prevents farmers from utilizing the appropriate techniques. Other reasons include the following: it is difficult to invest in the cultivation of various vegetables because the required agricultural materials are expensive; a system for selling and supplying various vegetables has yet to be established as there is limited functionality for setting prices that reflect added value in the market; and it is difficult to secure a stable labor force at farms.

[12] For details on matters such as the rapid increase in the number of restaurants in Cambodia and the diversification of restaurant types, refer to the following URL: https://www.phnompenhpost.com/post-focus/contemporary-khmer-food-western-deli-delights-these-siem-reap-eateries-have-it-all (accessed March 4, 2020)

Increased profitability through cultivation using small amounts of pesticides

Thanks to support from NAV and various other factors, the number of farmers who cultivate vegetables by using net houses is increasing in Kandal Province and other such locations. Providing a physical barrier that prevents entry for aphids that transmit viruses, the utilization of net houses is also considered an effective means of preventing climate damage, such as that caused by strong winds. Since he began using net houses, the farmer in the photograph has increased the number of vegetable varieties that he cultivates and reduced the amounts of pesticides that he uses, which has led to a substantial increase in income.

Another key issue in relation to the production of vegetables in Cambodia is the need for stable shipping throughout the year. Peak production for many vegetables that are in high demand by consumers (e.g., water morning glory and cabbages) is during the dry season from November to April, which is when the cultivation of rice, Cambodia's main crop, is suspended[13]. In contrast, the domestic production volume of vegetables decreases during the rice planting period and the rainy season from May to October, which is when farm fields are often flooded due to heavy rain. For these reasons, harvested vegetables tend to be concentrated in markets during the dry season and the vegetable prices drop. In contrast, the amount of vegetables produced in Cambodia during the rainy season is very low, which is a significant factor in their dependence on imported vegetables. Going forward, an effective means of securing seasonal independence and stable shipping[14] is considered to be the introduction of new varieties and the combination of practical cultivation techniques, including the use of vinyl mulch and net houses[15]. Another significant issue is that farmers tend to lack the knowledge and experience required to select crops in consideration of market needs, systematically produce vegetables and ship them at appropriate times, and keep production records appropriately, including details

[13] There are some exceptions. For instance, the peak production period for lettuce, tomato, ching guang juai, etc., is September.

[14] GDA of MAFF has worked to overcome seasonality by listing vegetables that can be harvested seasonally and guiding farmers by helping them choose suitable locations. For details, refer to the following URL: https://www.khmertimeskh.com/87260/vegetable-farmers-urged-increase-production-go-organic/ (accessed March 11, 2020)

[15] For details on this column, refer to the following URL: https://ali-sea.org/item/nethouse-helps-a-vegetable-producer-stop-using-chemical-pesticide/ (accessed March 4, 2020)

on the production costs incurred during the cultivation processes. To resolve this issue, it will be important for the farmers themselves to take advantage of opportunities to turn their attention to production in consideration of the market.

In the Cambodian agricultural sector, support is provided by foreign organizations, NGOs, and many other development partners. However, to establish a stable system that encompasses all stages from production to sales, it is necessary to adopt a comprehensive approach to various issues, such as technical improvements, infrastructure development, and market access securement. In recent years, MAFF has recommended CF and promoted the advantages of securing sales destinations through direct contract between producers and companies. For CF to take root, however, producers need to supply crops stably in levels of quantity and quality that match demand, so it is not easy for a single small-scale farmer to be a party to a contract. For this reason, strengthening competitiveness by creating farmer organizations (ACs) becomes even more important. Furthermore, the most important factor in CF is the relationship of trust between companies and producers, so it is essential that both parties strictly adhere to the terms of the contract. MAFF has developed and is now disseminating guidelines on CF, but it is also necessary to provide guidance to farmers who are not accustomed to maintaining a sales network through continuous contractual relationships and to help them improve their farming techniques.

(3) Post-harvest treatment

According to ADB (2016), about 25 to 40% of domestically produced vegetables are damaged due to inadequate post-harvest treatment techniques. However, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan (2016)[16] has pointed out that about 10% of food loss and disposal in ASEAN and South Asia occur during the consumption phase, while about 90% occur during the phases from production through to distribution and logistics. Particularly in rural areas, the roads tend to be in poor condition and elements of the cold chain network, such as refrigerated transportation, are not sufficiently developed (this issue is also related to the next section). Therefore, it is desirable for easily damaged products (e.g., leafy vegetables such as lettuce and fruit vegetable such as tomatoes) to be stored in facilities where appropriate temperature and humidity levels can be maintained after harvesting and for appropriate containers to be used during their storage and transportation in the future. In addition to these issues, the fact that the shipment of

[16] For details, refer to "Development of Cold Chain Logistics to ASEAN Region," published by Japan's MLIT (2016).

seasonal vegetables is concentrated in specific times of the year due to seasonally imbalanced production results in a drop in prices as well as gluts and spoilage of a large amount of vegetables. This is one of the causes of food loss.

Although the number of collection/shipping sites managed by farmer organization is still limited in Cambodia, this number is increasing. As mentioned earlier, one of these organizations is SAC[17], which is located in Svay Rieng Province and provides a base for the post-harvest treatment of vegetables from its member farmers. This collection/shipping site strengthens post-harvest quality management by providing a place for the cleaning, selection, packing, refrigerated warehouse storage, and shipping of vegetables in refrigerated light trucks, thereby helping to reduce harvest loss and add value. Similarly, a collection/shipping site was opened in Kandal Province in November 2019 using grassroots grant aid from the Japanese government. Currently, about 200 kg of vegetables are collected there per day, after which they undergo post-harvest treatment and are shipped to the wholesale market in Phnom Penh[18].

Photo 2-3 Kandal Province: Vegetable Shipping and Quality Control Center

Opened in November 2019, this center was built using grassroots grant aid from the Japanese government. It currently has 22 staff, so it still handles relatively low volumes. However, its refrigerated storage facility, which is mainly for leafy vegetables, can store up to 2 tons, while its non-refrigerated storage facility can store up to 3 tons.

(4) Distribution and logistics

In general, there are two types of entities that distribute vegetables to retailers: 1) mobile intermediate distributors who go around villages to buy vegetables and then transport them to market (collection and distribution) (Cambodians and Vietnamese); and 2) wholesalers who always trade in the market. There are relatively few of the latter, who purchase directly from producers or from the former. The latter accounts for

[17] According to an interview conducted by the Survey Team on January 27, 2020 (Monday).
[18] According to an interview conducted by the Survey Team on January 15, 2020 (Wednesday).

20% of all distribution, while the former accounts for about 80%. Retailers trade in the market, buying vegetables from wholesalers, intermediate distributors, and producers and then selling them to consumers.

Photo 2-4 Wholesale Market in Svay Rieng City, Svay Rieng Province

The woman in the photo is a wholesaler who handles leafy vegetables (e.g., water morning glory) at the Veal Yong wholesale market. She generally buys vegetables directly from the farmers and then sells them to retailers, but she also buys them from retailers for sale to restaurants and ordinary shoppers.

Figure 2-5 below shows the transitions in formal anticipated profits from the sale of conventional water morning glory for each of the stages from the farmer to the wholesale market. An intermediate distributor sets the purchase price from the farmer by including their profit in consideration of the purchase price by the wholesaler. In Figure 2-5, the intermediate distributor sells water morning glory to the market wholesaler by adding a margin of about 15.8% (USD 0.15/kg) to the price at which they bought the product from the farmer. This figure also shows that the wholesaler sells the water morning glory to the actual consumer by adding a margin of about 13.6% (USD 0.15/kg). The colored portions of the figure show the anticipated profits for the intermediate distributor and the wholesaler[19]. As the above suggests, unlike in the case of crops that are cultivated based on the assumption that they will be processed and exported at a later date (e.g., pepper and cashews [to be described later]), parties in the downstream part of VC (e.g., the intermediate distributor or wholesaler) only add certain margins that do not differ significantly according to the relevant stage of VC, so high added value is not given to the final product.

[19] The anticipated profit for the farmer is not shown here due to a lack of sufficient data on production costs, including labor costs.

		USD 0.15
	USD 0.15	Wholesale market Sells for USD 1.25/kg (KHR 5,000)
Farmer Sells for USD 0.95/kg (KHR 3,800)	Intermediary Sells for USD 1.1/kg (KHR 4,400)	

Source: JICA Team

Figure 2-5 Anticipated Profits for VC Actors from the Sale of Conventional Water Morning Glory

One of the major issues related to distribution in Cambodia is the failure to fully implement a system that guarantees market information, quality control, price formation, trading systems, labeling regulations, traceability, and hygiene control in the country's wholesale markets, where more than 90% of the total domestic consumption of vegetables is distributed. Consequently, even if farmers produce high-quality agricultural products, this added value is not likely to be reflected in their prices. This is another issue that needs to be tackled. Also, although there are three wholesale markets in Phnom Penh (i.e., Doeurm Kor Market, Chbar Ampov Market, and Neak Meas Market[20]), a significant issue is that, in Cambodia, enforcement of the Wholesale Market Law lies in the hands of each autonomous body. The roles that wholesale markets are supposed to play include the various functions mentioned above, but government-led efforts to accumulate the know-how required to run markets and establish the relevant systems are expected to progress in the future.

Photo 2-5 Phnom Penh City: Doeurm Kor Wholesale Market

There are three wholesale markets in Phnom Penh, including this market. This photo was taken at around 8 pm. The street was lined with a wide variety of agricultural products acquired from the Vietnamese border and throughout the rest of Cambodia. The market was very lively.

[20] In an interview conducted on January 17, 2020, the Survey Team found that the operator of the Neak Meas Market does not have accurate figures (e.g., quantities and prices) even though the market receives a large quantity of domestic and imported vegetables every day.

Photo 2-6 Phnom Penh City: Neak Meas Wholesale Market

This is the only wholesale market in Phnom Penh to be operated by a private company. Many imported and domestic vegetables arrive here every day, but the operators do not know the quantities and prices of the products.

Figure 2-6 below indicates the distribution channel for vegetables imported from Vietnam (and China). According to ADB (2016), Cambodian wholesalers often place orders with Vietnamese collectors by telephone, with the vegetables usually reaching the wholesale market in Phnom Penh about two days after the orders have been placed.

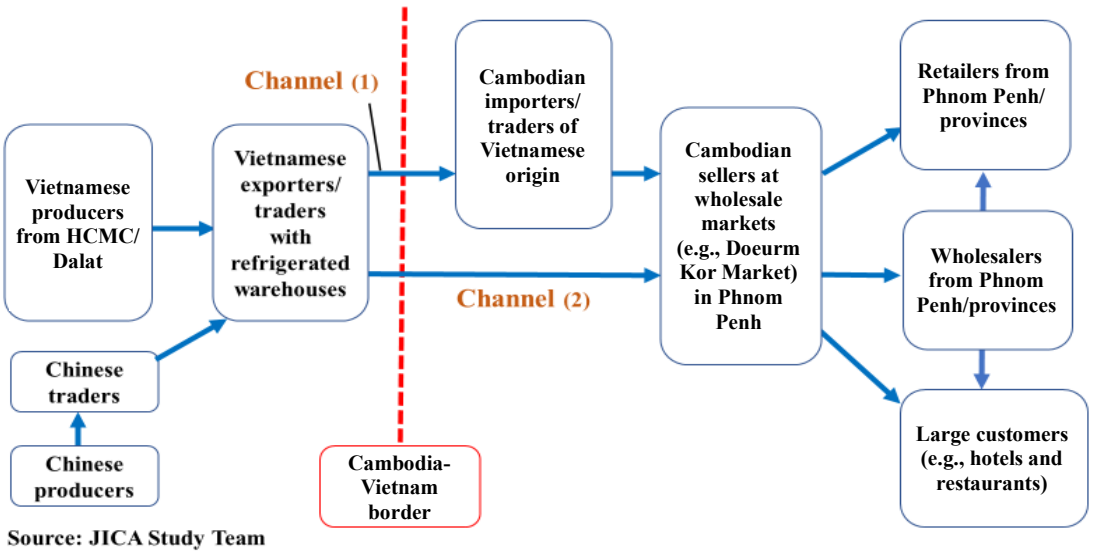


Figure 2-6 Distribution Channel for Vegetables Imported to Phnom Penh from Vietnam

Another important distribution issue is the lack of a cold chain network. AEON, a large-scale Japanese supermarket, opened a store in Phnom Penh in the mid-2010s, and various leading transport companies have also entered the market since then. As a result, the distribution channel has gradually changed. For instance, SAC has introduced the use of small refrigerated trucks thanks to grassroots support from the Japanese government mentioned earlier. In Thailand and other neighboring countries, foreign capital companies have generally led the development of cold chains. Therefore, the Cambodian government is expected to develop and implement various investment promotion policies, including tax benefits for foreign-capital distribution

and logistics companies. Specific cold chains that are suited to the needs of Cambodia are expected to be developed through private sector investment. At this stage, however, there are only a limited number of markets where agricultural products that have been kept fresh in a cold chain can be sold by adding value to them. Consequently, the development of cold chains is, in reality, considered to be a mid- to long-term goal for the country. According to interviews conducted by the Survey Team, one of the measures to be implemented was the introduction of light trucks with refrigeration equipment installed in their truck beds because large-sized trucks are subject to restrictions on entry into the center of Phnom Penh.

(5) Processing

Very little information was obtained on the processing of vegetables in large-scale processing factories. Interviews on small-scale vegetable processing that were conducted by the Survey Team in Svay Rieng Province revealed that small-scale farmers often sell small quantities of pickled vegetables in local markets. ADB (2019) also states that few investors are interested in processing vegetables and points out that investment in processing equipment is rare in areas with potential market scale, such as Phnom Penh and Siem Reap Province, and locations that have a climate suitable for vegetable cultivation, such as Mondulkiri Province and Kampong Speu Province. Given these circumstances, the processing of vegetables in Cambodia is extremely limited.

According to ADB (2019), two such companies were confirmed in Siem Reap Province, one of which procures raw materials from a small number of local farmers through CF and is planning to expand its processing production for both the domestic market and exports. Given that the number of domestic competitor companies is still assumed to be small, this is a field with great potential. Nonetheless, the costs required for processing remain an issue, the range of products to which additional value can be added by processing vegetables is considered to be limited, and the markets for such products are considered to be very small at present.

(6) Sales and retail

As mentioned earlier, inexpensive vegetables are imported from Vietnam and Thailand on a daily basis. However, due to consumer concerns and distrust of potential pesticide residue in imported vegetables, the

number of retailers in Phnom Penh handling low-pesticide vegetables cultivated by CF is increasing[21]. The reasons why vegetables produced by CF using reduced amounts of pesticides are mainly supported by middle- and high-income consumers are as follows: the distribution network (including wholesale markets) is not sufficiently developed to make vegetables accessible to more people, as mentioned earlier; there are concerns about the safety of vegetables as traceability has yet to be fully secured; and it is difficult to ensure that the quality and safety of vegetables sold in markets reach the levels demanded by most consumers because standards and criteria concerning the quality of agricultural products have yet to be established. While some private organizations have introduced independent certification systems, their public counterparts have yet to develop any. As private certifications may not be sufficiently compatible with the certification systems used in other countries, MAFF has endeavored in recent years to disseminate the Cambodian version of Good Agricultural Practices (Cam GAP), which stipulates a wide range of agricultural production processes.

There are four important points to note in relation to CF: 1) quality; 2) production volume; 3) price; and 4) shipment timing. NAV sets its own standards or criteria for quality and shipping because the national quality standards are inadequate. When the company enters into a contract with a farmer, one of the conditions is that the farmer has not used pesticides in the past year. The company examines the farmer's fields for traces of pesticide residue and checks whether the standards are met[22]. After the contract has been signed, the company provides technical guidance on the production methods (e.g., how to use net houses, pesticides and fertilizers) and various other types of information (e.g., market prices and trends of new technologies) to guarantee a prescribed level of quality. In terms of production volume, the supply of products in a given period (e.g., weekly or monthly) should be determined when the contract is signed and its observation is encouraged. The price is also agreed upon when the contract is signed, but this may be changed within certain periods (e.g., monthly) according to market prices. As for shipment timing, although one of the most significant issues concerning vegetable production in Cambodia is, as mentioned earlier, stable shipping throughout the year, contractors such as NAV enter into contracts only with farmers who have a sufficiently high level of technical ability to satisfy their proprietary standards as mentioned earlier. By

[21] For details, refer to the following URL: https://www.foodnavigator-asia.com/Article/2018/08/08/More-demand-for-organic-products-in-Thailand-and-Cambodia-but-production-costs-remain-high# (accessed March 4, 2020)

[22] Other conditions include the ability of farmers to purchase net houses with their own funds. According to an interview conducted by the Survey Team on January 17, 2020, the cost of a net house is, for example, about USD 8,400 for a floor area of 1,400 m^2.

entering into numerous contracts with such farmers, contractors aim to secure a supply of vegetables that, where possible, meets the contracted quantity even in the rainy season when the production volume generally drops.

However, many consumers have pointed out that existing low-pesticide vegetables are expensive, and the fact that the prices of such low-pesticide vegetables and organic vegetables[23] are often 20 to 30% higher than those of general vegetables[24] prevents consumers from purchasing them regularly. Table 2-3 below shows a comparison of the sales prices for water morning glory according to this survey[25]. The cost of low-pesticide vegetables was USD 1.9 to USD 2.0 per kilogram, which is about 60% higher than the price of general vegetables at USD 1.25 per kilogram.

Table 2-3 Price Comparison for Water Morning Glory

Category	Name of market	Price (USD/kg)	Production area
General vegetables (with low traceability)	Veal Yon Market (Svay Rieng)	1.25	Svay Rieng
Low-pesticide vegetables (reduced use of agro-chemicals)	Natural Garden (Phnom Penh)	2.0	Kandal
	AEON (Phnom Penh)	1.9	Svay Rieng

Source: Prepared by the Survey Team.

AEON, a leading Japanese supermarket that opened here in 2014, is one of the markets that sells low-pesticide vegetables. Other specialized retailers that sell such vegetables include NAV and Natural Garden. In recent years, the number of such stores has grown and competition has intensified, which has reportedly resulted in a declining trend in the profitability of ACs working on CF. The results of this survey have also confirmed that some ACs have abandoned the adoption of CF due to the complicated contractual procedures involved[26]. This and other such issues should be addressed in the future.

[23] As the term "organic" can be defined in many ways, its meaning has basically been incorporated within the term "low-pesticide vegetables" in this report.

[24] For details, refer to "Final Report on Feasibility Survey for the Establishment and Implementation of Food Safety Standards, and the Development of Inspection Business through the Public-Private Partnership in Cambodia," published by SPEC BioLaboratory, inc. (2019).

[25] Investigations were conducted in Svay Rieng Province on January 27, 2020, and in Phnom Penh on January 28, 2020.

[26] According to an interview conducted by the Survey Team on February 6, 2020.

Specialized retailers that handle low-pesticide vegetables

Natural Garden, which has multiple retail stores that sell low-pesticide vegetables in Cambodia, was featured alongside its Thai industry peers in an article published in "Food Navigator Asia" on August 8, 2018. The article points out that the need for low-pesticide vegetables is increasing in both countries, but high production costs remain a problem due to the high costs of fertilizers, organic seeds, and labor cost certification. According to the owner of Natural Garden, these high prices mean that 60% of its customers are Cambodian while the rest are foreigners.


(7) Characteristics of issues relating to vegetable VCs

The two most critical issues in efforts to improve vegetable VCs are as follows: 1) dealing with seasonal production and curbing imported vegetables; and 2) responding to the growing demand for food safety and quality, which is increasing mainly in major cities. To address these issues, consideration should be mainly given to modern production techniques (e.g., technical instruction on adjusting shipment timings), infrastructure development (e.g., establishment of collection sites), appropriate business models involving private companies (e.g., CF), and improved institutional design in relation to distribution and quality control (e.g., introduction of labelling regulations).

2.2.2 Pepper

(1) Basic information

In an examination of trends in the world's pepper market, it can be observed that, as shown in Table 2-4, Vietnam had the largest share of the volume of pepper production in 2018, producing about 273,000 tons, followed by Indonesia with about 88,000 tons and Brazil with about 80,000 tons[27]. According to the data

[27] For details, refer to the following URL: https://www.globaltrademag.com/global-pepper-market-is-expected-to-reach-840k-tonnes-by-2025/ (accessed March 4, 2020)

given in Table 2-5 on pepper exports in 2018, Vietnam exported about 142,000 tons, followed by Brazil with 73,000 tons and Indonesia with 36,000 tons. In contrast, Cambodia's export volume in 2019 was 1,760 tons[28]. In terms of export prices[29], global prices spiked between 2014 and 2016, driving the price per kilogram to as high as USD 8.7 in 2015. This prompted producers in Southeast Asian countries, such as Vietnam and Indonesia, to increase their production. As supply increased faster than demand, the price per kilogram fell to USD 5.2 in 2018, a decrease of more than 14% on the previous year.

Table 2-4 Leading Pepper-Producing Countries and Production Volumes (2018)

Ranking	Country	Volume (thousand tons)
1	Vietnam	273
2	Indonesia	88
3	Brazil	80

Table 2-5 Leading Pepper-Exporting Countries and Export Volumes (2018)

Ranking	Country	Volume (thousand tons)
1	Vietnam	142
2	Brazil	73
3	Indonesia	36

In terms of the consumption of pepper, three countries accounted for approximately 41% of global consumption, with Vietnam ranking first at 166,000 tons, followed by India at 86,000 tons and the United States at 68,000 tons.

According to Global Trade magazine, consumption is expected to grow stably at an average of 1.2% per year from 2019 to 2025[30]. Figure 2-7 below shows trends in the pepper production volume and the cultivated area in Cambodia from 2010 to 2019. The production volume increased substantially by about 13.5 times during this period, while the cultivated area increased by about 8.7 times. However, due to price drops in 2018 as mentioned earlier, production stagnated and the cultivated area remained unchanged for 2018 and 2019.

[28] According to the "Cambodia Pepper Sector Country Report 2019."

[29] For details, refer to the following URL: https://www.globaltrademag.com/global-pepper-market-is-expected-to-reach-840k-tonnes-by-2025/ (accessed March 4, 2020)

[30] As above.

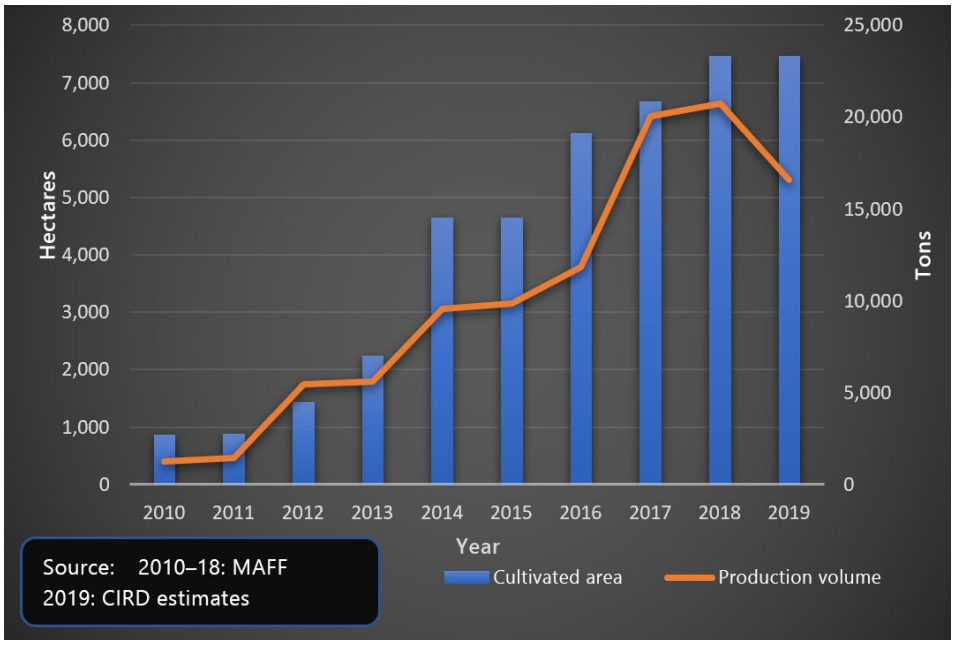


Figure 2-7 Trends in Pepper Production Volume and Cultivated Area in Cambodia (2010–2019)

Table 2-6 below shows a breakdown of pepper exports from Cambodia in 2019. As mentioned above, the total export volume in 2019 was 1,760 tons, which accounts for 10.6% of pepper production in 2019. Based on this export data, more than 90% of this production was ordinary pepper (grown with no reduction in the amounts of pesticides used) while the rest was products grown using reduced amounts of pesticides. Cambodian pepper is famous for its fruity aroma and good flavor, hence its high price on the international market. As mentioned above, its export price on the international market was USD 5.2 per kilogram in 2018, but the price of GI Kampot pepper, which has a geographical indication (GI), was about USD 15 per kilogram[31] and the price of non-GI varieties was also higher than international standards[32]. However, as described later, nearly 90% of pepper produced in Cambodia is believed to be shipped to neighboring countries such as Vietnam and Thailand in an unprocessed state[33], which poses a significant issue for the future.

[31] For details, refer to the following URL: https://chusepepper.com.au/cambodia-pepper-exports-of-2019/ (accessed March 5, 2020)

[32] According to an interview conducted by the Survey Team on January 22, 2020.

[33] For details, refer to Youssey Lak (2018): "Value Chain Analysis of Memot Pepper in Cambodia."

Table 2-6 Pepper Exports from Cambodia (2019)

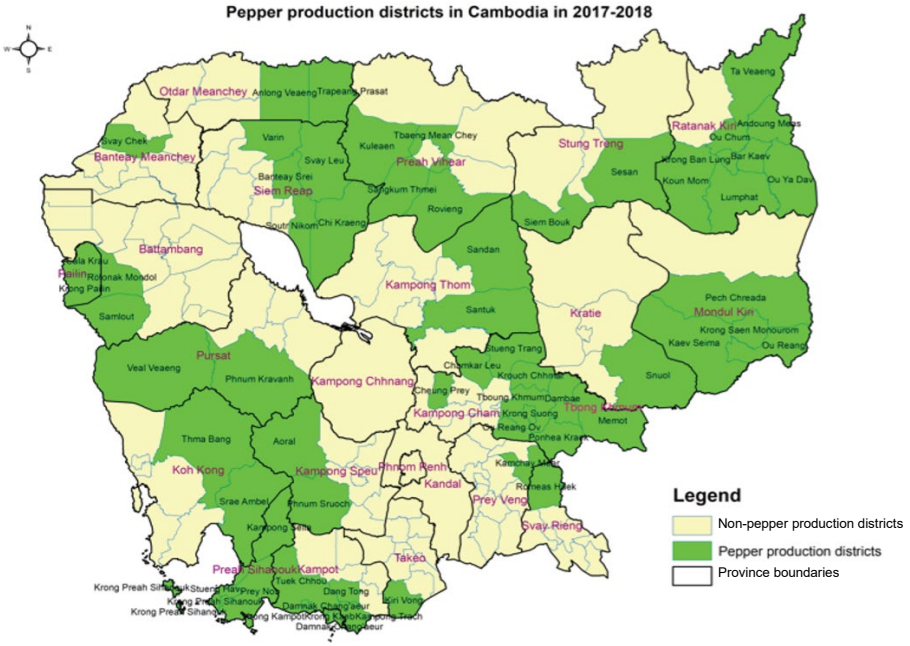
Pepper type	Export volume (tons)
Conventional pepper	1,600
Low-pesticide pepper	80
GI Kampot pepper	50
Low-pesticide Kampot pepper	30
Total	1,760

Source: "Cambodia Pepper Sector Country Report 2019"

Providing data on pepper production areas in Cambodia, Figure 2-8 below shows that this product is widely produced in 19 provinces[34]. It should be noted that Tbong Khmum Province, which is located in the southeast at the border with Vietnam, produces about 75% of the total. Tbong Khmum also hosts several manufacturers that operate processing plants and storage facilities. As mentioned earlier, Kampot pepper, which has acquired a GI, is produced in the southwestern province of Kampot. Pepper is also produced in northern regions, such as Preah Vihear Province and Odor Meanchey Province, and in northeastern regions, such as Mondulkiri Province and Ratanakiri Province[35].

[34] For details, refer to the following URL: https://www.khmertimeskh.com/9044/pepper-production-in-cambodia-to-increase/ (accessed February 29, 2020)

[35] SIM and HENG (2015) classified pepper farms with an area of less than 1 ha as small, 1 to 5 ha as medium, and 5 ha or more as large.



Source: Prak Sereyvath, Cambodia Pepper Sector Country Report 2019

Figure 2-8 Distribution of Pepper Production Areas in Cambodia

Tbong Khmum Province was selected for this survey as it is the largest pepper producer. As shown in Figure 2-9 below, the pepper VC in Tbong Khmum has four main channels.

1) The first channel (indicated first by green arrows and then by blue arrows in Figure 2-9 below) involves final products being produced in Cambodia by using domestically produced raw materials. A small portion of these final products is exported, with the rest being shipped to the domestic market for domestic consumption and the tourism sector. This channel accounts for less than 10% (approx. 7–8%) of total production.

2) The second channel is indicated by red arrows, with unprocessed pepper being collected domestically and then transported overseas by ship from Sihanoukville Port to overseas production or processing bases in Europe and other regions. This channel also accounts for less than 10% (approx. 2–3%) of total production.

3) The third channel (indicated by light blue arrows) accounts for about 30% of total production, with unprocessed pepper being collected domestically and then shipped by land to Thailand.

4) The fourth channel (indicated by yellow arrows) has the largest share at about 60%, with unprocessed pepper being collected domestically and then shipped by land to Vietnam.

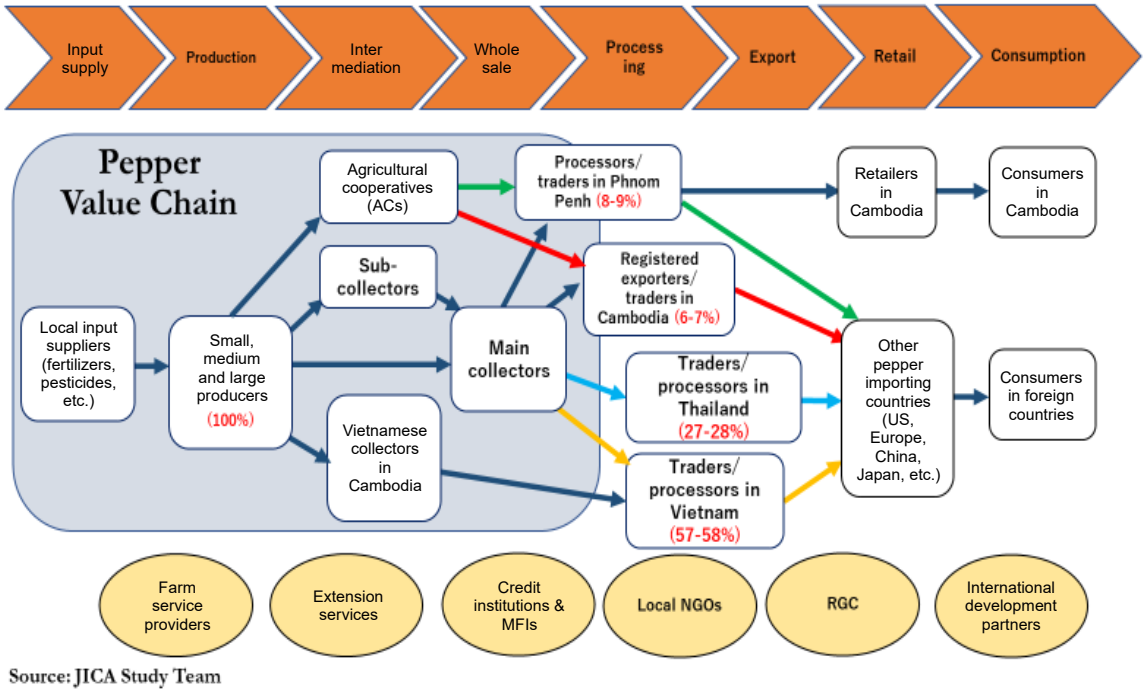


Figure 2-9 VC for Pepper

(2) Production (agricultural materials, production infrastructure, etc.)

As mentioned earlier, pepper production had been increasing since around 2010, but it began to slow in 2018 when the market price plunged and then entered a falling trend in 2019. In terms of changes in production, some leading processing companies have been expanding their operations in Tbong Khmum since several years ago[36], and they have undertaken a radical review of their raw material suppliers. These leading manufacturers expanded direct business with ACs and stopped making purchases from conventional collectors. Currently, these manufacturers procure raw materials from farmers through CF via ACs. The manufacturers issue instructions concerning production, including information on countermeasures for diseases and pests and the appropriate utilization of pesticides, to ACs and the farmers carrying out CF for them and provide them with post-harvest treatment techniques and other support through training. Overall, however, only a few farmers are able to enter into CF contracts. As is the case for vegetables, in order to increase the number of farmers that will play a central role in CF going forward, competitiveness and techniques need to be improved through various organizations (ACs) and the government needs to develop and disseminate CF guidelines.

[36] According to an interview conducted by the Survey Team on January 20, 2020.

	**Photo 2-7 AC in Memot District, Tbong Khmum Province** In this photo, members of an AC called the Cambodian Spice Agricultural Union are being interviewed. This association supplies pepper to leading pepper processing companies through CF. Their pepper is produced in accordance with 17 criteria (restrictions on the use of pesticides, maximum residue, etc.).
	**Photo 2-8 Freshly Harvested Pepper in Memot District, Tbong Khmum Province** This photo shows freshly harvested pepper in the yard of a collector's home. Collectors sun-dry it for a few days to reduce the moisture content. Most of the collected pepper is sold to Vietnamese traders, but some is sold to Thai traders.

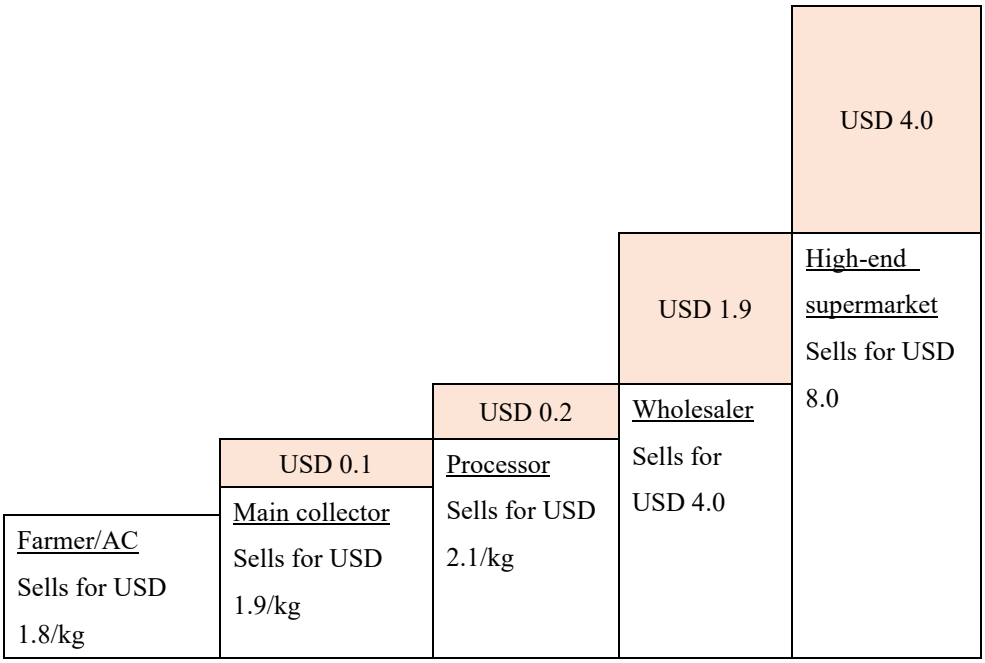
There have been many reports of an illegal influx of agricultural materials from neighboring countries[37]. According to an interview conducted by the Survey Team, illegal imports of such materials have decreased in recent years due to MAFF's management of code numbers indicated on the containers of agricultural materials[38].

In the mid-2010s, the market price of pepper was USD 10.5 per kilogram, but the price had decreased to between USD 1.8 and USD 1.9 per kilogram by 2020, greatly reducing the income of farmers. Figure 2-10 below shows the anticipated profits for each actor in the pepper VC. While the anticipated profits for the collector and primary processor are low, those for the wholesale market and high-end supermarket are high[39]. As mentioned earlier, however, most pepper is exported in an unprocessed state to neighboring countries, so considerable profits are considered to be lost.

[37] For details, refer to SIM and Heng (2015) and Youssey Lak (2018).

[38] According to an interview conducted by the Survey Team in Tbong Khmum Province on January 20, 2020.

[39] The anticipated profit for the farmer or AC is not shown here due to a lack of sufficient data on production costs, including labor costs.

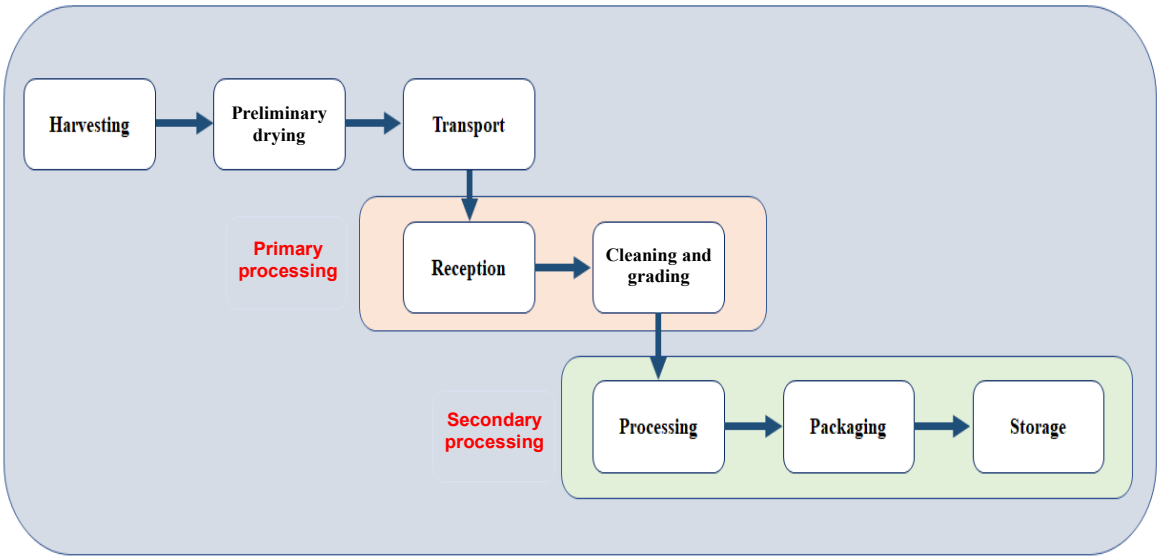


Source: JICA Team

Figure 2-10 Anticipated Profits for VC Actors from the Sale of Pepper

(3) Post-harvest treatment

Figure 2-11 below summarizes the processes performed in the standard post-harvest treatment of pepper. After harvesting, preliminary drying is performed to reduce the moisture content appropriately, after which the pepper is normally transported to factories or processing plants by trucks. As mentioned earlier, however, the quality often deteriorates during transportation due to an excessive loss of moisture resulting from exposure to high temperatures. For this reason, it is necessary to transport the pepper as quickly as possible. In the subsequent primary processing, the pepper is unloaded and weighed at the factory before being cleaned (removal of foreign substances) and sorted. At this stage, impurities (e.g., pebbles and leaf fragments) are removed and the pepper berries are then sorted to remove any that are outside the standard size range or deformed. In the secondary processing, the raw materials are input into processing equipment and then dehydrated by further drying them to produce pepper grains. After that, the pepper grains are ground to produce powdered pepper. In general, this processed pepper is then wrapped in a vinyl material. One of the purposes of packaging the pepper in this way is to prevent damage during shipping. Finally, the product is stored in a warehouse away from direct sunlight and at an appropriate humidity level. This is important because exposure to sunlight causes product discoloration while a high ambient humidity shortens the product's shelf life.



Source; JICA Study Team

Figure 2-11 Post-Harvest Treatment of Pepper

Leading processing companies have invested heavily in the necessary equipment and complied with international standards. The production processes used by Sela Pepper, Cambodia's largest pepper production company, include the following: 1) harvesting; 2) cleaning (removal of foreign substances); 3) sorting; 4) sterilization; 5) drying; 6) cooling (and grinding); 7) packaging; 8) storage; and 9) shipping. In 2015, the company established a processing plant and an inspection laboratory equipped with a washing machine and a superheated steam sterilization facility in Tbong Khmum. The company also made additional investments in grinding and packaging facilities. In 2017, Sela Pepper not only expanded its factories but also obtained HACCP, ISO 22000, and ISO 14000 certification for future exports to the international market[40].

In the post-harvest treatment, leading processing companies carefully monitor the room temperature and humidity level in their storage facilities because inadequate temperature and humidity control can lead to discoloration and flavor deterioration. Farmers who have been engaged to carry out CF deliver pepper to manufacturers via ACs according to CF standards. Since the number of farmers engaging in CF is actually very low, most farmers lack the necessary knowledge and technologies, including those related to room temperature and humidity control. Therefore, it is important to construct storage facilities that can control the temperature and humidity levels by utilizing government policy or private funds. At the same time, it is also

[40] For details, refer to the following URL: https://www.phnompenhpost.com/business/kingdoms-black-pepper-looks-international-market (accessed February 29, 2020)

important for the government to comprehensively strengthen the relevant knowledge and technologies possessed by farmers, including ordinary farmers who do not engage in CF.

(4) Logistics

Leading processing companies use heavy trucks to transport products while controlling conditions such as the temperature and humidity levels and paying attention to the product packaging. However, the cost of transporting products from the processing plant in Tbong Khmum to Sihanoukville Port is extremely high. In fact, this cost is reportedly as high as that incurred in transporting products from Sihanoukville Port to Europe by ship if the costs of various procedures (e.g., customs) are subtracted[41]. In addition, although they focus their production in Tbong Khmum Province, the country's largest pepper production site, these companies have made efforts to secure contracts with farmers from other provinces, such as Preah Vihear, Kampong Thom, and Mondulkiri, to diversify their sources of raw materials.

Because food safety has been regarded as crucial in international markets in recent years, leading processing companies in Cambodia are exploring various ways to develop their own domestic traceability systems. One of the companies interviewed in this JICA survey stated that it normally collects 1 kg samples of pepper from CF farmers and sends half of each sample to the company's inspection laboratory in Vietnam for quality testing. The other half is registered for traceability by using a QR code and stored in Cambodia. In general, three types of testing are used: (i) physical testing of the weight and volume of the foreign substance; (ii) chemical testing of the concentration and evaporative effect; and (iii) microbiological testing of the amount of salmonella (per 25 g of pepper) and the amount of colitis germ (per gram of pepper).

(5) Processing

Sela Pepper has invested an amount equivalent to more than JPY100 million, and it established its own processing plant in Tbong Khmum Province in 2015. Capable of processing approximately 1.5 tons per hour, the plant has obtained Good Manufacturing Practice (GMP) certification. In contrast, the German company Fuchs does not process any pepper in Cambodia. Instead, it sends raw materials procured by CF from pepper farmers in Tbong Khmum Province to its main factory in Germany for processing.

[41] According to an interview conducted by the Survey Team on January 22, 2020.

On the other hand, most of the pepper produced by farmers who do not engage in CF seems to be shipped by land to neighboring countries such as Vietnam and Thailand. However, huge funds are required for investment in processing equipment, as was the case with Sela Pepper. Consequently, farmers and ACs find it difficult to conduct the processing themselves. In addition, since many farmers depend on shipments to neighboring countries partly because of the insufficiently developed domestic market, Cambodian farmers are greatly affected by the price conditions in neighboring countries[42].

Types of pepper products and production methods

According to an article published on May 17, 2018, in the Phnom Penh Post, Cambodia's leading English language newspaper, the price per kilogram for Kampot black pepper was USD 15, that for of Kampot red pepper was about USD 25, and that for Kampot white pepper was USD 28. The reason for the higher prices of white and red pepper is that more labor is required in the cultivation, harvesting and processing stages and that this labor is reflected as an added value. When pepper is harvested, the ears are normally picked from the vine, and the yield from a single vine is about 2 kg in a dry state. Farmers harvest unripe (green) berries for black pepper, but they wait until the berries are completely ripe and red for red pepper. After the berries have been picked, they are dried for 3 to 4 days in the sun. White pepper is produced by removing the peel from ripe berries and then drying it. Although some leading processing companies sell white pepper and red pepper at present, they are few in number compared to those selling black pepper.

Source: https://www.phnompenhpost.com/business/price-woes-kingdoms-non-gi-pepper-farmers (accessed March 8, 2020)

(6) Sales and retail

Figure 2-9 above shows that about 8 to 9% of total production is destined for the domestic market while about 10% is exported. In the domestic market, pepper is sold mainly in high-end supermarkets. For example, Sela Pepper sells in 31 stores under a partnership with major supermarkets such as AEON[43]. The company is also proactively looking to grow its exports, so it has strategically obtained a Certificate of Origin from MOC as well as British Retail Consortium Global Standard (BRCGS)[44] certification to expand its export channels. Its main export destinations include India, the United States, New Zealand, Taiwan, Thailand, Germany, and Japan[45].

[42] For details, refer to the following URL: https://www.phnompenhpost.com/business/price-woes-kingdoms-non-gi-pepper-farmers (accessed March 8, 2020)

[43] For details, refer to the company's official website: https://selapepper.com/#top (accessed February 29, 2020)

[44] An international retailing standard established by the British Retail Consortium, BRCGS guarantees the quality and safety of food and compliance with operational standards and, due to this guarantee and the fulfillment of legal obligations by manufacturers, protects consumers. This standard is a requirement for retailers, manufacturers, and food and drink service providers.

[45] For details, refer to the following URL: https://www.phnompenhpost.com/business/kingdoms-black-pepper-looks-international-market (accessed February 29, 2020)

Even now, more than 85% of total pepper production in Cambodia is shipped to Vietnam and Thailand as a raw material. Although pepper has the potential to be developed as a souvenir in the tourism sector, the size of the domestic market remains small. Going forward, it is important for Cambodia to develop foreign markets and increase export volumes. The government will need to take the lead in continuing to work on issues such as expanding export markets, improving branding and public relations activities, and diversifying product lineups through public-private partnerships.

(7) Characteristics of issues relating to the pepper VC

One of the main issues relating to the pepper VC is that the majority of pepper is shipped to neighboring countries in an unprocessed state. Pepper is a type of agricultural product that is expected to be processed, so it must inevitably undergo processing until it is transformed into a product. It is through this processing that value is added to it and the price for the final consumer is set. Therefore, the long-term goal for a VC is considered to be enhancing processing techniques domestically while strengthening exports. One issue faced by producers is that they need to enhance product quality by improving stable technologies through various organizations (ACs) and conducting the post-harvest treatment jointly. Another issue is that VC needs to not only guarantee quality through organizations but also make CF more widespread so that farmers can secure shipping destinations in the future. To achieve this, the government needs to implement measures such as disseminating and strengthening CF guidelines.

2.2.3 Cashews

(1) Basic information

According to research conducted in Cambodia by the Survey Team on international market trends for cashews, the global trade volume for cashews in 2018 was 1.91 million tons while the market for raw cashew nuts (RCNs) is expected to grow at an annual rate of 8.6% based on estimates from figures for the past five years. Meanwhile, the global market for cashew kernels is expected to grow at an annual rate of 6.0%. In 2018, the top five RCN producers were Vietnam, India, Cote d'Ivoire, the Philippines, and Benin[46]. The international market for cashews is expected to grow at an average rate of 4.6% per year from 2020 to 2025[47],

[46] For details, refer to the following URL: https://www.globalnote.jp/post-5632.html (accessed March 1, 2020)

[47] For details, refer to the following URL: https://www.mordorintelligence.com/industry-reports/global-cashew-market (accessed March 8, 2020)

which promises to give rise to significant demand in the future. In 2017, the countries with the high consumption of cashews were India (302,000 tons), the United States (143,000 tons), Germany (36,000 tons), the Netherlands (17,000 tons), and the United Kingdom (16,000 tons).

Both Vietnam and India are leading exporters of cashews. In particular, Vietnam's cashew exports are increasing every year. As shown in Figure 2-12 below, Vietnam's export volume increased by 16.1% YoY in 2014, 8.5% YoY in 2015, 5.6% YoY in 2016, and 1.8% YoY in 2017. While the rate of increase in volume remained almost flat, the volume itself increased significantly in 2018 by 10.8% YoY. According to the Vietnam Trade Promotion Agency, the country exported 391,000 tons of cashews in 2018, with the United States, China, the Netherlands, the United Kingdom and Australia as the major export markets[48]. Going forward, demand is expected to be high in European markets such as the Netherlands, Germany, and the United Kingdom[49].

Figure 2-12 Export Volume for Cashews in Vietnam (2013–2018)

[48] For details, refer to the following URL: http://en.vietrade.gov.vn/index.php?option=com_content&view=article&id=2617:vietnams-cashew-nut-export-forecast-to-hit-us3-billion-in-2017&catid=270:vietnam-industry-news&Itemid=363e (accessed March 8, 2020)

[49] For details, refer to the following URL: https://www.cbi.eu/market-information/processed-fruit-vegetables-edible-nuts/cashew-nuts/europe/ (accessed March 8, 2020)

Even though Vietnam is the world's largest exporter of cashews, the country imported about 65% of its raw materials[50], including some produced in Cambodia, in 2018. As described below, it is estimated that over 90% of the cashews produced in Cambodia are shipped to Vietnam.

According to a document published by the International Finance Corporation (IFC) and the European Union (EU) (2010), an objective evaluation of the cashews produced in Cambodia can be presented as follows.

- The kernel production from shipped RCNs is about 24% to 28%, which is almost the same as that for Vietnam, and cashews produced in Cambodia tend to be bigger and more valuable than those from Vietnam.
- Cambodian cashews are easy to shell, so little value is lost during their processing as they do not suffer much damage.
- Cambodian cashews tend to obtain premium prices because they are cultivated using reduced amounts of pesticides.

Figure 2-13 below shows a map of cashew cultivation areas in Cambodia. Kampong Thom Province, Kratie Province, and Ratanakiri Province have more than 25,000 ha of cultivated land, followed by Kampong Cham Province with 20,000 to 25,000 ha, and Preah Vihear Province and Stung Treng Province with 15,000 to 20,000 ha.

[50] For details, refer to the following URL: https://www.oliveiraagint.com/single-post/2018/05/17/The-largest-exporter-in-the-world-Vietnam-still-imports-65-of-raw-cashew-nuts (accessed March 8, 2020)

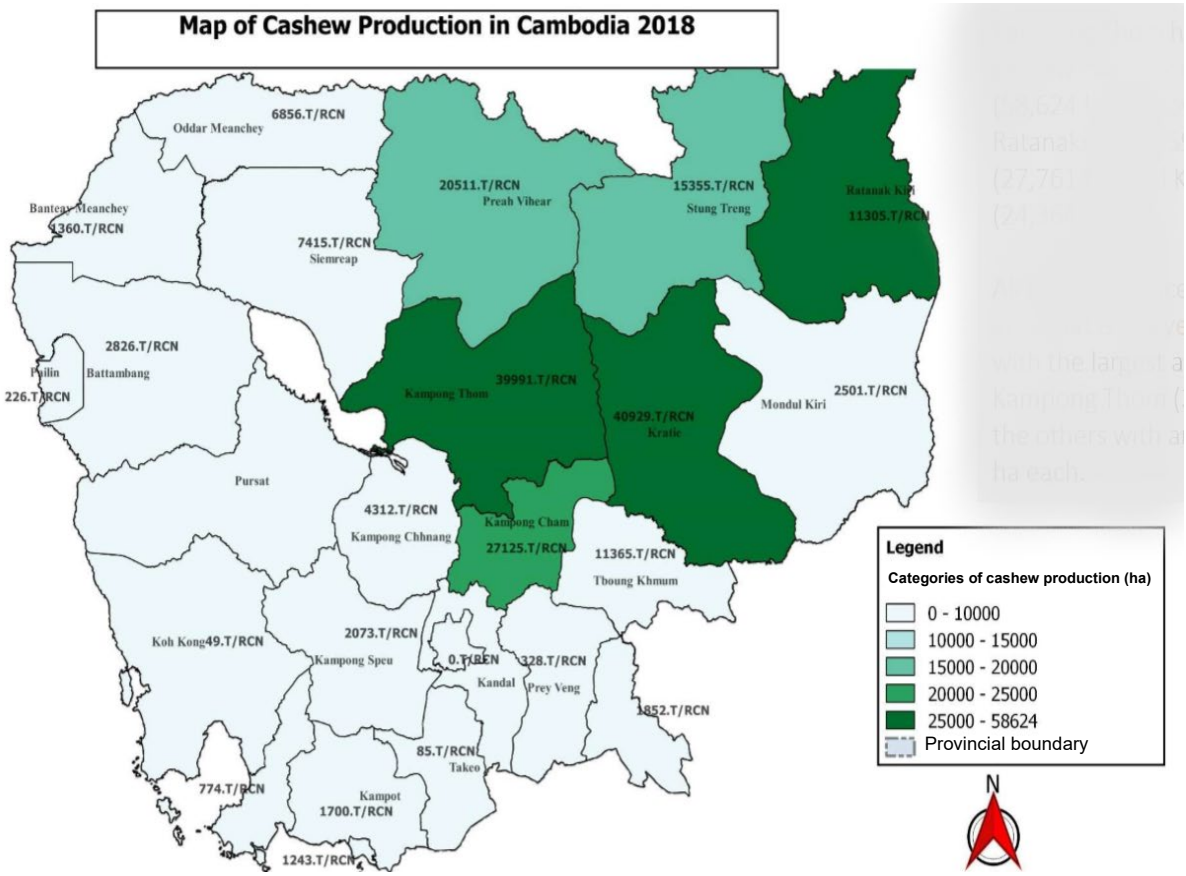


Figure 2-13 Map of Cashew Production in Cambodia (2018)

Figure 2-14 below shows trends in Cambodia's RCN production. The country's production in 2010 was about 69,000 tons and it fluctuated for a number of years thereafter. Since 2018, however, it has been on an upward trajectory, having reached 148,000 tons in 2018 and 180,567 tons in 2019 and being expected to rise to 244,568 tons in 2021. The Swiss aid organization HEKS (2019) reported that production doubled between 2017 and 2019 partly due to an increase in productivity secured through the widespread use of a new type of seed (described in the "Production" section).

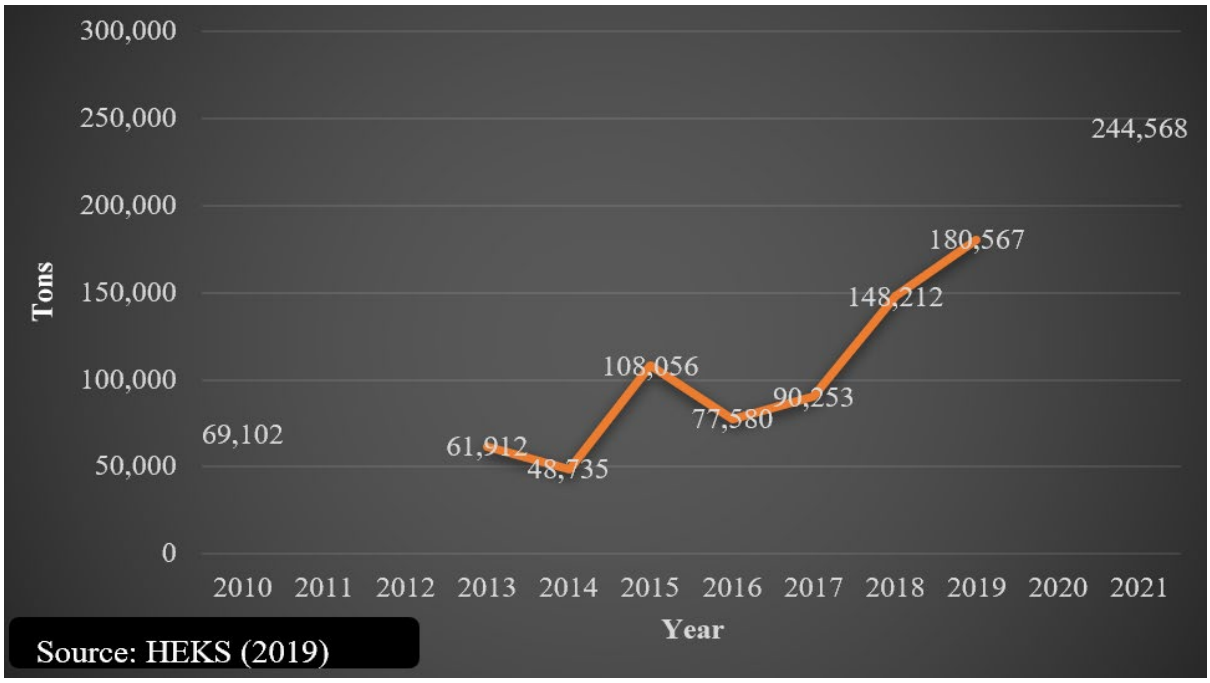
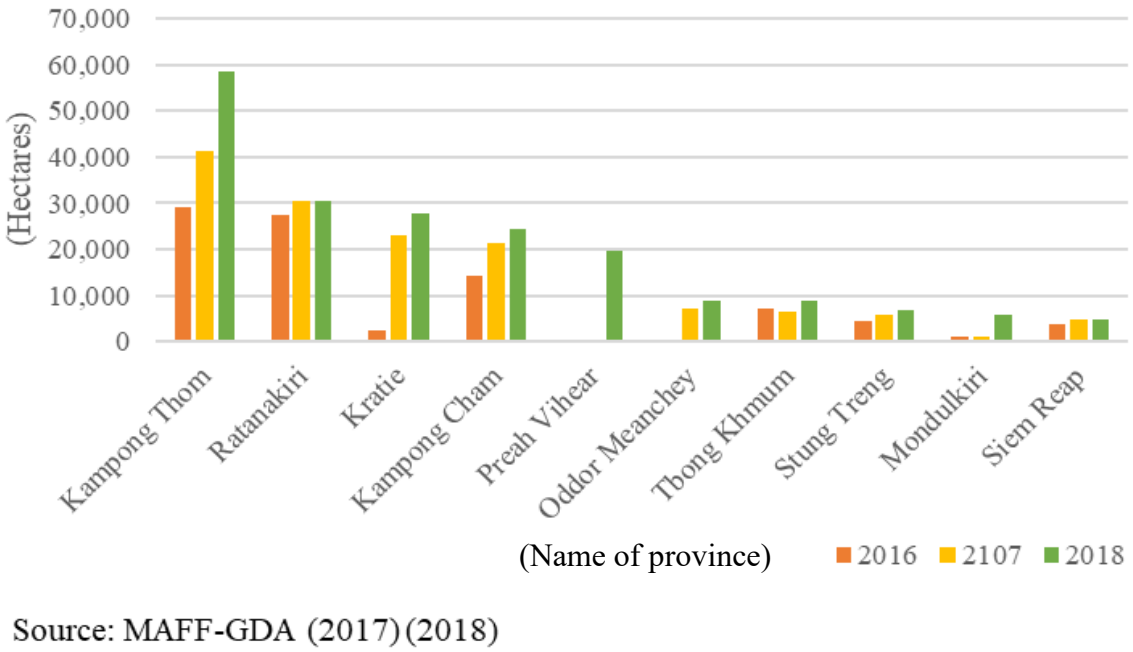


Figure 2-14 Trends in Cashew Production in Cambodia

Figure 2-15 below shows the top 10 provinces with the largest cultivated areas in 2016 to 2018. In 2016, Kampong Thom Province and Ratanakiri Province had the largest production areas in Cambodia. The former continued to show significant year-on-year increases of about 43% in 2017 and about 42% in 2018. The production area in Kratie Province increased by about 9.7 times from the previous year in 2017, while that in Kampong Cham Province increased steadily with a year-on-year rise of about 51% in 2017 and about 14% in 2018. Since the production areas in other provinces are also steadily expanding, cashew production in Cambodia is expected to continue to rise.



Source: MAFF-GDA (2017) (2018)

Figure 2-15 Top 10 Provinces with the Largest Cultivated Areas for Cashews (2016–2018)

Figure 2-16 below shows the classification of cashew producing farmers by land area. The most notable point is that nearly 80% of the total consists of small-scale farmers who own less than 5 ha of land (indicated in green in the figure), followed by those who own 5 ha or more but less than 10 ha (16%; indicated in blue in the figure). The smallest share is accounted for by farmers who own 10 ha or more (6%; indicated in yellow in the figure).

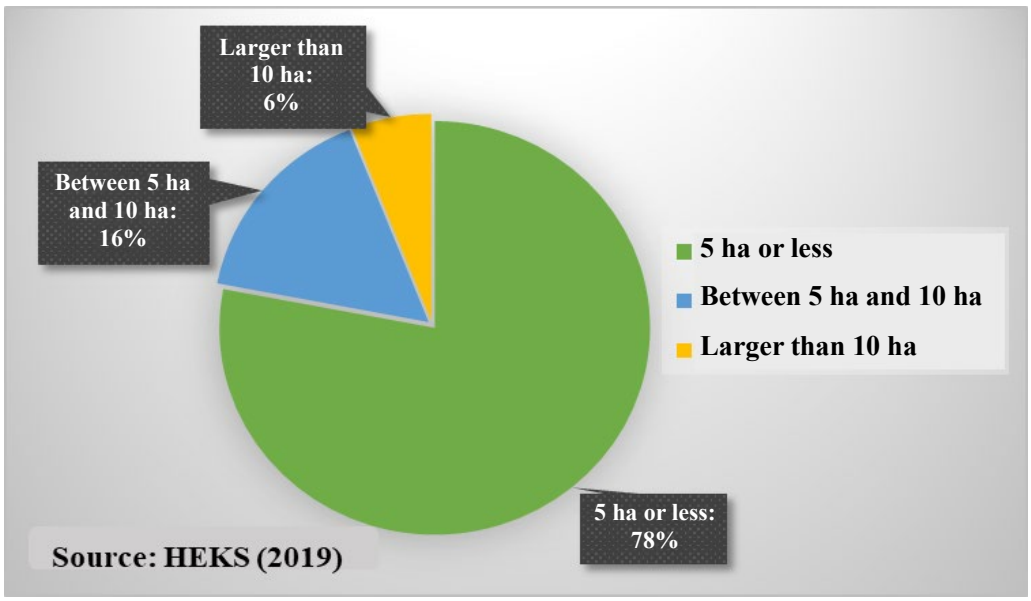


Figure 2-16 Classification of Cashew Producing Farmers by Land Area

Figure 2-17 below provides a more detailed breakdown of small farmers who own less than 5 ha of land, who account for about 80% of the total number of cashew producers. This figure shows that farmers who own 2 ha or more but less than 5 ha account for 51%, followed by those who own 1 ha or more but less than 2 ha (28%) and those who own less than 1 ha (21%).

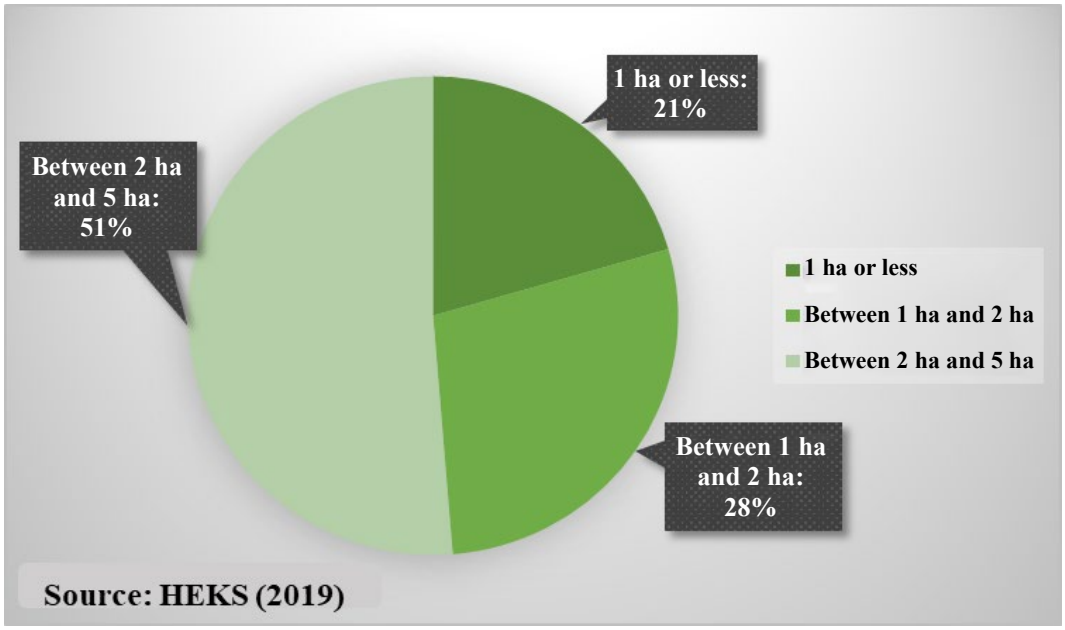


Figure 2-17 Breakdown of Cashew Producing Farmers Owning 5 ha or Less

Figure 2-18 below shows a cashew VC that encompasses all stages from the input of agricultural materials through to consumption. The following four main points should be noted in relation to the cashew VC: 1) about 90% of the total production volume for cashews is shipped from farmers (producers) to collectors; 2) about 97% of the amount that the collectors receive is shipped to wholesalers; 3) about 94% of the amount that the wholesalers receive is delivered to processors in Vietnam (this includes cashews that pass through traders in Vietnam); and 4) about 85% of the amount that processors in Cambodia receive is exported to wholesalers in Thailand, Korea, and other countries, followed by about 11% to wholesalers in Cambodia and about 4% to domestic retailers.

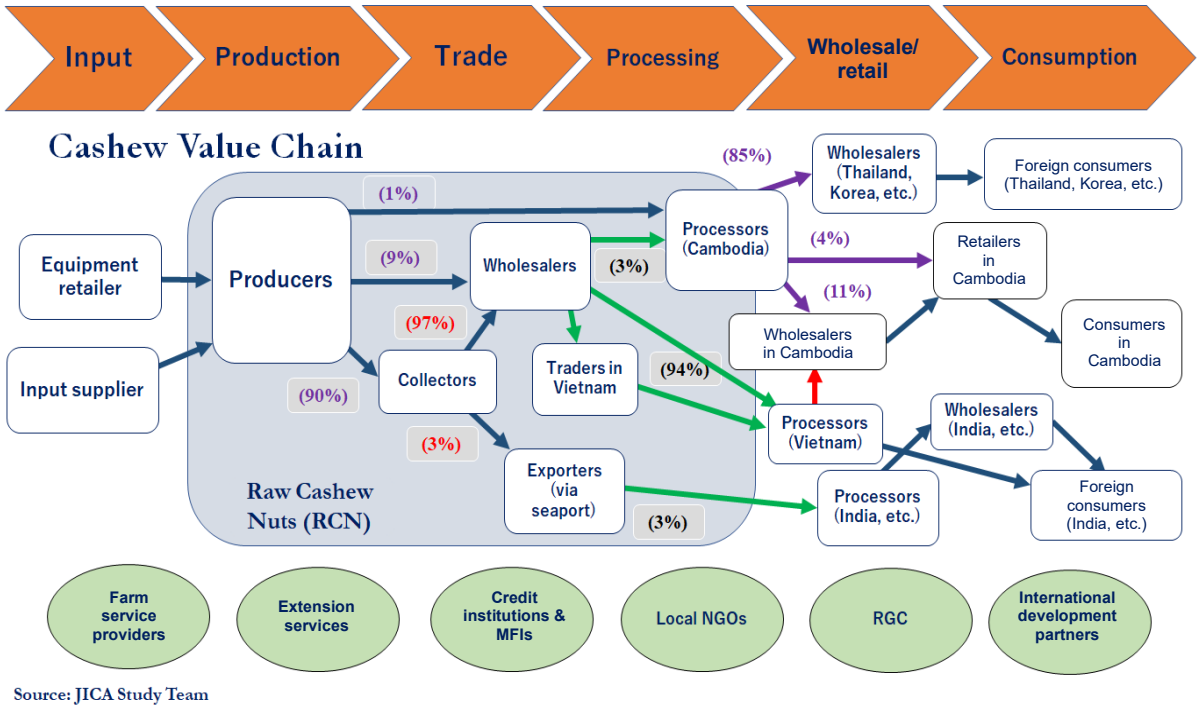


Figure 2-18 VC for Cashews

To calculate the lost profit for cashews produced in Cambodia[51], the production volume for 2019 of 180,567 tons, as shown in Figure 2-14 above, was used. Figure 2-18 above shows that at least 90% (approx. 16.7 million kg) of RCNs produced as raw materials in Cambodia are shipped to Vietnam and Thailand. As Figure 2-19 below shows, the price of cashews after secondary processing is USD 16.0 per kilogram. Therefore, the lost profit is USD 267.2 million (= approx. 16.7 million kg × USD 16.0). The red arrow in Figure 2-18 above indicates that RCNs produced in Cambodia are processed in Vietnam and then delivered to Cambodian wholesalers, which means that products that have already lost profits in Vietnam are being imported back to Cambodia.

(2) Production (agricultural materials, production infrastructure, etc.)

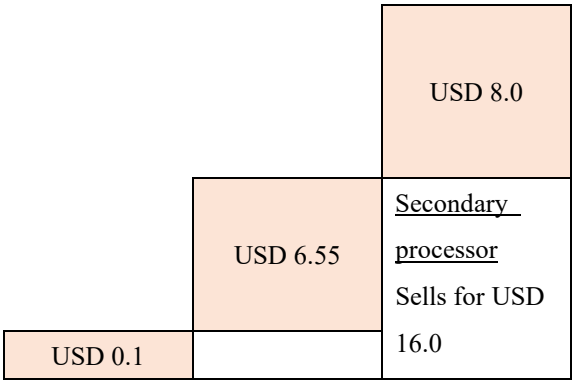
Cashew production tends to be greatly affected by the price of land. For example, 1 ha of land in a conventional cashew production area such as Kampong Cham Province costs between USD 10,000 and USD 20,000, while it would cost between USD 3,000 and USD 5,000 in either Preah Vihear Province or Kampong

[51] Calculated using the following formula: Lost profit ≈ (Product price – Raw material price) × Production volume, where Product price ≈ International trade price of cashews and Raw material price ≈ Farm gate price in Cambodia

Thom Province. The increased cashew production that has been observed in areas with low land prices in recent years is one of the factors behind the growth in production volume.

In terms of agricultural materials, as described in 3.5.2 “Status of Pesticide Use by Farmers,” farmers generally get their knowledge of pesticides from the sales staff at stores, but the staff do not necessarily have sufficient knowledge (e.g., a scientific understanding of the effects of using a mix of pesticides and other chemicals). As a result, when farmers use pesticides together with other chemicals, they often use a combination of products that may have different names but contain the same active ingredient. Consequently, specific active ingredients are often used in excessive quantities. If agricultural materials are illegally imported from neighboring countries, farmers may continuously use them without knowing the correct dosage as the instructions on the packages are written in foreign languages. This is another factor behind the excessive use of certain active ingredients. According to HEKS (2019), meanwhile, the M23 seed was introduced in Kampong Cham Province in 2006, before being widely introduced in other provinces from around 2010. Compared to traditionally used seed species[52], M23 is also preferred by foreign buyers due to its larger kernel despite its slightly higher price.

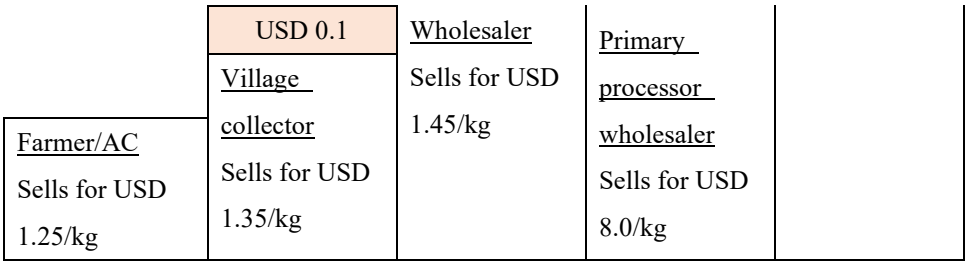
Figure 2-19 below shows the formal anticipated profits for each actor after cashew production in the cashew VC[53]. As this figure shows, the anticipated profits for both the collector and the wholesaler are as low as USD 0.1 per kilogram[54]. In contrast, those for the primary and secondary processors are relatively large at USD 6.55 and USD 8.0 per kilogram, respectively. As mentioned earlier, this suggests that Cambodia, a country that exports most of the cashews that it produces, has a large assumed profit loss in the subsequent distribution processes.



[52] The advantages of conventionally used seeds are their low prices (KHR 500–1,000/kg), the large yield per kilogram, and the reduced inconvenience in maintenance and management (e.g., pest control).

[53] The anticipated profit for the farmer is not shown here due to a lack of sufficient data on production costs, including labor costs.

[54] The anticipated profit for the farmer or AC is not shown here due to a lack of sufficient data on production costs, including labor costs.



Source: JICA Team

Figure 2-19 Anticipated Profits for VC Actors from the Sale of Cashews

HEKS (2019) shows that the average yield per hectare in 2018 was estimated about 727 kg based on a cashew cultivation area of 203,807 ha and a production of 148,212 tons. According to the information collected in Cambodia, it was estimated that the harvest per hectare in 2018 would be approximately 714 kg[55]. In the meantime, as shown above, about 78% of cashew producers are small-scale farmers who own 5 ha or less of land[56]. ADB (2016) identifies the following fact as the key factor behind this: many farmers lack the necessary production skills and knowledge. Therefore, there is a pressing need to strengthen the production skills and knowledge of farmers, especially small-scale ones. Specifically, as farmers cannot prevent diseases and insect pests appropriately because they lack sufficient specialist knowledge on pesticides and insecticides, the challenge is to provide them with technical instructions on the appropriate implementation of such measures[57]. However, it has also been pointed out that small-scale farmers failed to utilize a number of inputs of pesticides and fertilizers due to a lack of knowledge and financial resources, which actually resulted in the production of cashews using reduced amounts of pesticides[58]. Although the neighboring country of Vietnam is one of the world's largest cashew producers and one of the largest exporters of cashew kernels, it is often criticized for its inappropriate use of pesticides. This suggests that the continued production of low-pesticide cashews could be providing the country with its competitive advantage in international markets[59]. Meanwhile, the Cambodian MAFF and the Vietnam Cashew Association (VINACAS) signed a Memorandum of Understanding (MOU) on the promotion of cashew production in December 2017[60]. This MOU allows for the cashew export volume from Cambodia to Vietnam to be

[55] In contrast to Vietnam, the world's largest cashew producer and exporter, the production volume per hectare in Cambodia in 2014 was 1,181.7 kg. The yield per hectare was about 60% that of Vietnam. For details, refer to the following URL: https://vietnamnews.vn/economy/296772/plan-targets-higher-cashew-yields.html (accessed March 8, 2020)

[56] HEKS (2019) describes farmers who have 5 ha or less of land as "small-holder farmers."

[57] For details, refer to ADB (2019).

[58] Refer to ADB (2016).

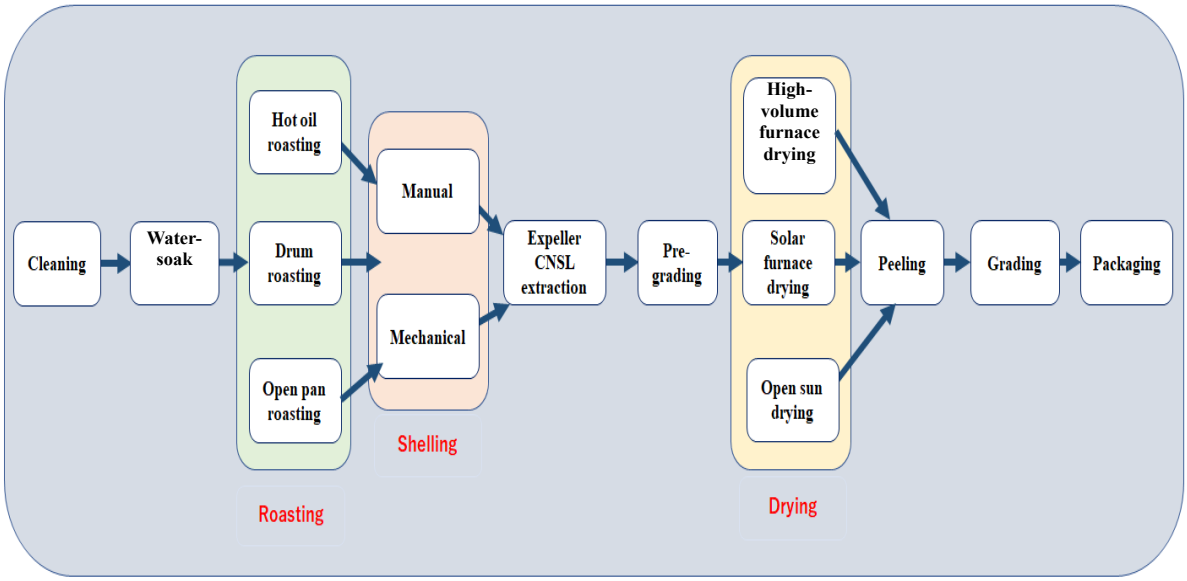
[59] Refer to ADB (2016).

[60] For details on MOU, refer to the following URL: https://www.khmertimeskh.com/95334/vietnam-bump-orders-khmer-cashews/ (accessed March 5, 2020)

increased to one million tons a year by 2028, the collection of RCNs, the transfer of drying technologies, and the construction of processing factories. According to the media, VINACAS also agreed to the promotion of CF and other such matters[61].

(3) Post-harvest treatment

Figure 2-20 below illustrates the various processes performed, from the post-harvest treatment of cashews to their commercialization. For cashews to be commercialized, a large number of processes need to be conducted. The main processing stages are "Roasting," "Shelling," and "Drying" (indicated in red in the figure). In particular, the degree of roasting has a significant effect on the taste and texture of the product in subsequent processes. As mentioned in the "Production" section, the roasting process is important as it offers an opportunity to add value to the product, but most cashews are shipped to neighboring countries in their RCN state at present.



Source: JICA Study Team

Figure 2-20 Cashew Processing from Post-Harvest Treatment to Commercialization[62]

Many quality management issues arise during the various post-harvest processes. In particular, RCN quality is affected by weather conditions, with frequent rain during the harvest season giving rise to a gradual decline in RCA quality, for example. When RCNs are left lying on the floor for several days after harvesting,

[61] For details, refer to the following URL: https://www.khmertimeskh.com/301893/demand-for-cambodian-cashews-on-the-rise/ (accessed March 5, 2020)

[62] In this figure, the abbreviation "CNSL" means "cashew nutshell liquid."

as can often be seen, their color turns from white to black. At present, when buyers purchase RCNs from farmers, the bagged RCNs are transported by truck or tuk tuk. RCNs are often damaged due to the impact caused by movement during transportation, so improvements should also be made to the transportation of RCNs. Furthermore, it has also been pointed out in relation to RCN sales that buyers discount the transaction prices based on their visual checks of RCNs if, for example, RCNs have a high water content or the grain size varies. In recent years, since traceability has been viewed as a critical factor on both the domestic and international markets, it is important to manage product quality comprehensively at each production site. On top of that, it is also important to conduct R&D into various issues related to post-harvest processes, such as transportation (e.g., how to avoid damage when loading the truck or cart), packaging (e.g., appropriate materials for packaging), and storage (e.g., appropriate temperature and humidity), and to strengthen the government and private institutions that disseminate related technologies and knowledge. At the same time, it is necessary to promote the strengthening of post-harvest treatment facilities, mainly through private investment.

(4) Distribution

In the current distribution process, wholesalers living in urban areas, such as provincial capitals, play an important role in cashew distribution and logistics. As can be seen in the figure showing a cashew VC, most of RCNs pass from collectors, who handle 90% of total production, to wholesalers. The wholesalers usually ship most of RCNs directly or indirectly through Vietnamese buyers to Vietnamese processors in compliance with contracts entered into with Vietnamese processors and buyers. Therefore, wholesalers need to adjust their shipping volumes in accordance with their respective contracts with Vietnamese processors and buyers, so many of them have their own storage facilities. In fact, some have large-scale facilities that can store up to 20,000 tons[63]. RCNs are dried in advance and then shipped in 80 kg bags. RCNs with a high water content are dried for a few days before shipment. At present, the storage facilities of private wholesalers play an important role in the cashew VC.

While wholesalers tend to be situated, as mentioned earlier, in provincial urban areas, small-scale collectors tend to operate closer to the farmers. These small-scale collectors procure around 4 to 5 tons a day. ACs play a similar role for their members in each region. On average, ACs produce up to 500 tons of RCNs

[63] According to interviews conducted in Cambodia, the income earned by wholesalers is between KHR 400 to 500 (approx. USD 0.1) per kilogram.

a year, but each cooperative often have only minimum equipment or materials such as weighing scales and packaging materials[64]. In addition, according to interviews conducted by the Survey Team, the cooperatives often complain that collectors can easily get price discounts because RCNs often have a high water content when they are shipped. The reason for these complaints is that the producers do not possess drying facilities, so they cannot dry RCNs sufficiently before shipment. To ensure that an acceptable water content is maintained and that transactions are conducted at stable prices, it is desirable for adequate collection sites equipped with drying facilities and storage facilities to be constructed by ACs or the relevant regions.

(5) Processing

According to HEKS (2019), as of December 2019, there were four semi-mechanized processing plants (indicated by red buildings in Figure 2-21 below) in the provinces of Tbong Khmum, Kampong Thom, Kampong Speu, and Kandal and seven manual processing plants (indicated by blue buildings in the same figure) in the provinces of Kampong Thom, Ratanakiri, Kampong Cham, and Kampot[65]. According to the report, the country's total processing capacity in 2019 was 26,000 tons, but its operational capacity in the same year was only 4,490 tons, or a utilization rate of 17.3%. The reasons for this are as described below.

- Lack of sufficient funds to purchase RCNs (raw materials)
- Lack of human resources capable of issuing instructions or workers who have appropriate processing techniques due to the limited number of cashew machine processing technicians
- Inability to increase the production volume due to difficulty finding export markets (buyers); in other words, the supply capacity cannot be increased due to an inability to secure sufficient demand in advance

[64] According to interviews conducted in Cambodia, shipping prices in 2018 ranged from KHR 4,000 to 5,000 (USD 1.0–1.25) per kilogram.

[65] The Survey Team for the "SDGs Business Model Formulation Survey with the Private Sector for Establishing a Value Chain and Securing High Added Value for Cashew Nuts in Cambodia" reported the presence of other processing facilities in Cambodia. To link these products to the market, it is desirable to conduct a survey aimed at identifying processing facilities in Cambodia.

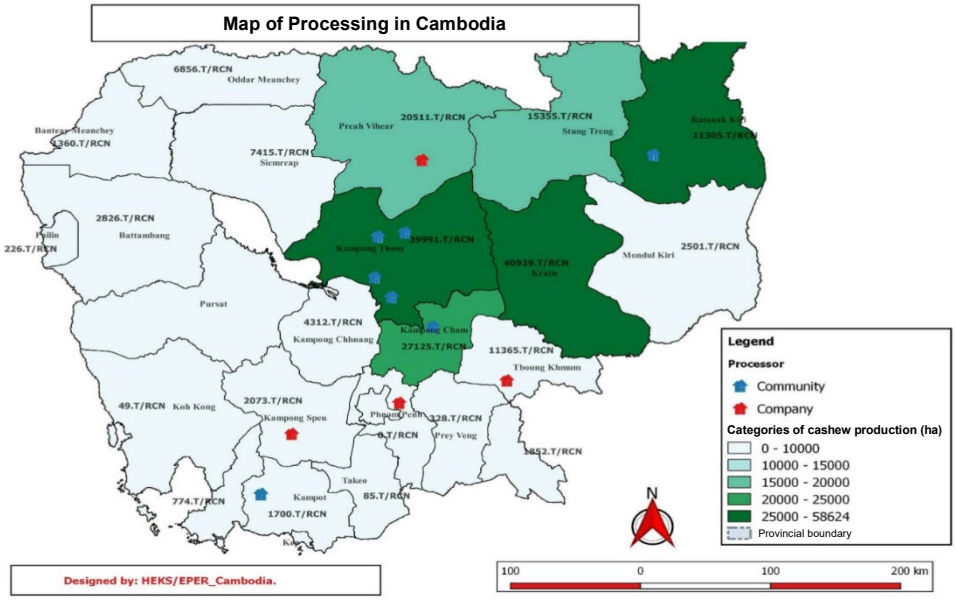


Figure 2-21 Location of Cashew Processing Plants in Cambodia

Photo 2-9 Cashew-Processing Plant in Svay Rovieng District, Preah Vihear Province

This picture shows the interior of a cashew processing plant located in the southern part of Preah Vihear Province. About 50% of its raw materials are purchased directly from farmers, 25% from ACs, and the rest from collectors. While its current export destinations are China and South Korea, the plant intends to expand into other export markets in the future.

(6) Sales and retail

As mentioned above, the international market for cashews is expected to grow at an average rate of 4.6% per year from 2020 to 2025. Cambodia's cashew industry has great potential, because its cashews are not easily damaged during processing and they could obtain premium prices due to the use of reduced amounts of pesticides. However, it seems likely that it will take several years to strengthen the country's processing capacity, because it takes time to promote investments in machines or facilities for processing and, as mentioned earlier, to foster human resources equipped with the necessary processing techniques.

Furthermore, several issues will likely need to be overcome for cashew exports to be expanded. As confirmed by Figure 2-20, it is desirable for primary and secondary processing to be conducted in Cambodia in order to increase domestic profits from cashew production, but the high processing costs in this country mean that many wholesalers have already entered into contracts with processing companies and trade companies in Vietnam and are engaging in business with them. As a result, more than 90% of RCNs produced in Cambodia are shipped to Vietnam, as mentioned earlier. Another challenge is that VINACAS has a strong influence on market prices.

In the domestic market, although Figure 2-18 shows that only 4% of cashews are shipped to domestic retailers, most of them are sold by businesses in the tourism sector in Siem Reap Province and other such locations. The national tourism sector sells cashews as souvenirs at between USD 16 to USD 18 per kilogram[66], so earnings are very high. Therefore, if recognition of Cambodian cashews is improved at home and abroad through product diversification and branding, there is a possibility that domestic profits may be increased. However, the overall picture shows that the size of the export market is considerably different from that of the domestic market. Therefore, if the government and the private sector work together to build a cashew VC (e.g., by constructing storage facilities) and strengthen its processing capacity in particular, the cashew sector can expect to enjoy large profits in both the domestic and international markets over the mid- to long term.

(7) Characteristics of issues relating to the cashew VC

Like pepper, cashew nuts are a type of agricultural product that is expected to be processed, so the state of its VC in Cambodia shares something in common with that of the pepper VC. Currently 90% of cashews are shipped to Vietnam and Thailand in their RCN state, so considerable profits are considered to be lost. However, as the processing and distribution system in Vietnam is already highly advanced, it is impossible to replace it immediately with a Cambodian equivalent. As a long-term strategy, then, it is necessary to strengthen the domestic system by, for example, constructing processing facilities.

Farmers lack sufficient techniques in areas such as disease and pest prevention with pesticides, and the considerable loss incurred in the subsequent post-harvest treatment and transportation is another pressing issue. To resolve this issue, it is considered necessary to develop systems that will allow each AC to conduct

[66] According to ADB (2019).

the post-harvest treatment appropriately with the aim of reducing losses and improving quality by shipping products after they have been sorted to eliminate damaged goods and adopting a grade classification system based on size and quality. At the same time, it is also important to develop a system in which high-quality products will be sold at high prices.

2.2.4 Issues Relating to the Establishment of Agricultural Value Chains

(1) Summary of issues relating to the establishment of AVCs

In the preceding sections, issues associated with establishing VCs for the target commodities of this survey (vegetables, pepper, and cashews) are discussed. Table 2-7 below summarizes issues specific to the respective commodities as well as shared issues.

Table 2-7 Specific and Shared Issues Associated with the Target Commodities

Commodity	Summary of issues
Vegetables	a) The rise in incomes among Cambodian consumers has been accompanied by a growing awareness of food safety and quality. However, consumer demands have not been met due to insufficient institutional frameworks, such as safety and hygiene standards and traceability. b) Largely because of the seasonal dependence of domestic production, large quantities of fresh food products have been imported from neighboring countries (particularly Vietnam), but effective countermeasures have yet to be taken.
Pepper Cashews	c) The post-harvest treatment techniques for these commodities are inadequate. In particular, the lack of processing techniques and facilities means that high-quality domestically produced agricultural products are shipped to neighboring countries such as Vietnam. As a result, Vietnam has become one of the world's leading exporters, while Cambodia has served as the primary harvest supplier to Vietnam[67]. Similar situations can be observed for rice and other such commodities, although they are not discussed in this report. These matters can be described as structural issues faced by Cambodia.
Shared issues	<u>Post-harvest treatment techniques and related physical infrastructure</u> d) These issues include post-harvest losses and quality degradation caused by inadequate post-harvest treatment techniques and physical infrastructure. <u>Institutional issues</u> e) Due to a lack of statistical data on domestic production, imports and exports, and markets, it has not been possible for measures and plans to be prepared or implemented based on objective data.

[67] Refer to ADB (2016).

	f) The institutional development of food safety and hygiene standards has been insufficient. g) A system in which product prices vary depending on quality and other such factors has not been developed. <u>Transportation and logistics</u> h) TA logistics infrastructure including the cold chain network has not yet been sufficiently developed. <u>Financial issues</u> i) Farmers and SMEs have lacked sufficient processing equipment and operation capital. <u>Production</u> j) Productivity and product quality are unstable because farmers lack sufficient knowledge of cultivation techniques. k) The structure of ACs is vulnerable. l) The system for supporting farmers, including the promotion of CF, is insufficient.

(2) Specific issues to be addressed

The above issues and the relevant government countermeasures are summarized in Table 2-8 below. From a short-term perspective, urgent issues can be roughly classified as follows: collection of data on production volume, distribution volume, import volume and export volume; securement of traceability; and development of guidelines for quality and hygiene inspections as well as infrastructure development such as agricultural roads to improve access. From a mid-term perspective, the establishment of a framework for sustaining VC system is required, including the development of the necessary national laws and regulations, policymaking aimed at attracting private companies, and discussions on the adoption of a subsidy system. From a long-term perspective, working together between public and private sectors are required, based on the above-mentioned infrastructure, to jointly conduct discussions on the adoption of special agricultural economic zones and the development of long-term market development plans and, most importantly, activities aimed at raising awareness among the people concerned (e.g., the provision of guidance on the appropriate use of pesticides to farmers, the provision of hygiene guidance to those engaged in distribution and wholesale, and the fostering of food safety awareness among consumers).

Table 2-8 Roles of Government in Each Stage of an AVC

VC stage	VC issues	Government roles				
		Information	Establishment of rules and systems	Support		
				Technologies	Infrastructure	Funds
Input (agricultural material store, etc.)	- Dependency on imports raises cost and quality control issues - Lack of sufficient knowledge and inappropriate use of agricultural materials among many farmers	• Publish information on registration information and safe use	• Ensure thorough implementation of pesticide quality inspections • Ensure thorough implementation of pesticide management systems • Strengthen monitoring of and guidance to agricultural material stores • Develop guidelines and manuals on appropriate use of pesticides	• Conduct R&D into new varieties with high adaptability to climate and soil and disease resistance • Cooperate with stores, ACs, etc. in providing guidance to farmers on appropriate use of pesticides and fertilizers	• Promote agricultural mechanization	• Attract private companies, including seed companies and pesticide manufacturers • Reduce costs by promoting joint purchasing through ACs
Production (individual farmer, AC, farmer group, etc.)	- Seasonal dependency of domestic production and resultant dependency on imports (vegetables) - Production of safe, high-quality crops	• Improve market access • Collect and organize producer information, data, etc. and organize	• Develop laws and guidelines on contract farming and promote contract agriculture	• Provide guidance on GAP • Provide guidance on AC operations • Provide guidance on production	• Develop large-scale irrigation and agricultural roads • Develop farmland irrigation	• Provide AC funds

	(vegetables) that can not satisfy market needs - Lack of production statistics for some commodities obstructs business matching (e.g. pepper and cashews) - Inadequate system for systematically producing and shipping agricultural products	statistical information • Publish standards on food safety and information on monitoring results	• Promote transparent price formation process • Set Maximum Residue Limit (MRL) • Establish and promote inspection verification systems, such as GAP • Develop guidelines and formats aimed at strengthening AC functions • Promote utilization of GI	techniques for shipment timing adjustment • Provide guidance on formulating business plans to ACs • Provide guidance on legal matters related to contract farming • Provide guidance on post-harvest treatment, etc.	• Develop market information disclosure system • Promote shared use of transportation (trucks, etc.) by ACs • Develop joint shipping facilities	
Distribution/ wholesale (local broker, middle man, wholesaler, retailer, carrier, etc.)	- Post-harvest losses and quality degradation observed due to insufficient development of the cold chain and local roads (domestic distribution) - Post-harvest losses and quality degradation observed due to inappropriate packaging for transportation - Lack of a system for the separate distribution of safe, high-quality	• Share information on market conditions, etc. • Disclose market monitoring results	• Set and operate standards (indication rules, standardization of shipping standards, etc.) • Introduce traceability system • Develop system for wholesale markets (price formation, collection and shipping, settlement, development of	• Provide guidance on skill improvements aimed at preventing damage during transportation (packaging, etc.)	• Develop logistics infrastructure (national and agricultural roads) • Develop public storage facilities as well as collection and shipping facilities • Establish cold chain network	• Promote and attract private investment

	agricultural products and general agricultural products - Lack of unified operational rules for wholesale markets (price formation, collection and shipping, settlement, information, hygiene, etc.)		laws and guidelines concerning food hygiene, and accumulation of operational know-how)			
Processing (primary processing, food plant, etc.)	- Post-harvest losses and quality degradation observed due to inadequate post-harvest treatment techniques and physical infrastructure - Insufficient processing capability means that most agricultural products are exported to neighboring countries as raw materials rather than final products (pepper, cashews, rice, etc.)		• Develop guidelines on hygiene guidance • Promote systems for hygiene management, such as HACCP	• Provide guidance on processing techniques	• Ensure stable electricity supply (ELC, special economic zones, processing complexes, etc.)	• Attract investment for adoption and promotion of innovative technologies • Provide preferential treatment for electricity prices
Retail (wholesale market, local market, supermarket, restaurant, etc.)	- Failure to raise awareness of quality standards and indication systems - As a result, failure to ensure that prices are set in accordance with quality and, except for in the case of few high-class food stores, failure	• Disclose market monitoring results	• Introduce price formation system in accordance with quality • Develop guidelines on hygiene guidance • Implement on-site inspections	• Provide hygiene guidance and training	• Develop market infrastructure	• Improve access to finance

	to meet growing food quality needs focused in urban areas		• Introduce traceability system			
Import/export (importer/exporter, quarantine, etc.)	- Procedures and fees for acquiring various types of export permits and licenses serve as a barrier to trade - Low processability of agricultural raw materials exported from Cambodia prevents the creation of sufficient added value - Difficulties associated with closing the gap over the short term on neighboring exporting countries that have established a significant lead by developing their logistics and securing sales channels - Difficulties associated with the management of unofficial trade with neighboring countries along national borders	• Develop import and export statistics	• Strengthen national border quarantine system • Develop export standards and plans and simplify procedures	• Develop quarantine officers	• Develop fumigation facilities, etc.	• Improve customs system

Source: Prepared by the Survey Team.

* Underlined text indicates countermeasures that are assumed to be short term (five years or less).

Based on the issues and government roles described above, the Survey Team has summarized government countermeasures for strengthening VC in Table 2-9 below by sorting them into the following six key ministries. For each issue, the name of the ministry that should take charge and a rough estimate of the period of time required to achieve it are indicated.

Table 2-9 Roles of Ministries in Relation to Classified Issues in an AVC

Area	Countermeasures	Period	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Water Resources and Meteorology (MOWRAM)	Ministry of Health (MOH)	Ministry of Commerce (MOC)	Ministry of Industry, Science, Technology and Innovation (MISTI)	Ministry of Tourism (MOT)
(A) Development of a database and information on production	➢ Develop a database on annual production volumes and monetary values, imports and exports, etc. ➢ Provide market information on the main commodities in the domestic and international markets Note: MAFF is engaged in developing statistical information based on data collected by the National Institute of Statistics (NIS).	Short term	◎					

Area	Countermeasures	Period	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Water Resources and Meteorology (MOWRAM)	Ministry of Health (MOH)	Ministry of Commerce (MOC)	Ministry of Industry, Science, Technology and Innovation (MISTI)	Ministry of Tourism (MOT)
(B) Formulation and implementation of food safety and quality standards and systems	➢ Formulate food safety and quality standards (short term) ➢ Implement on-site inspections for food business operators and introduce regulations and guidance based on the inspection results (medium term) ➢ Develop an inspection system for food quality and safety (medium term) ➢ Accelerate responses to market needs (safe, high-quality agricultural products) by promoting CF (short term) ➢ Strengthen traceability by establishing rules for quality and indication of origin (medium term)	Short to medium term	○		○	◎	○	○

Area	Countermeasures	Period	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Water Resources and Meteorology (MOWRAM)	Ministry of Health (MOH)	Ministry of Commerce (MOC)	Ministry of Industry, Science, Technology and Innovation (MISTI)	Ministry of Tourism (MOT)
(C) Strengthening of the production system	➢ Improve cultivation processes by promoting GAP (short term) ➢ Strengthen ACs by providing guidance on operations and business practices (short term) ➢ Provide guidance on production techniques to facilitate shipment timing adjustment (medium term) ➢ Develop infrastructure, including irrigation facilities and agricultural roads (short term)	Short to medium term	◎	○				
(D) Establishment of a system for strengthening techniques and facilities related to post-harvest treatment and processing	➢ Collect technical information and develop technologies related to post-harvest treatment and processing ➢ Support quality improvements and added value by providing technical guidance to private small and medium-sized food processing and distribution companies ➢ Attract technologies and funds from the private sector (medium term) ➢ Develop subsidized projects and financing systems at the national level (long term)	Medium to long term	○				○	

Area	Countermeasures	Period	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Water Resources and Meteorology (MOWRAM)	Ministry of Health (MOH)	Ministry of Commerce (MOC)	Ministry of Industry, Science, Technology and Innovation (MISTI)	Ministry of Tourism (MOT)
(E) Development of a transaction system in the wholesale market	➢ Establish policies and legal systems for operating and managing the wholesale market and formulate a step-by-step development plan based on Japan's Wholesale Market Law, etc. (medium term) ➢ Gradually develop the public wholesale market by using government and development partner funds (long term) Note: For the development of the wholesale market, it is necessary for MAFF to cooperate and coordinate with other concerned parties, including local governments and the Ministry of Commerce.	Long term	◎			?		
(F) Improvement of access to funds for establishing AVCs	➢ Provide short- and long-term funds through the Rural Development Bank, private banks, MFIs, etc.	Short to long term	◎					
(G) Retail	➢ Introduce a price formation system in accordance with quality and standards (long term) ➢ Strengthen regulations concerning inappropriate and/or incorrect indications (long term)	Long term	○			◎		

Area	Countermeasures	Period	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Water Resources and Meteorology (MOWRAM)	Ministry of Health (MOH)	Ministry of Commerce (MOC)	Ministry of Industry, Science, Technology and Innovation (MISTI)	Ministry of Tourism (MOT)
(H) Imports and exports	➢ Simplify the permit and licensing system for exports (long term) ➢ Develop standards and regulations for import and export (medium term) ➢ Strengthen the quarantine system for the importing of agricultural products from neighboring countries and develop data on imported goods	Medium to long term	○		○	◎		

Source: Prepared by the Survey Team.

(A) Development of a database and information on production

To appropriately plan and monitor agricultural policies and agriculture businesses, information on agricultural production, consumption, pricing, and trade needs to be periodically investigated and updated and then disclosed to the public. In Cambodia, an agricultural census was conducted first in 2013 and then again in 2019 (the results of the 2019 census have not yet been disclosed) to summarize information on matters such as agricultural resources (possession of agricultural land, irrigation, and agricultural roads), production conditions (major agricultural products, livestock products, and fishery products), and village populations. For the various production areas, however, information on matters such as commodity coverage, provincial data breakdowns, and update frequency is limited, so there is insufficient information to develop agriculture businesses with a focus on specific commodities. Furthermore, information on post-production distribution and processing as well as pricing is extremely limited. Particularly in terms of trade with neighboring countries, it is not possible to acquire information on trade and the unofficial distribution of goods across national borders because of the difficulties involved in managing the movement of people and goods along such borders. Nonetheless, it is important to develop an online database to allow such statistical information to be shared effectively.

Until now, statistical systems have been developed with the cooperation of the World Bank and FAO. Particularly in the Crop Diversification Programme run by the World Bank (2019 to 2025)[68], the development of information systems (Improving Agriculture Information Systems and Quality Control Management) is being conducted as one of the project's five key actions.

(B) Formulation and implementation of food safety and quality standards and systems

As mentioned earlier, given that consumer needs for food safety and quality have rapidly increased in recent years, the development of standards and systems that address these needs is a key issue. Since these needs are increasing among the middle and wealthy classes in urban areas, the following requirements need to be satisfied: 1) establishment and operation of food quality and safety standards; 2) production of agricultural products in accordance with these standards; and 3) monitoring, guidance, and regulation in relation to violations of the relevant rules (distribution of foods that are not compliant with the standards) at

[68] For details, refer to the following URL: http://documents1.worldbank.org/curated/en/371481535122607741/pdf/Project-Information-Document-Integrated-Safeguards-Data-Sheet-Cambodia-Agricultural-Sector-Diversification-Project-P163264.pdf

the time of distribution or sale. In this section, the current status and future direction for 1) are summarized here, while 2) is summarized in "(C) Strengthening of the production system" and 3) is summarized in "(E) Development of a transaction system in the wholesale market" and "(G) Retail."

For the development of food safety and quality standards, it is necessary to first establish the standards and then formulate rules concerning on-site inspections and guidance on observing the standards, allocate a budget and personnel for the enforcement of these rules, and finally actually apply the rules on site.

One problem in relation to the establishment of these standards is that the Food Safety Law, which is supposed to provide the legal basis for the standards, has yet to be enacted. The Cambodian government prepared a draft of this law in 2018 in cooperation with FAO, but it has not yet been adopted as a bill. Hopefully, the bill will be enacted in the near future.

Next, in relation to rules concerning on-site inspections and guidance on observing the standards, the Law on the Management of Quality and Safety of Products and Services, which was enacted in 2000 mainly by MOC, will provide the foundation for the legal framework. This law stipulates the need to provide appropriate indications of the quality and safety of commodities and services, including foods, and provides an outline of the regulations and guidance to be applied in conducting on-site inspections to confirm appropriate indications and responding to violations of the relevant law. However, regulations on conducting inspections and providing guidance in accordance with the above-mentioned outline have not yet been adequately developed, and the organization, personnel, and budget required to implement them are insufficient. As a result, at the market and retail level, information on the safety, quality, and origin of foods is handled only by some high-end markets and other organizations as part of their own efforts. Except for that, consumers cannot access such information at present.

The key point in the future formulation of the Food Safety Law is the streamlining of roles for the relevant ministries. For example, the above-mentioned Law on the Management of Quality and Safety of Products and Services stipulates the actions to be taken (business suspension, product recall, etc.) in response to violations of the law with the aim of ensuring the use of appropriate indications. From the viewpoint of food safety, however, the Food Safety Law also needs to stipulate similar measures, so it will be necessary to sort the various roles between these two laws.

In relation to this issue, the streamlining of ministries to be in charge of foods for each section of VC was clarified in Inter-Ministerial Prakas No. 868. This prakas summarizes the roles and a coordination system for the six ministries involved in food safety (MAFF, MIH, MOC, MOH, MOT, and MEF) with a view to preventing health damage that is attributable to food and enhancing the international competitiveness of Cambodian agricultural products. Further details are provided in the next section by looking at case studies involving multiple ministries.

(C) Strengthening of the production system

As mentioned earlier, the important issues in relation to the production stage for vegetable VCs in Cambodia are seasonal imbalances in production and harvests and the need to establish a system for producing safe, high-quality agricultural products. Each of these issues is described below.

- Establishment of a system for producing safe, high-quality agricultural products

  This system is achieved by matching farmers that possess the appropriate production techniques with private enterprises that are seeking safe, high-quality agricultural products. However, as mentioned in the previous section, conventional VCs in Cambodia face some fundamental issues (lack of standards for assessing and guaranteeing quality and a monitoring/regulation system for ensuring strict compliance with these standards). There is also a problem with the link between production sites and consumers. To resolve these issues, unconventional VCs that involve CF have now been established and, for the time being at least, this form of distribution is expected to be the mainstream approach. The following are some possible options for the direction in which the government should take in order to expand VCs for high-quality agricultural products through CF.

  - Strengthen farmer organizations: Promoting the formation of farmer organizations, such as ACs, enhances their purchasing power for agricultural materials, etc., levels out their production techniques, and increases shipment volume, thereby helping to expand shipping channels and promote the adoption of CF.
  - Improve farming techniques: By promoting the use of seeds based on characteristics such as the nature of the cultivation site and season, spreading the adoption of appropriate agricultural materials, and sharing practical cultivation techniques, it is possible to promote seasonally independent cultivation

systems and diversify the range of crops. GAP offers one possible means of systematically incorporating these techniques and incorporating them in quality assessments. Although the Cambodian government has formulated Cam GAP and is working to promote its dissemination, it is necessary to discuss its dissemination in conjunction with the expansion of markets that provide added value to safe, high-quality products, because these types of techniques place a heavy burden on the producers from a technological and labor perspective.

- Develop VC infrastructure: By developing production facilities such as net houses and small-scale irrigation facilities that use compact water pumps, it is possible to prevent diseases and pests and stabilize agricultural production. The development of collection and shipping center will allow multiple farmers to select, process, and ship their agricultural products in batches, strengthen their sales negotiation capabilities, and diversify their sales channels.
- Support CF: If matching is implemented between distributors and retailers and between supermarkets and restaurants while farmers promote CF with those parties involved in VC, the farmers can stably anticipate their profits even prior to production and systematically plant seeds for the following year. This also makes it easier for farmers to discuss investments for purposes such as scaling up their operations.
- Ensure effective coordination among the relevant MAFF departments: Coordination among the Department of Agricultural Extension, the Department of Agricultural Cooperative Promotion, the Department of Sanitary and Phytosanitary, the departments in charge of the various commodities, and other MAFF organizations allows a broad and effective approach to farmers to be taken.

➢ Adoption of technologies to address seasonally imbalanced production

- About 70% of vegetable production in Cambodia takes place during the dry season, possibly due to restrictions imposed by the hot and humid production environment. Since the country's domestic products are generally very palatable, it will be possible to expand the domestic product market once the production environment has been well developed. Therefore, efforts to introduce the technologies described below are feasible in production sites located near to districts with high consumption, particularly Phnom Penh and Siem Reap.

- Mapping should be performed for areas where production takes place during the rainy season, which is when production tends to decrease, and areas with access to water during the dry season that are suitable for the production and distribution of vegetables.
- With reference to case studies from neighboring countries, discussions should be held in relation to production techniques that can be applied even in hot and humid environments, such as the use of high ridges, the implementation of rain shield cultivation, and the introduction of varieties that are resistant to moisture damage.

➢ Production of safe, high-quality agricultural products and development of a distribution system by strengthening CF

CF falls under the jurisdiction of the Agro-Industry Development Office of DAI. In addition to promoting CF, the Agro-Industry Development Office provides support to ACs and other organizations in relation to zoning and agricultural land development processes in order to identify agricultural products with good potential and establish VCs for these products. In addition, the office is also carrying out the following initiatives.

- Strengthening of administrative services to support initiatives by private enterprises (coordinate with private initiatives in relation to agricultural support, production techniques, infrastructure development, etc.)
- Organization of farmers who actually engage in CF, strengthening of their operational capabilities, promotion of stable production, implementation of quality assurance, strengthening of coordination with the Department of Agricultural Cooperative Promotion, and enhancement of production capabilities in coordination with GDA
- Diversification of production (linked to diversification of market needs)

(D) Establishment of a system for strengthening techniques and facilities related to post-harvest treatment and processing

One issue that needs to be addressed in relation to post-harvest treatment is that, because farmers lack the appropriate knowledge and techniques and post-harvest treatment facilities have not been sufficiently

developed, large-scale losses are generated after the harvest. As mentioned in the section on post-harvest treatment in relation to vegetable VC analysis, vegetable losses of 25 to 40% are generated in the post-harvest treatment stage. Similar conditions can lead to quality degradation for pepper and cashews, as well. Therefore, it is necessary to disseminate appropriate post-harvest treatment techniques to farmers on a commodity basis. In terms of MAFF's response, while these losses are supposed to be handled centrally by DAI in accordance with the law, most of the losses are, in reality, handled by the Department of Rice Crop and the Department of Horticulture & Secondary Crop under GDA in a vertically structured division of responsibilities while DAI mainly handles crops that are not covered by those departments (pepper, cashews, etc.). DAI is also in charge of developing techniques for post-harvest treatment and processing in the Laboratory of Agricultural Products and Foods (LAPF), but a system for this has not yet been developed.

Similar to the case with post-harvest treatment, one issue that needs to be addressed in relation to processing is that the development of processing facilities is insufficient. In particular, since agricultural products that are expected to be processed (e.g., pepper and cashews) are shipped to neighboring countries in an unprocessed state, these products are inevitably supplied to collectors and buyers at low prices. In addition, as explained in the section on the anticipated profits for various commodities, since value is added to these products in neighboring countries after they have been processed, the biggest issue is that considerable profits are lost on the Cambodian side. To avoid such losses, these products would preferably be produced, processed, and sold (exported) in Cambodia, but processing them in Cambodia would be expensive because the necessary facilities have yet to be developed and the level of processing techniques is low, which makes neighboring countries relatively advantageous. Another issue is that the markets for canned foods, drinks, confectionery, and other products that are made in Cambodia by processing horticultural products (e.g., vegetables and fruit) are relatively small compared to those for pepper and cashews. According to distributor interviews conducted by the Survey Team, because the markets for processed products are small, the production of a single product in large quantities would result in large amounts of the product having to be disposed of because there is no adjustment function for surplus products that have not been distributed. Given this, it is considered important for the Cambodian government to promote the development of post-harvest treatment and processing facilities, mainly by attracting private sector investment, while also proceeding with the creation of markets for domestically processed foods and the development of processed products.

(E) Development of a transaction system in the wholesale market

As mentioned in (B) above, the food needs of consumers—particularly middle class consumers in urban areas—are gradually changing in pace with Cambodia's rapid economic growth. The safety of agricultural products is one area that is attracting particular attention. In the various production areas, there have been cases where actions such as the introduction of Cam GAP and the implementation of CF initiatives in coordination with high-end supermarkets have been taken. However, an examination of VC as a whole reveals that, in reality, the system for guaranteeing the distribution of safe, high-quality agricultural products, which covers issues such as the establishment and monitoring of food safety standards, the issuing of recalls for foods that violate the law, and the issuing of guidance and penalties to violators, is not functioning adequately.

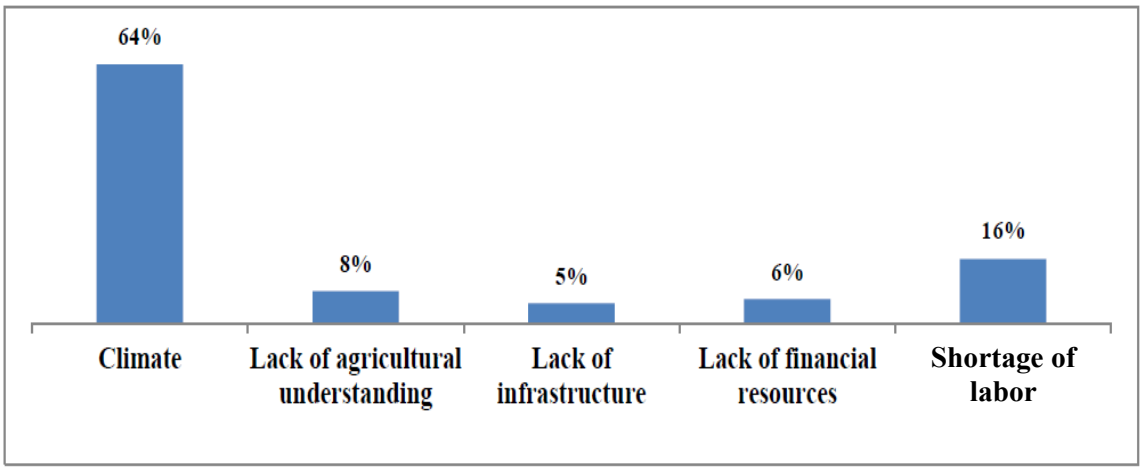
Furthermore, the price formation process between farmers and collectors or distributors, between collectors or distributors and wholesalers, and between wholesalers and retailers are basically conducted through direct negotiations, which means that information on market needs and prices is not shared sufficiently among the parties concerned. This situation gives rise to problems such as the following: farmers lack adequate negotiation skills during price negotiations so they are forced to sell their products at the prices offered by the collectors; and production is not conducted promptly in response to market needs. Furthermore, many conventional wholesale markets lack a hygienic environment and a waste disposal system, which raises waste and food hygiene issues.

One indispensable approach to addressing these issues is the development of wholesale markets. The aim of developing wholesale markets is to modernize the entire market transaction system by, for example, promoting efficient distribution (collection, sorting, and shipping), developing a hygienic environment, collecting and sharing market information, introducing a fair and transparent transaction system, and introducing a quick settlement system. This approach must be taken in a step-by-step manner based on a mid- to long-term strategy. In Cambodia, it is necessary to first review the current market system and then develop a roadmap that envisions how the market system should develop in the long run.

(F) Improvement of access to funds for establishing AVCs

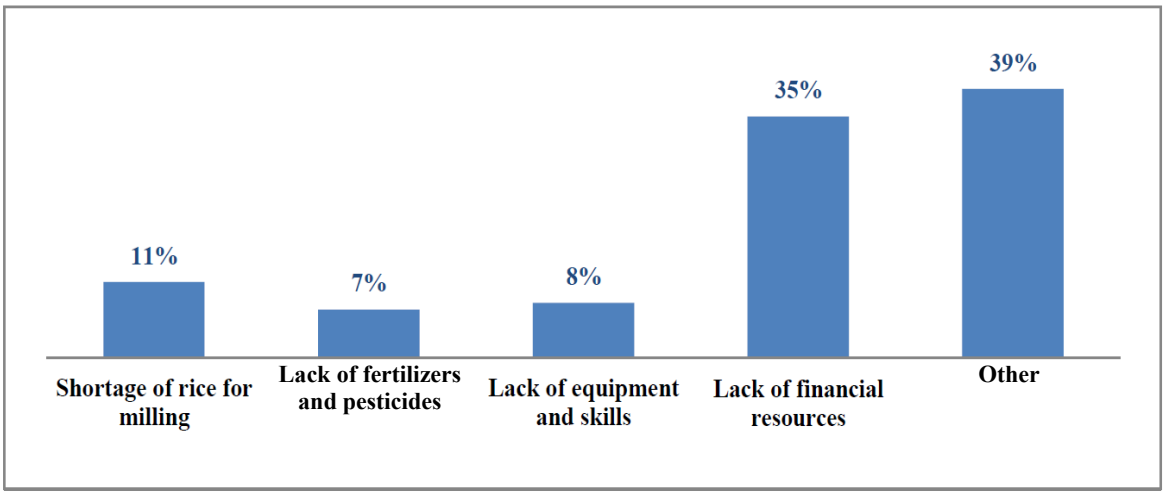
In Cambodia, the supply of funds is not bad because many banking institutions are developing services. However, funding for the agricultural sector, particularly small-scale agriculture businesses, is still limited.

According to the National Bank of Cambodia (2016)[69], 80% of financing is concentrated on rice and only 20% is allocated to other commodities. According to an investigation, the biggest issue that rice millers face in their business operations is securing access to funds. This differs considerably from the biggest issue cited by rice farmers, which is droughts, floods, and other problematic weather conditions.



Source: Research Paper on Agriculture Financing, 2016, National Bank of Cambodia

Figure 2-22 Problems Faced by Rice Farmers



Source: Research Paper on Agriculture Financing, 2016, National Bank of Cambodia

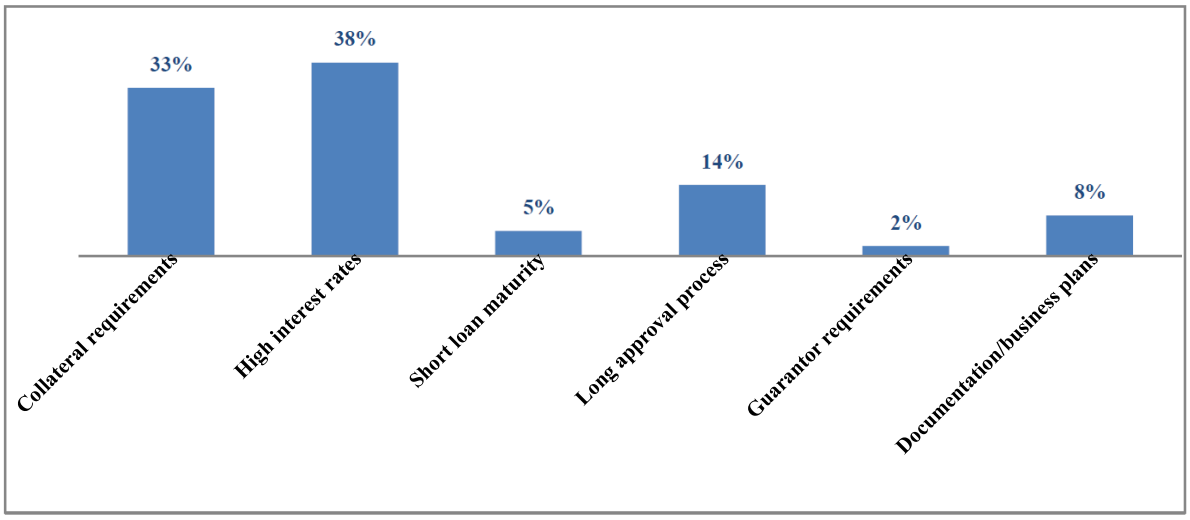
Figure 2-23 Problems Faced by Rice Millers

This reflects a situation where distributors who purchase agricultural products from a large number of farmers and make their profits by distributing and selling them in large lots require a higher initial investment

[69] Research Paper on Agriculture Financing, 2016, National Bank of Cambodia

and operational funds than farmers who sell their own products in small lots. For the strengthening of VC, access to funds dedicated to distributors is a particularly pressing issue.

An examination of funding sources suggests that bank financing is used by businesses that require a relatively large investment, while micro credit loans are used for small-scale financing related to the input materials and living expenses of the farmers. In both of these cases, the bottleneck to accessing funds is the high interest rate (approx. 10%) and availability of security[70]. This high interest rate reflects the rapid economic growth (7–10%) that Cambodia has experienced in recent years. In other words, it is difficult for businesses to attract investment from the private sector and achieve growth if they are not expected to achieve profit rates of around 10%.



Source: Research Paper on Agriculture Financing, 2016, National Bank of Cambodia

Figure 2-24 Issues Relating to Bank Financing and Micro Credit Loans

To strengthen VC by improving access to funds under these circumstances, it is necessary to implement the following initiatives: 1) lighten the burden of a high interest rate by developing facilities through subsidized projects and strengthening the public financing system; 2) improve access to funds by providing guidance to farmer organizations on the preparation and implementation of business plans; and 3) promote business matching by sharing the needs of actual consumers and production site information and improve the investment environment.

[70] Research Paper on Agriculture Financing, 2016, National Bank of Cambodia

Having already been implemented with support from the World Bank[71], these initiatives should be leveraged to develop an environment that will finally allow investments to proceed autonomically on a business basis.

(G) Retail

Although there was no opportunity to conduct an in-depth investigation of retail in this survey, a conventional distribution and sales system cannot, as mentioned in (B) and (E) above, adequately address the potential needs associated with safe, high-quality foods. As a result, these market needs are addressed only in relatively niche markets where agricultural products are shipped directly from the production sites to limited high-end markets through CF. It is necessary to modernize the entire VC through the initiatives described in (B) and (E) above over the mid to long term, but a step that is considered important over the short term is to start expanding shipments to high-end markets through CF, which is currently working, and then accumulate some success cases.

For example, the relevant ministry or agency should establish a system for cracking down on cases where agricultural products labelled with indications of origin, which is common practice in high-end supermarkets such as AEON, are found to provide false information.

(H) Imports and exports

A description of imports and exports is omitted here, because they were not included within the scope of investigation for this survey.

(For example, according to some Japanese-affiliated companies operating in Cambodia, the acquisition of permits and licenses and the payment of fees for food exports must be executed a number of times for various authorities, which hinders promoting exports. Therefore, MOC and other concerned parties may need to promote a review and simplification of the approval and licensing system.)

One possible option for guaranteeing the safety of imported agricultural products is to develop quality and safety standards, strengthen the quarantine system for imported agricultural products in accordance with these

[71] For details, refer to the following URL: https://projects.worldbank.org/en/projects-operations/project-detail/P163264

standards, collect data on imported agricultural products at the time of quarantine, and then develop a database on imported agricultural products in the future.

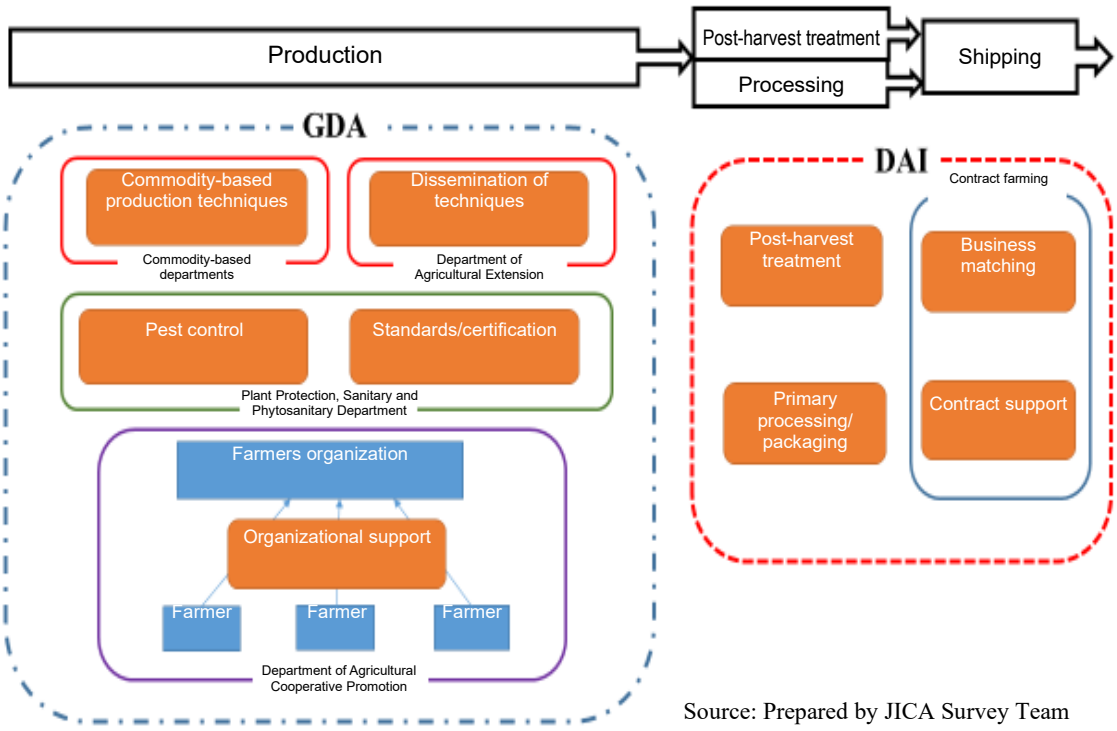
(3) Division of roles among relevant ministries and agencies in relation to the strengthening of AVCs

So far, issues relating to vegetable, pepper, and cashew VCs in Cambodia have been summarized and their classifications and the necessary government actions have been described. Some of these issues require coordination among multiple MAFF departments, while others require coordination among multiple ministries and agencies. The reason for this is that issues relating to AVCs consist of various stages, including production, distribution, and sales, and the issues cannot be improved unless the roles and coordination of the concerned parties in each stage are reviewed as a set. Three issues are described below as specific examples.

(i) Strengthening of production

In Cambodia, agricultural production initiatives fall under the jurisdiction of MAFF. This ministry consists of a variety of different departments, including the following: departments engaged in work related to paperwork and administration, such as the Department of Planning and the Department of Accounting Affairs; departments engaged in work related to the fields of agriculture and forestry, such as the Department of Rice Crop and the Department of Forest & Forestry Community; departments engaged in work related to the field of fisheries, such as the Department of Aquaculture Development. If, for example, the focus is on vegetables, which is the target of this VC analysis, the Department of Extension will provide technical guidance to farmers at the production site in cooperation with PDAFF of the local government, while the Department of Agricultural Cooperative Promotion will promote farmer organizations and provide support for the strengthening and systemization of AC functions. The Department of Sanitary and Phytosanitary is in charge of applying sanitary and phytosanitary (SPS) measures and conducting inspection certifications for Cam GAP. Departments that are divided up on a commodity basis, such as the Department of Rice Crop, the Department of Horticulture & Secondary Crop, and the Department of Industrial Crops, are engaged in the provision of production support through technical guidance dedicated to specific commodities. As mentioned in (C) above, DAI is in charge of processes ranging from the harvesting of agricultural products to primary processing. More specifically, it is engaged in the provision of support for CF (preparation of guidelines for matching and CF), post-harvest treatment, primary processing, and quality control through all of these

processes. The figure below shows a simplified depiction of the division of roles, with GDA mainly in charge of production and DAI mainly in charge of post-production areas. To improve VC and enhance the added value, appropriate administrative services must be provided in each of the stages ranging from production to distribution and consumption. In the various initiatives explained above, MAFF departments play their respective roles. To provide more effective support for farmers, MAFF departments need to provide comprehensive services through interdepartmental coordination.



Source: Prepared by JICA Survey Team

Figure 2-25 Division of Roles among MAFF Departments in Relation to the Strengthening of Processes Ranging from the Production to the Shipment of Agricultural Products

(ii) Food safety

As explained earlier, an AVC is a broad concept that covers processes ranging from production to consumption. To establish an improved AVC system that offers greater stability, it is important to take a comprehensive approach to various issues, including improvement of production techniques, infrastructure development, market access, food safety, border controls, and quarantine. To this end, it is necessary to clarify the roles to be played in each stage under the law. The following table provides a summary of the laws applicable to each stage of an AVC in Cambodia and a description of their current statuses.

Table 2-10 Summary of Laws Applicable to Each Stage of an AVC in Cambodia and Their Current Statuses

Issue	Status of development of corresponding bill
Establishment of food safety standards	A draft of the Food Safety Law was prepared in 2018 with the cooperation of FAO, but it has still not been approved yet. DAI is preparing an another draft of a bill on food safety, as well.
Securement of safety for agricultural materials	The Pesticide and Fertilizer Law, which was formulated in 2012, stipulates that information on safety (acute and chronic), safety during use, and environmental considerations is a prerequisite for registration. MAFF conducts examinations based on this stipulation, registers pesticides, conducts on-site inspections of pesticide distributors and sellers, and issues guidance as necessary. Details on the examination procedures were not confirmed in this survey.
Preparation of usage standards for the agricultural product production stage	The Pesticide and Fertilizer Law stipulates that responsibility lies with the pesticide user if the surrounding environment, or the general public suffer harm. However, at the field level, some farmers do not necessarily have sufficient knowledge of how pesticides should be used appropriately. Therefore, disseminating information on and raising awareness of the appropriate use of pesticides is considered an important issue going forward. However, following the government's approval of a standard concerning GAP in 2010, technical guidance on this standard was promoted and, in 2016, the unified brand and logo "Cam GAP" was developed. Under the five-year plan that has been in place since 2017, initiatives such as seeking harmonization with ASEAN GAP and disseminating information on Cam GAP throughout the nation are being implemented.
Support for the development and introduction of quality control techniques required for distribution to meet food safety standards	The development status and implementation status for laws and regulations concerning HACCP were not confirmed in this survey.
Development of rules for indications concerning quality and standards	The Law on the Management of Quality and Safety of Products and Services established by the Ministry of Commerce stipulates that all manufacturers, distributors, and sellers must provide appropriate indications of quality, respond in the event of a violation of the law, and meet other such requirements with a view to protecting the consumer (health and safety).

Introduction of system for conducting monitoring and inspections to confirm compliance with the standards	The Law on the Management of Quality and Safety of Products and Services stipulates that inspectors designated by the Ministry of Commerce must conduct on-site inspections and sample collections and provide guidance based on the inspection results. However, the Factory Law, which falls under the jurisdiction of the Ministry of Industry and Handicraft, stipulates that all manufacturers, including food processing companies, must be subject to on-site inspections conducted by the Ministry of Industry and Handicraft and receive guidance from the ministry based on the inspection results under the same law. Therefore, it is unclear how roles are shared between these ministries with respect to manufacturers that are designated by the Ministry of Commerce and manufacturers that are subject to the Factory Law.

Coordination with MAFF as well as other ministries and agencies is an important point in relation to the above-mentioned comprehensive approach to issues associated with AVC. For food safety in particular, there is a wide variety of relevant fields. As a specific example of an inter-ministerial prakas (decision) concerning this issue that multiple ministries and agencies are involved in, Inter-Ministerial Prakas No. 868 is explained in Table 2-11 below. As mentioned in (B) above, this prakas summarizes the roles and a coordination system for the six relevant ministries with a view to preventing health damage that is attributable to food and enhancing the international competitiveness of Cambodian agricultural products. Basically, for each step such as production, primary processing, secondary processing, sales, consumption, and import/export, the ministry in charge and its roles and responsibilities are specified.

Table 2-11 Roles of Relevant Ministries in FVC in Cambodia (Inter-Ministerial Prakas No. 868)

Name of ministry	Roles and responsibilities
MAFF	➢ Prepare safety policies for agricultural products and primary products. ➢ Conduct on-site inspections and provide guidance to private enterprises concerning agricultural production and primary processing. ➢ Certify the quality and safety of export agricultural products. <u>Agricultural products</u> These products include farm products, aquatic products, livestock products, and animal products caught by hunting.

	Primary processing The term "primary processing" refers to processing that does not change the nature of the product, such as the washing, grinding, peeling, and cutting of agricultural products. However, primary processing does not include activities conducted at a factory or the premises of a small or medium-sized manufacturer.
MIH (now MISTI)	➢ Prepare safety management policies for secondary products of agricultural products. ➢ Award business permits or licenses to business operators conducting secondary processing for foods, develop safety standards for secondary products, and conduct monitoring and on-site inspections. ➢ Award permits or licenses for the importing or exporting of secondary products. Secondary processing The term "secondary processing" refers to the processing of primary products at a factory or the premises of a small or medium-sized manufacturer. Secondary processing includes refining, sterilization, blending, and cooking.
MOC	➢ Design and implement a legal framework for the surveillance of food sellers with a view to protecting the consumer. ➢ Participate in the development of safety standards and submit proposals with a view to representing consumer interests and protecting the consumer. ➢ Request the performance of activities concerning FVC areas that are under the jurisdiction of other ministries or agencies and conduct follow-ups on the activities. ➢ Provide appropriate guidance on food that is not compliant with food safety standards by, for example, sharing information, providing support on compliance with laws and regulations, issuing a warning and an administrative fine, launching a lawsuit that will require the payment of a penalty, suspending the business, confiscating the relevant food products, and/or launching a recall. Market The term "market activities" refers to sales, advertising, storage, exhibition, money transfers, receipt of goods, and distribution conducted for the purpose of concluding a sale or exchange. These activities include direct sales, sales by farmers, and sales conducted at supermarkets, retail markets, and street stalls. However, they do not cover the consumer sector (described in MOH below).
MOH	➢ As the sole agency responsible for the political framework for managing food safety in the consumer sector, MOH promotes the effective implementation of the following tasks in coordination with relevant ministries and agencies. ✓ Prepare policy on hygiene and sanitation. ✓ Draft proposals on standardization in consideration of consumer health. ✓ Monitor and inspect the hygiene and sanitation of food and food businesses.

	✓ Implement a certification program and issue hygiene and sanitation assurance certificates for food businesses. Consumer sector The term "consumer sector" refers to places where final consumption by the consumer occurs. Specifically, it includes restaurants, diners, cafés, catering sites, hospitals, schools, hotels, and food stalls.
MOT	➢ In the consumer sector, MOT issues food business licenses and conducts on-site inspections for tourism-related businesses (restaurants and diners for tourists, etc.) and then provides information on such matters in response to requests from other ministries and agencies.
MEF	➢ Take the lead in conducting inspections of food entering the country in order to decide whether other relevant ministries and agencies should be involved. ➢ Share information on food importers with MOC and other relevant ministries and agencies.

Source: Prepared by the Survey Team based on Inter-Ministerial Prakas No. 868 (October 2010), SPEC BioLaboratory, inc. (2019), etc.

As explained earlier, the inspection and guidance system for food safety seems to have been developed under the general legal framework. However, a more detailed examination of the individual activities reveals that there are phases where the division of roles is ambiguous. For example, if MOC conducts on-site inspections and provides guidance on labeling to a business operator and MISTI conducts on-site inspections and provides guidance on quality control to the same business operator during the secondary processing phase, it is necessary to determine how the legal frameworks should be efficiently coordinated and implemented in the field. Therefore, it is important for details concerning how to actually operate the set framework in the field and the shared roles to be organized.

(iii) Food sales

As a framework for cooperation among ministries and agencies concerning the sale of products, Inter-Ministerial Prakas No. 61 addresses the enforcement of Sub-Decree No. 133 on Marketing of Products for Infant and Young Child Feeding. Sub-Decree No. 133 is a sub-decree on the sale of powdered milk that came into effect in November 2005, while Inter-Ministerial Prakas No. 61 is a detailed regulation for the

enforcement of the sub-decree. Both the sub-decree and the inter-ministerial prakas provide frameworks for collaboration centered on MOH, with MOH cooperating with MAFF, MIH, and MOC as shown above[72].

As shown in Figure 2-26, the actor responsible for production in the powdered milk VC is the General Directorate of Animal Health and Production (GDAHP) of MAFF, while the actor responsible for processing is MIH and the actor responsible for distribution and sales is MOC. The sub-decree and inter-ministerial prakas are related to the health of babies, infants, and mothers. Given this, MOH provides advice on inspections and monitoring conducted by MIH in relation to the secondary processing of domestic products. MOC provides advice to each ministry concerning inspections and monitoring of the content and language of advertisements and labels with a view to protecting the consumer. This framework conforms to the division of roles between ministries and agencies shown in Table 2-11, and it indicates that sub-decrees and inter-ministerial prakases function in a unified manner in relation to the production and sale of powdered milk. Going forward, it will be necessary to verify whether a comprehensive regulation and guidance system covering the series of processes from production to processing, distribution, sales, and consumption has been established for each individual food group (as with the case of powdered milk) and gradually develop the requisite legal system.

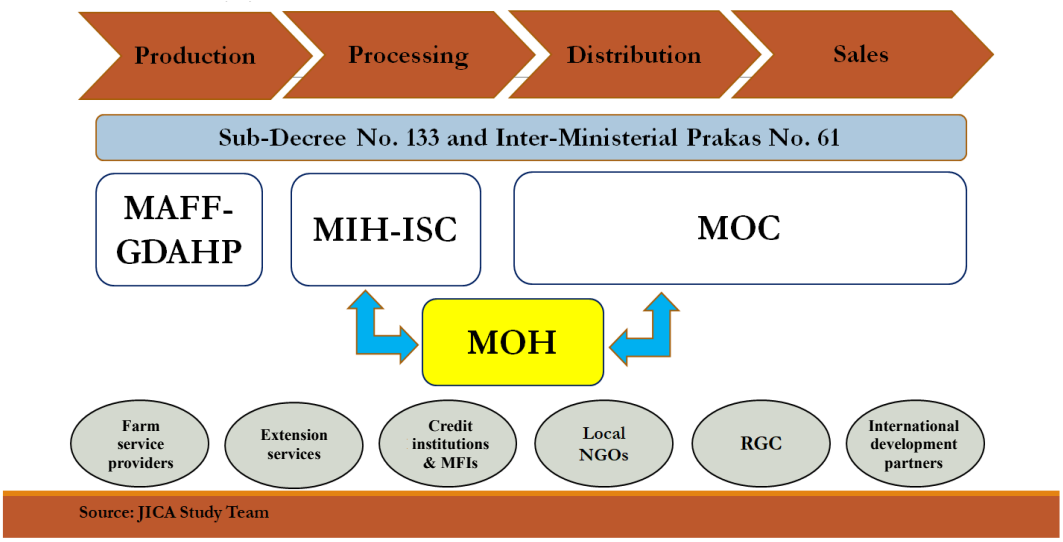


Figure 2-26 Sub-Decree No. 133 on Marketing of Products for Infant and Young Child Feeding and Inter-Ministerial Prakas No. 61

[72] Under Inter-Ministerial Prakas No. 61, the Ministry of Information (MOI), MOH, MAFF, MOC, and MIH are all subject to this framework. However, MOI was omitted from this analysis because the ministries subject to Inter-Ministerial Prakas No. 868 (i.e., MOH, MAFF, MOC, MIH, MOT, and MEF) are the main actors in this survey.

2.3 Sharing of DAI Tasks Relating to AVC

As mentioned in the preceding paragraph (1), GDA exercises jurisdiction mainly over crops and issues related to agricultural production, and it has been stipulated that the Department of Agro-Industry (DAI) shall be in charge of processes from the harvesting of crops through to primary processing. Although DAI formulates its activity policies within a large framework in accordance with the prakas, it does not necessarily develop the detailed rules required for their implementation. Furthermore, as the establishment of a VC is relatively new ground in terms of agricultural policies, there are insufficient resources (budget, human resources, infrastructure, etc.) available for its implementation. Therefore, strengthening the roles of DAI is considered a potential means of comprehensively and effectively strengthening AVC, which is composed of a series of processes from production to sales. For this purpose, JICA too is planning to dispatch experts to DAI and provide support for the strengthening of AVC in the future. In this survey as well, DAI will be discussed repeatedly as an important department.

(1) Overview of the Department of Agro-Industry (DAI)

Established in 2002, DAI now has a total of 70 staff members, including 1 director and 5 deputy directors. Here, a summary is provided of the types of work carried out by DAI in accordance with MAFF's Prakas No. 358 (October 2020) on the establishment of the department as well as details obtained from concerned DAI parties through interviews. As the latter often overlaps with the mandate of other departments in MAFF or other ministries or agencies, they will need to be organized again in the future.

Table 2-12 Overview of DAI's Duties

Office name	Duties stipulated in the prakas	Current status of DAI initiatives
(1) Processing Management Office (no. of staff: 11)	➢ Provide technical guidance and conduct inspections to add value to non-processed and (semi-)processed agricultural products on the market. ➢ Provide guidance to farmers and food processing companies on	DAI provides technical guidance and training to farmers, ACs, and SMEs engaged in agricultural product processing. According to the interview, training sessions on processing techniques have been held in 12 provinces over the last year, and DAI also provides guidance on GMP.

	processing techniques (i.e., primary processing). ➢ Provide evaluations and advice on investment plans related to agriculture and food processing. ➢ Conduct inspections on the quality and safety of processed and semi-processed products at private companies, etc., in cooperation with other MAFF departments.	
(2) Laboratory of Agricultural Products and Foods (LAPF) (no. of staff: 15)	➢ Analyze the quality of non-processed and processed agricultural products. ➢ Analyze food quality and safety.	LAPF consists of sections such as the following: the Physic-Chemical Section; the Microbiology Section; and the Technical Development, Quality, Safety and Training Section. The Physical-Chemical Section conducts analysis of pesticide residues; the Microbiology Section conducts R&D into genetically modified crops (GMO); and the Technical Development, Quality, Safety, and Training Section provides technical guidance (e.g., post-harvest treatment techniques, such as temperature and moisture control) and takes in interns from local universities. LAPF prepares standard operating procedures (SOPs) concerning the laboratory and analyzes incidents in line with FORT scheme stipulated in Inter-Ministerial Prakas No. 868 as well as guidance provided by MOH.

(3) Agribusiness Office (no. of staff: 9)	➢ Collect and analyze information on matters such as market supply and demand and price trends. ➢ Provide food businesses with advice and guidance on quality and safety management and packaging to enhance competitiveness in the market. ➢ Provide certification on the quality of non-processed and processed agricultural products.	The Agribusiness Office is in charge of marketing activities, including the design and packaging of processed agricultural products, and provides marketing guidance to farmers, ACs, and SMEs. It is also responsible for promoting local agricultural markets as well as community and village events. In addition, it has begun preparations for creating an agribusiness database with the support of the World Bank[73].
(4) Agro-Industry Development Office (no. of staff: 9)	➢ Investigate ACs and other such organizations to determine whether any agricultural products have potential. ➢ Provide support for the zoning and agricultural land development processes with the aim of establishing a VC with a focus on the above-mentioned agricultural products.	The Agro-Industry Development Office is responsible for CF and economic land concession (ELC). Sub-Decree No. 36 (February 2011) stipulates that MAFF will chair the Sub-Committee on CF Promotion, and MAFF's Prakas No. 560 (October 2017) allows DAI to serve as the secretariat for the sub-committee. This office carries out practical work related to CF Promotion Committee, holds workshops on CF, and drafts reports on CF (published twice a year).

Source: Prepared by the Survey Team based on MAFF's Prakas No. 358. The staff numbers are accurate as of the investigation conducted by the Survey Team (January 2020).

In addition, the Administration and Personnel Section have 13 staff, while the Planning and Accounting Section have 7 staff.

[73] According to DAI, the World Bank is planning to launch an agribusiness database in 2022, but it is still in the planning stages so the details have yet to be determined. In addition, donors provide support to DAI in areas such as the following: development of the Agro-Industry Strategic Development Plan by IFAD (incomplete); preparation of a draft of the Law on the Quality and Safety of Agricultural Products by FAO; construction of LAPF building by the Chinese government; and dispatching of individual experts by the Korea International Cooperation Agency (KOICA).

(2) Direction for strengthening DAI capabilities that contribute to improving VCs

Table 2-9 classifies issues related to the establishment of an AVC and initiatives that the government should undertake. Furthermore, this section sorts and describes the roles to be played by DAI, which is responsible for managing the entire AVC, according to their length (short term and medium to long term).

Short term

- Develop a database and provide information concerning the production and sale of agricultural products (production volumes by commodity, monetary sales volumes, domestic and foreign agricultural market conditions, import and export data, etc.).
- Strengthen the sales capabilities of farmers and promote their responsiveness to market needs (safe, high-quality agricultural products) by promoting CF.
- Develop food quality and safety standards with the aim of promoting the production of safe, high-quality agricultural products.

Medium to long term

- Develop policies and legal frameworks for market operations and management and prepare a step-by-step development plan with the aim of creating modern wholesale markets.
- Promote investments from public business operators, private business operators, and donors with the aim of developing post-harvest treatment and processing facilities.
- Establish domestic processing, sales, and export systems for agricultural products that are currently shipped to neighboring countries as raw materials.

Next, interviews were conducted about the work that DAI departments were currently engaged in for the specific purpose of advancing these plans and about the optimal direction to be taken in the future. The results of these discussions are summarized below. Going forward, the necessary materials and human resources, time period, feasibility, and other such factors need to be evaluated and discussed in relation to the items listed on a departmental basis and then incorporated into a medium- to long-term strategy.

Processing Management Office

Table 2-13 Key Points in Strengthening the Capabilities of the Processing Management Office

Details
The key points in strengthening the capabilities of the Processing Management Office are as follows. ➢ Strengthen the capabilities of inspectors of non-processed and processed agricultural products. ➢ Improve knowledge of food additives and ingredients for the above inspections. ➢ Strengthen farmers' processing capabilities in accordance with the following standards: HACCP, GHP, GMP, ISO 9001 and ISO 22000. ➢ Strengthen post-harvest treatment capabilities. ➢ Analyze good case studies of governmental organizations that play similar roles in other countries (e.g., PhilMech in the Philippines, etc.)[74].

Source: Prepared by the Survey Team based on discussions held on February 20, 2020.

The Processing Management Office is in charge of developing and disseminating processing techniques, and it provides support for technical improvements in the post-harvest treatment, a weak point in Cambodia's agricultural sector. It is desirable for the Processing Management Office to test a technology application model under an actual business model in cooperation with other departments while improving the technological level.

Laboratory of Agricultural Products and Foods (LAPF)

Table 2-14 Key Points in Strengthening the Capabilities of the Laboratory of Agricultural Products and Foods

Details
The key points in strengthening the capabilities of the Laboratory of Agricultural Products and Foods are as follows. ➢ Strengthen the ability to disseminate information on food safety and quality. ➢ Strengthen the ability to analyze food safety and quality. ➢ Strengthen the biosafety management.

Source: Prepared by the Survey Team based on discussions held on February 20, 2020.

[74] PhilMech is a government agency under the Department of Agriculture (DOA) of the Philippines that conducts research and development and disseminates knowledge and technologies related to post-harvest and mechanization. For details, refer to the following URL: https://www.philmech.gov.ph/?page=about_us-philmech (accessed March 8, 2020)

LAPF judges compliance with quality standards, which is indispensable if DAI is to institutionalize food quality management over the medium to long term. While it is necessary for LAPF to gradually increase its capabilities, DAI as a whole is required to clarify its own role in the implementation of Inter-Ministerial Prakas No. 868.

Agribusiness Office

Table 2-15 Key Points in Strengthening the Capabilities of the Agribusiness Office

Details
The key points in strengthening the capabilities of the Agribusiness Office are as follows. ➢ Improve marketing knowledge and information and collect information on the distribution of vegetables in Phnom Penh. ➢ Conduct networking and business matching for agribusinesses. ➢ Perform mapping for each agricultural commodity and prepare for the World Bank's creation of an agribusiness database. ➢ Strengthen the traceability system. ➢ Strengthen the ability to develop an agricultural product certification system. ➢ Analyze good case studies of governmental organizations that play similar roles in other countries (e.g., PhilMech in the Philippines, etc.)[75]. ➢ Organize and strengthen small and medium-sized agribusiness unions. ➢ Analyze long-term issues associated with improving VCs (e.g., modernization of traditional VCs centered on wholesale markets and advancement of a quality control system) and develop a roadmap.

Source: Prepared by the Survey Team based on discussions held on February 20, 2020.

It is desirable for the Agribusiness Office to address mid- to long-term issues, such as modernizing wholesale markets, strengthening the post-harvest infrastructure, and providing marketing guidance to farmers and SMEs.

[75] Refer to footnote 70.

Agro-Industry Development Office

Table 2-16 Key Points in Strengthening the Capabilities of the Agro-Industry Development Office

Details
The key points in strengthening the capabilities of the Agro-Industry Development Office are as follows. ➢ Strengthen the capability to plan and implement CF workshops. ➢ Monitor and evaluate CF activities. ➢ Strengthen the ability to organize information related to CF. ➢ Perform zone mapping for the agro-industry and enhance the capabilities of the Management Information System (MIS) and the Geographic Information System (GIS).

Source: Prepared by the Survey Team based on discussions held on February 20, 2020.

Improving conventional market systems requires long-term initiatives. CF can be expected to help contribute to the efficient creation of a business model over the short term by providing a direct connection between actual consumers and producers. However, significant issues remain, such as the complexity of administrative procedures and the lack of a platform for connecting stakeholders. The Agro-Industry Development Office has various CF support tools, and it is necessary to further expand the provision of technical support related to matching and the conclusion of contracts in cooperation with the private sector and other ministries, agencies, and departments.

2.4 Initiatives of Other Development Partners and Organizations

Table 2-17 below summarizes AVC initiatives that have been undertaken by other development partners and organizations.

Table 2-17 AVC Initiatives Undertaken by Other Development Partners and Organizations

Implementing organization	Project information	Description
USAID	Building Safe Vegetable Value Chains in Cambodia[1)] 2016–2019	This project was implemented by the Horticulture Innovation Lab at UC Davis using USAID funds. In this project, the following actions were taken with the aim of establishing a safe vegetable VC: a pilot test of a post-harvest technique for horticulture vegetables;

	USD 479,000	research and demonstrations concerning coordination with the market; and strengthening of the capabilities of farmers and other parties involved in VC.
ADB	Agricultural Value Chain Infrastructure Improvement Project 2018–2020 USD 2,000,000	To tackle the core problems in Cambodian agriculture (i.e., low productivity, low added value, and low resource efficiency), this project was conducted to strengthen post-harvest treatment and distribution facilities, improve agricultural production and service infrastructure, enhance disaster control capabilities in villages, and strengthen business relationships with parties involved in VC. These activities are expected to help increase added value for agricultural products at the target sites.
IFAD	Project for Agricultural Development and Economic Empowerment (PADEE)[2)] 2012–2018 USD 35,000,000	With the aim of improving agricultural productivity and quality of life by diversifying the income sources of farmer households in target 246 communes situated in 33 districts within 5 provinces, this project was conducted to improve access to financial services, improve access to agricultural techniques and markets, and provide business implementation support to MAFF and other organizations.
	Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE)[3)] 2015–2021 USD 52,500,000	To improve the technique dissemination service that can be used by small-scale farmers, this project is being conducted with the aim of developing agriculture into a useful, resilient business in cooperation with weak small-scale farmers with low incomes. To this end, the project is undertaking tasks such as implementing effective policies, strengthening the dissemination service, and developing infrastructure capable of supporting agriculture that is resistant to climate change.
CIRD[76]	Memot Pepper Market System Analysis (2015)	For the Memot District of Tbong Khmum Province, which is the largest pepper production area in Cambodia, analysis of issues related to key points (e.g., production, input, and collectors) was conducted and specific recommendations aimed at strengthening the pepper VC were made.

[76] Cambodia Institute for Research and Rural Development (https://cird.org.kh/home)

HEKS[77]	Cambodian Cashew Nut Value Chain Assessment Report (2019)	VC analysis of the following topics was conducted from various perspectives by using detailed data and information: soil types and production areas; stakeholders; cashew trade conditions in Cambodia and abroad; and agricultural material suppliers. Recommendations were also made to help strengthen the cashew VC.

Source: Prepared by the Survey Team

Source: 1) https://horticulture.ucdavis.edu/project/cambodia-safe-vegetables (accessed March 4, 2020)

2) Supervision report, June 24, 2016, Asia and the Pacific Division Programme Management Department

3) Supervision report, Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE)

[77] HEKS EPER: Swiss aid organization (https://en.heks.ch/)

Chapter 3 Distribution, Use, and Regulation of Pesticides

3.1 National Policy and Development Plan

Before an investigation into the distribution, use, and regulation of pesticides in Cambodia was started, a preliminary review of the Rectangular Strategy and the Agricultural Sector Strategic Development Plan, both of which play an important role in discussions concerning the development of Cambodia, was conducted.

3.1.1 Rectangular Strategy

The Rectangular Strategy was first announced at the start of the third Hun Sen administration in July 2004 as a national economic development strategy. Formally known as the Rectangular Strategy for Growth, Employment, Equity and Efficiency in Cambodia[78], this strategy was seen as a constitution for the country's economic policy according to the Supreme National Economic Council, serving as the national development strategy document with the highest precedence in Cambodia. It sets out four strategic pillars and favorable environments for each political objective and political environment. As such, it is referred to as the Rectangular Strategy[79]. The Rectangular Strategy Phase IV is now being implemented (starting from 2018).

During the Rectangular Strategy Phase III, which ran from 2013 until 2018, national revenue doubled from USD 2,264 million to USD 4,560 million. Throughout the same period, the budget of MAFF tripled, which explicitly indicates that this budget is intensively allocated to the relevant sectors.

The Rectangular Strategy Phase IV has been formulated to achieve the country's long-term goals of becoming an upper-middle-income country by 2030 and a high-income country by 2050.

In continued recognition of the significance of the agricultural sector as the core of the economy and regarding diversification and productivity improvements in the sector as pressing challenges despite the country's strong industrial growth, this phase of the strategy is also aimed at converting agriculture into high value-added activities.

[78] Rectangular Strategy for Growth, Employment, Equity and Efficiency in Cambodia

[79] https://www.maff.go.jp/j/budget/yosan_kansi/h27itaku_seika_butu/attach/pdf/h27itaku_seika_ippan-228.pdf

3.1.2 Agricultural Sector Strategic Development Plan

Sub-Program 1.10 of the Agricultural Sector Strategic Development Plan 2014–2018 sets forth the goal of strengthening the capacity of the National Agricultural Laboratory (NAL).

Sub-Program 1.10: To strengthen the technical capacity in analytical works and quality control on soil, fertilizer, water, pesticides, agricultural chemical residues, and technology in order to increase agricultural productivity, quality, and safety of agricultural products for domestic consumption and exportation.

Having set a goal of strengthening NAL in 2014 in accordance with the above-mentioned plan, MAFF has gradually done so by preparing relevant standard operation procedures for the laboratory and employing competent officers. The table below presents the specific targets for the plan.

Table 3-1 NAL's Development Plan under the Agricultural Sector Strategic Development Plan 2014–2018

Indicators	Unit	2013	2014	2015	2016	2017	2018
Samples to be tested	No. of samples	550	605	665	731	804	884

Source: Agricultural Sector Strategic Development Plan 2014–2018

3.2 Long-Term Trends in Pesticide Use

This section of the report starts by looking at long-term trends in the amounts of pesticides used, after which the increasing dependence of Cambodian farmers on the use of chemical pesticides will be reviewed. In the subsequent section, the collected data will be verified and evaluated based on literature and information acquired during the field survey and a comparison with official statistics. After that, the fact that this increased use of chemical pesticides may be unavoidable and irreversible if the country aims to become an upper-middle-income country by 2030 and a high-income country by 2050, as declared in the Rectangular Strategy mentioned above, will be confirmed.

3.2.1 Trends in Pesticide Imports

Pesticide imports values since 1980 have been reviewed and graphically presented based on FAO statistics. In spite of some yearly variations, it can be generally observed that the values remained very low until around 2000 compared to those of 2020, after which they rose dramatically, especially in the mid-2000s. The import value was reportedly approximately USD 1.65 million in 2005 but this had risen to USD 44.8 million by 2015, which is roughly equivalent to a 27-fold increase.

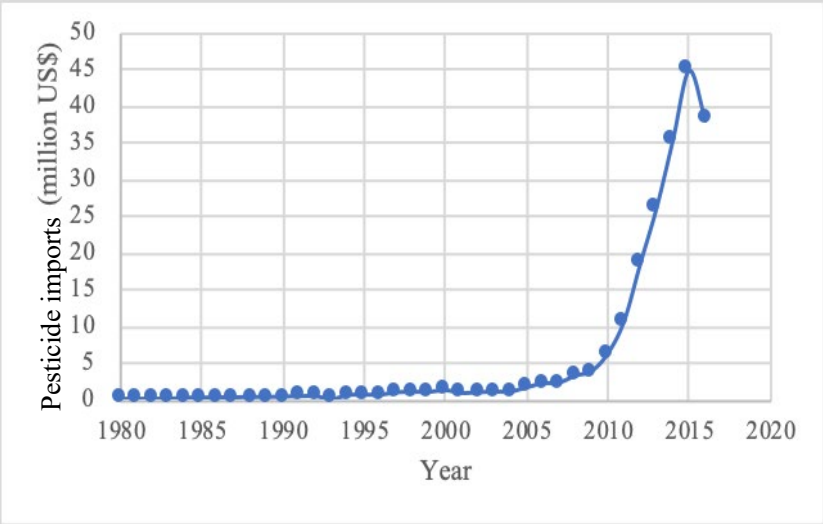


Figure 3-1 Trends in Pesticide Imports in Cambodia

Source: FAOSTAT

The Law on the Management of Fertilizers and Pesticides was enacted in 2011. It is therefore assumed that recent import values do not deviate significantly from the country's actual import status. However, it should be noted that older data contains estimates produced by FAO, as summarized below, and these estimates may contain errors due to a lack of accurate records on pesticide imports. The significant rise in pesticide imports experienced in the 2010s may, therefore, be partly attributable to changes made to the data collection method.

FAO estimates:	1980 to 1995 and 1997 to 1999
Manual estimates:	2005 to 2006
Official government data:	1996, 2000 to 2004, and 2007 to 2018

According to an investigation conducted in Takeo Province and Pailin Province in 2011 by a village development NGO in Cambodia called the Centre d'Etude et de Développement Agricole Cambodgien (CEDAC)[80], only 18% of pesticide products had labels written in Khmer and the remaining 82% had labels written in other languages. Accordingly, the import values shown for the 1980s and 1990s in the figure may be higher if it is assumed that FAO estimates included data on pesticide products with labels written in Khmer but not on informal imports with labels written in other languages. As discussed above, however, it is not technically feasible to make any further inferences or to verify the import values due to a lack of accurate records on pesticide imports.

In any event, the literature review and the series of farmer interviews conducted during the survey period revealed two fundamental facts: 1) pesticide use in Cambodia had been significantly lower than that found in other parts of Asia from 1980s to 1990s; and 2) Cambodian farmers had been using chemical pesticides increasingly often and becoming dependent on them since around 2005.

In the interview survey, a sugarcane farmer from the S'ang District of Kandal Province made the following statements.

1. We used to control a certain type of insect that poses a problem to sugarcane cultivation by utilizing natural enemy insects that occur in the rice straw laid at the bottom of sugarcane stems in the area without having to use chemical pesticides.
2. However, increasing labor shortages in the mid-2000s forced us to use chemical pesticides, especially in managing weeds, so we could no longer make use of the insect's natural enemies.

This indicates that biological controls for sugarcane production were prevalent until around 2005 in the S'ang District, but the use of chemical pesticides has increased since then due to a shortage of manpower.

The figure below presents data on pesticide imports overlaid with data on the country's employment by sector. This illustration is almost consistent with the information provided by the farmer from the S'ang District. From this, we can draw the following two conclusions: 1) rapid economic growth has accelerated labor transfers from the agricultural sector into other sectors and induced a transformation of the rural socioeconomic structure; and 2) labor shortages for crop production in farmland areas has resulted in the

[80] As described later, an investigation of pesticide stores located near the border with Vietnam in Takeo Province and the border with Thailand in Pailin Province revealed that only 18% of pesticide products had labels written in Khmer, while 58% had those written in Vietnamese, 23% in Thai, and the remaining 1% in Chinese, Arabic, and English.

increased use of pesticides. In interviews conducted at the same district, some farmers said that they do not want their children to take over the family's farm, implying that the current labor shortage is expected to become more evident in the coming decades.

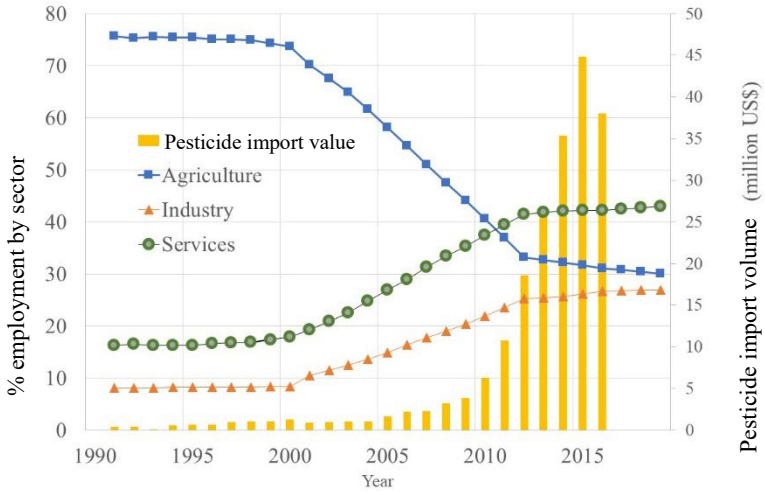


Figure 3-2 Trends in Pesticide Imports and Employment by Sector

Source: Data on employment by sector is from the World Bank
Data on pesticide imports is from FAOSTAT

Cambodia aims to become an upper-middle-income country by 2030 and a high-income country by 2050. For these goals to be achieved, the country's industries are expected to advance in the coming decades, which may widen the income gap between the agricultural and non-agricultural sectors. Therefore, the increase in the use of pesticides is likely to continue going forward and this development may be irreversible.

3.2.2 Pesticide Use in a Socioeconomic Context

Information on pesticide use in the socioeconomic context of Cambodia from the 1980s to the present day has been collected, assembled and reviewed.

Social conditions and pesticide use in the 1980s

In the period between the overthrow of the Pol Pot regime in 1979 and the signing of the Paris Peace Agreement in 1991, the Vietnamese-backed People's Revolutionary Party gradually gained power under the leadership of Heng Samrin in the midst of a power struggle among four domestic factions that were split into two groups[1]. Having fled Phnom Penh, Pol Pot group subsequently formed the Coalition Government of

Democratic Kampuchea with the National United Front for an Independent, Neutral, Peaceful and Cooperative Cambodia (FUNCINPEC), which was founded in 1981 by Norodom Sihanouk, and the Khmer People's National Liberation Front (KPNLF), thereby deepening the political confrontation with the People's Revolutionary Party (Hatsukano).

In light of this political situation, emergency food assistance was provided by the international community in the two years following the overthrow of the Pol Pot regime in 1979 (ibid.). However, Western nations did not support the Vietnamese-backed Cambodian People's Revolutionary Party; instead, the Soviet Union and its Eastern European allies provided a small amount of assistance to the country in the midst of the Cold War in 1980s. Following the enactment of liberalizing reforms and the collapse of the Cold War structure in the latter half of the 1980s, though, Western nations began providing assistance to Cambodia (Hatsukano).

According to Shinohara[2] and Hatsukano, the country's means of production were nationalized during this era, and the national economy relied on subsistence agriculture and rudimentary industries. The country's main political agenda was food self-sufficiency, but its rice production was severely affected by a drought that swept through Southeast Asian countries in 1987.

Preap et al.[3] reported that, prior to 1980, only 7% of farmers used pesticides in their farm production. Consequently, it was supposed that the use of pesticides had been minimal throughout the 1980s. However, the government established the Compagnie Centrale des Materiels Agricoles (COCMA) in 1979 as an entity for receiving pesticides that were imported as aid, which then led to an inflow of pesticides through the foreign aid framework. In the early 1980s, DDT[81] and other types of pesticides were imported to control malaria through the World Health Organization (WHO) and the Red Cross, and this was followed by an influx of DDT from former Soviet Union and other Eastern Bloc countries in the midst of the Cold War. It has also been reported that FAO imported 2,100 tons of pesticides between 1979 and 1982[4]. As mentioned above, Western nations began providing foreign aid in the latter half of the 1980s, and imports of pesticides were resumed through aid from the Netherlands and Japan's 2KR (Second Kennedy Round) aid program.

In the interview survey conducted for this survey, a farmer from the Preaek Norint Commune in Ansang Sak Village, Battambang Province, explained that although farmers from the village had used DDT in the

[81] DDT is an abbreviation for dichloro-diphenyl-trichloroethane, which is a type of organochlorine-based insecticide. DDT is known to have a high persistence in the environment and, due to its solubility in fat, it causes a biological concentration through the ecological chain. According to international cancer research institutes, it is classified as 2B (possibly carcinogenic to humans).

latter half of the 1980s, they had later come across insects that were resistant to DDT. As a result, they were reportedly forced to spray their fields with shampoo and alcohol in an attempt to control the insects.

Social conditions and pesticide use in the 1990s

Following the signing of the Paris Peace Agreement in 1991, the United Nations Transitional Authority in Cambodia (UNTAC) took over administration of the country in 1992. It deployed peacekeeping operations and convened the International Committee on the Reconstruction of Cambodia (ICORC) in accordance with the Paris Peace Agreement. During this period, the international community vowed to support the post-conflict reconstruction of Cambodia in recognition of the peacekeeping operations being conducted by UNTAC and the commitment of ICORC to provide reconstruction assistance. The 1993 Cambodian Constituent Assembly election was won by FUNCINPEC, a royalist political party, rather than the Cambodian People's Party (CPP), which had replaced the Kampuchean People's Revolutionary Party. FUNCINPEC then formed an unprecedented coalition government with the CPP. With Norodom Ranariddh from FUNCINPEC serving as First Prime Minister and Hun Sen from CPP serving as Second Prime Minister, the coalition government adopted a system that utilized the governing network of CPP while at the same time respecting the results of the election (Hatsukano).

Against this background, the economy continued to grow at 5% per annum even after the withdrawal of UN due to the low inflation rate. The growth rate rose to 7% per annum between 1995 and 1996, keeping the country on the path to economic growth. In 1997, however, armed conflict broke out between First Prime Minister Norodom Ranariddh's party and Second Prime Minister Hun Sen's party, which eventually led to the suspension of foreign aid. To make matters worse, the Cambodian economy suffered badly when the Asian financial crisis hit the region, resulting in the growth rate dropping to 1% per annum in 1997 and then 0% in the subsequent year. Despite the severity of the situation, however, the country's economy recovered to achieve 7% annual growth in 1999. It has since become a member state of the Association of Southeast Asian Nations (ASEAN).

Although Cambodia's economy had already taken off in the latter half of the 1990s, the country was still reliant on foreign aid but pesticides were not used very much in farming communities, with only a small amount of pesticides being imported in the 1990s, as reported by Flor et al. (2018)[5] based on papers published by Khun et al., Jahn et al. and Winarto. In the same paper, Flor et al. (2018) reported that a survey

conducted in the 1990s had found that pesticides were used by 59% of farmers surveyed during the dry season but not as much during the rainy season (27%). According to CEDAC[6], only 30 different pesticides were available in Cambodia during those years. This figure differs considerably from the number of pesticides registered (with full and provisional status) in 2018, which had reached 1,076 according to the Department of Agricultural Legislation (DAL) and the Statistics on Pesticides and Fertilizers (2018). It is clear that the range of pesticides that were available on the market during that period were significantly limited. Referring to the papers published by Lando et al. and Winarto, Flor et al. (2018, ibid.) further stated that pests and diseases were considered less significant concerns in Cambodia than they were in neighboring countries. She then suggested that farming practices in Cambodia were sustainable and that only minimal pest management was needed during this period compared with other countries. As a first step toward formalizing pesticide use, the Cambodian Deputy Prime Ministers signed a sub-decree (No. 69) on October 28, 1998, entitled "Standards and Management of Agricultural Materials," pertaining to the regulation of seeds, chemical fertilizers, and pesticides in agriculture (CEDAC, ibid.).

Social conditions and pesticide use in the 2000s

In the 2000s, CPP gained more political stability, winning the 2003 general election by securing 73 of the 123 seats in the National Assembly. With the country enjoying overwhelming political stability, Cambodia's economy continued to experience high growth (Hatsukano, ibid.). The country joined the World Trade Organization (WTO) in October 2004 and then signed the Japan-Cambodia Investment Agreement in 2007. During this period (i.e., from 2004 to 2007), the country achieved a GDP growth rate of 10% or more each year. This robust economic growth was bolstered by foreign-owned enterprises in the garment, real estate, construction, tourism and other service sectors along with the strong agricultural sector (Hatsukano, ibid.). GDP per capita was USD 300 in 2000, but this had risen to USD 782 by 2010. However, the country's economic growth dropped to 0.1% in 2009, the year after the collapse of the Lehman Brothers, due to its manufacturing and construction sectors plunging into negative growth, but it then recovered in subsequent years[7].

In 2002, JICA formulated an assistance strategy with the subtitle "From Reconstruction to Development." This marked a new chapter in Japan's assistance to Cambodia following the latter's reconstruction. However,

it should also be noted that China has emerged as the major aid provider to Cambodia since the mid-2000s (Hatsukano, ibid.).

In light of this, the country experienced significant changes in its employment statistics by sector as mentioned earlier. The agricultural sector had begun to see a decline in its labor force since the early 2000s, which had accelerated the use of pesticides. This decade can be viewed as the beginning of a new age in use of pesticides in Cambodia.

Chhay et al.[8] reported that national figures on the use of pesticides rose from 200,000 L in 2002 to 3.4 million L in 2004. Based on Sub-Decree No. 69, MAFF issued a ministerial declaration (No. 598) containing the Lists of Pesticides in Cambodia on December 15, 2003. This declaration provided three lists of pesticides: 1) banned pesticides (116 common names); 2) restricted pesticides (40 common names); and 3) permitted pesticides (136 common names). Between 2004 and July 2011, only 562 pesticide trade names from 26 pesticide companies were registered with DAL (CEDAC, ibid.). With pesticide imports and usage rising dramatically during this decade, the government's pesticide management system was launched.

Social conditions and pesticide use in the 2010s

Wishing to take advantage of the lower wages paid in Cambodia, foreign-owned enterprises have been moving part of their production out of China or Thailand into ASEAN region since around 2010, and the "China plus one" and "Thailand plus one" strategies have come to attract more attention. The number of Japanese companies expanding their business into Cambodia, mainly in the labor-intensive production area, has also increased (Mitsubishi UFJ Research & Consulting, ibid.). However, the wage rate in Cambodia, which used to be very low, has risen sharply in recent years, with the country's minimum wage having increased year on year from USD 60/month in 2012 to USD 170/month in 2018 (ibid.). This wage surpassed the minimum wage in rural parts of Vietnam. Therefore, there has been widespread concern that this sharp rise in the minimum wage will diminish Cambodia's international competitiveness and have a negative impact on the expansion of foreign-owned enterprises into Cambodia (ibid.).

During this time, Cambodia achieved an annual growth rate of 7% or more for seven consecutive years from 2011 to 2017. It is truly noteworthy that the country continued to enjoy steady growth even in 2015 and 2016, when other emerging economies suffered from a slowdown and recession (ibid.).

In 2012, MAFF completed its “Project of Capacity Building for the Quality Standard Control of Agricultural Materials (Chemical Fertilizers and Pesticides)” (QCAM), which was started in 2009 with aid from JICA. It also increased the capability of NAL to perform pesticide formulation analysis and that of DAL to carry out on-site inspections. Leveraging the momentum generated by the implementation of this project, MAFF drafted and enacted the Law on the Management of Pesticides and Fertilizers in 2012.

In an interview with retailers and farmers conducted in 2011, CEDAC (ibid.) discovered that there had been an increase in the number of labels written in Khmer. Furthermore, since MAFF led a national campaign against banned pesticides in April 2011, DAL inspectors have been visiting pesticide stores to check for banned products since then.

According to an interview study covering 400 households (Flor et al., 2018), 100% of the farmers surveyed (N = 400) applied a certain amount of pesticides each season and only 3% of them mentioned non-chemical pest control methods (physical or biological) in their replies (Flor et al., 2018). It would seem, then, that farmers were engaged in agriculture that was largely dependent on chemical pesticides during this period.

3.3 National Management System for Key Agricultural Materials

3.3.1 Policies Relating to Agricultural Production Materials

Data on customs tariffs in Cambodia has been compiled and presented with a focus on fertilizers and pesticides. It has been confirmed that the government does not impose any type of customs duties other than those pertaining to value added tax on both fertilizers and pesticides.

Table 3-2 Customs Duties on Fertilizers and Pesticides

Fertilizer/pesticide classification	Unit	Customs duty	Special tax	VAT	Export tax
Animal or vegetable fertilizers[*1]	kg	0	0	10	0
Nitrogen fertilizers[*2]	kg	0	0	10	0
Superphosphates[*3]	kg	0	0	10	0
Potassium manure[*4]	kg	0	0	10	0
Fertilizers containing multiple fertilizing elements and other types of fertilizers[*5]	kg	0	0	10	0

Fertilizer/pesticide classification	Unit	Customs duty	Special tax	VAT	Export tax
Insecticides, rodenticides, fungicides, herbicides, germination inhibitors, plant growth regulators, disinfectants and other materials[6*]	kg	0	0	10	0

1: Animal or vegetable fertilizers (regardless of whether they are mixed or chemically treated) and fertilizers produced through the mixing or chemical treatment of animal or vegetable products
2: Mineral or chemical fertilizers only
3: Mineral or chemical fertilizers only
4: Mineral or chemical fertilizers only
5: Fertilizers, including those (mineral or chemical) containing multiple fertilizing elements (nitrogen, phosphorus, or kalium), and other products of this type in tablet or similar form or in packages with a weight of 10 kg or less (including both the fertilizer and the package)
6: Fertilizers in retail form, packaged form, drug form, or product form (e.g., bands containing sulphur, cores, candles, and flypaper) only

Source: General Department of Customs and Excise of Cambodia
http://www.customs.gov.kh/publication-and-resources/customs-tariff-of-cambodia-2017/
(accessed December 31, 2019)

As shown above, the government's intervention in the country's fertilizer and pesticide market has been minimal, which has resulted in a negligible price distortion. This is an appropriate policy for long-term agricultural material price formation, but it should be noted that, in the early stages of economic growth, policy intervention is an important means of promoting economic growth.

3.3.2 Law on the Management of Pesticides and Fertilizers

In Cambodia, the Law on the Management of Pesticides and Fertilizers was signed on January 14, 2012, just a few months earlier than the completion of QCAM in March 2012. Since then, MAFF has consistently and steadily coordinated the development and authorization of relevant sub-decrees and prakases to ensure that this law is enforced. The table below summarizes the preparation status for each of the relevant instruments. The article numbers indicate those identified in this law. When this law was enacted, it was assumed that 25 instruments, including prakases and sub-decrees, would be required for its enforcement. To date, 12 instruments have been authorized.

Table 3-3 Preparation Status of Sub-Decrees and Prakases Relating to the Law on the Management of Pesticides and Fertilizers

ID	Article	Prakas type	Statement/description in the law	Title of sub-decree or prakas
1	9	Prakas	List of pesticides	Prakas No. 484 P MAFF, dated November 26, 2012, concerning the list of pesticides in the Kingdom of Cambodia
2	13	Prakas	Guidelines on pesticide samples	Not available

ID	Article	Prakas type	Statement/description in the law	Title of sub-decree or prakas
3	14	Prakas	Technical protocols on pesticide bio-efficacy tests	Not available
4	21	Prakas	Procedures and standard requirements for pesticide registration	Prakas No. 415 P MAFF, dated August 17, 2012, concerning the procedures and standard requirements for pesticide registration
5	25	Prakas	Guidelines for pesticide labels and model pesticide labels	
6	28	Joint prakas with MOH	Management of household pesticides and public health pesticides	DAL will propose sending a letter to the Ministry of Health to draft this Joint Prakas on the Management of Household Pesticides and Public Health Pesticides, MAFF-MOH
7	31	Joint prakas with MIME	Guidelines on standard requirements and safety measures for the operation of pesticide formulation, packaging, and repackaging	Not available
8	32	Joint prakas with MOE	Guidelines on pesticide storage	Not available
9	40	Prakas	Procedures for the management of pesticides in trade	Prakas No. 120 P MAFF, dated April 11, 2013, concerning the procedures for managing pesticides in business operations
10	43	Joint prakas with MOE	Guidelines on safety measures for pesticide use and the disposal of pesticide waste and used packages	A draft procedure has been prepared and sent to the Ministry of Environment for review
11	47	Joint prakas with MOE	Temporary detention or confiscation for destruction in accordance with the code of criminal procedures in force	Not yet proposed (only for pesticides confiscated due to violations committed by the seller); Joint Prakas on Rules for the Destruction of Pesticides, MAFF and MOE
12	55	Prakas	Guidelines on fertilizer samples	Not available
13	56	Prakas	Procedures for fertilizer bio-efficacy tests	Not available
14	63	Prakas	Procedures and standard requirements for fertilizer registration	Prakas No. 415 P MAFF, dated August 17, 2012, concerning the procedures and standard requirements for fertilizer registration
15	75	Sub-decree	Procedures for the use of urea in causing explosives shall be determined by a sub-decree	The Ministry of National Defence (not MAFF) is responsible for controlling urea fertilizer used for the purposes of national security (non-agricultural use), so this ministry shall adopt its own regulations for registration, imports, and storage
16	75	Prakas	Procedures for the management of fertilizers in trade	Prakas No. 119 P MAFF, dated April 11, 2013, concerning the procedures for managing fertilizers in business operations
17	82	Prakas	Format of trade record book for pesticides and fertilizers	Not available
18	87	Prakas	Procedure and requirements for the accreditation of technical personnel and researchers and the operation of laboratories to analyze pesticides and fertilizers	Not available
19	88	Joint prakas with MOE	Specification for service fees	Joint Prakas on Service Fees According to Type, MAFF-MOEF
20	92	Prakas	Procedures for primary inspections and validity checks for the distribution of pesticides and fertilizers	Prakas No. 099 P MAFF, dated February 4, 2015, concerning the procedures for conducting primary inspections and validity checks for the distribution of pesticides and fertilizers
21	94	Joint prakas with MOJ	Format and procedures for obtaining legal qualification as pesticide and fertilizer inspection officials	Inter-Ministerial Circulation No. 321 C (MAFF), dated July 01, 2015, concerning formalities related to pesticide and fertilizer inspection officials who have qualified as justice police agents of the Ministry of

ID	Article	Prakas type	Statement/description in the law	Title of sub-decree or prakas
				Agriculture, Forestry and Fisheries for the enforcement of the Law on the Management of Pesticides and Fertilizers
22	96	Sub-decree	Uniforms, insignias, and rank symbols for pesticide and fertilizer inspection officials shall be determined by a sub-decree	Sub-Decree on the Uniform, Symbols and Insignias of Pesticide and Fertilizer Inspection Officials
23	100	Prakas	Procedures for the inspection of pesticides and fertilizers	Prakas No. 176 P MAFF, dated June 14, 2013, concerning the procedures for inspecting pesticides and fertilizers
24	103	Prakas	Procedures and authority for imposing transactional fines	Prakas No. 199 P MAFF, dated May 20, 2014, concerning the procedures and authority for imposing fines for offenses set forth in the Law on the Management of Pesticides and Fertilizers
25	104	Joint prakas with MAFF& MOEF	Inspection officials who have participated in the suppression of specific offences set forth in this law may be rewarded at the government's discretion	Standard Papers of the Royal Government: Decision on the Provision of Incentives to Officers Having Participated in the Suppression of Offenses

3.3.3 Enforcement Status of the Law on the Management of Pesticides and Fertilizers

This section reviews the enforcement status for the Law on the Management of Pesticides and Fertilizers by first observing how the situation changed following the implementation of QCAM. It can be generally observed that only 18% of pesticides had labels written in Khmer at the time QCAM was implemented, but this figure had risen to about 80% by 2020. This section also confirms that this change was mostly realized owing to the on-site store inspections carried out by DAL and the support provided by the increased capacity of NAL to perform pesticide formulation analysis.

Next, the main activities carried out by DAL in relation to the enforcement of the Law on the Management of Pesticides and Fertilizers are described. In particular, this section refers to DAL's remarkable achievements that have been made in preventing illegal pesticide imports by viewing records of the monetary penalties levied by DAL for pesticide trafficking. In the section describing the current status of pesticide management by DAL, it will be confirmed that, given the fact that the number of registered pesticides reached 1,000 cases in 2018 and that pesticide companies are obligated to renew the registration for each of their products every three years, NAL now has adequate capability to manage pesticides in Cambodia.

The final section addresses an issue concerning the enforcement of the Law on the Management of Pesticides and Fertilizers by discussing the fact that, compared to Japan, Cambodia has a lot of products similar to pesticides containing emamectin benzoate, for example, which complicates pesticide management.

Furthermore, although the joint prakas issued last year provides laboratory staff with financial incentives[82], the report issues a reminder that careful consideration needs to be given to supporting the younger generation staff at the laboratory to ensure their stable, long-term retention.

Changes since the implementation of QCAM

Informal Products: It is said that more than 80% (i.e., 80–90%) of pesticide products sold in Cambodia are imported and sold through formal channels[83]. The above estimate agreed almost completely with the observations made during the field surveys that we conducted in the provinces of Kandal and Battambang (January and February 2020) by visiting various retailers and farm households.

However, in a study conducted by CEDAC in 2011 near the national border with Vietnam in Takeo Province and the national border with Thailand in Pailin Province, it was found that only 18% of pesticide products displayed in the stores there had labels written in Khmer, while 58% had them written in Vietnamese, 23% in Thai, and the remaining 1% in languages such as Chinese, Arabic, and English.

In contrast with the figure of 18% that was obtained in 2011 as described above, the percentage of products with labels written in Khmer reached approximately 80% in 2020, indicating a remarkable improvement during that decade. This demonstrates two fundamental facts: 1) MAFF has continued to intensively allocate financial and human resources; and 2) the ceaseless law enforcement efforts undertaken by DAL, such as conducting on-site retailer inspections, have proven successful.

DAL activities: DAL's activities after the completion of QCAM are summarized as follows based on a report issued by DAL. After QCAM ended, DAL had distributed more than 10,000 copies of the guidelines to provincial and local governments and hosted various workshops throughout the country to disseminate information on banned and restricted pesticides. DAL has periodically updated the list of banned and restricted pesticides and convened capacity development seminars targeted at traders.

As a result of various strenuous efforts, the incidence of illegal trade in banned and restricted pesticides and the use of pesticides with labels written in languages other Khmer has dropped as already mentioned.

[82] These incentives are also reflected in the salaries of individual analyzers, and the increase in income due to analysis work has reached approximately 60% of their monthly income.

[83] This estimate was produced by officers from the central DAL and DAL for Kandal Province.

The following statistics concerning fines for illegal conduct also show that DAL has made proactive efforts to eliminate illegal pesticides.

1. From 2014 to 2015, the amount of penalties against violations accrued as a result of inspections carried out by DAL was over KHR 100 million (approx. JPY 2.7 million) annually.
2. The range of the annual amount of penalties against violations dropped to KHR 60 million (approx. JPY 1.6 million) in the subsequent years from 2016 to 2018.

The above-mentioned workshops and other dissemination activities were funded from the national budget in combination with funds provided by development partners. For example, it was reported that Australian aid provided via CAVAC also contributed to the dissemination of such information to 11 key provinces in Cambodia and other provinces in the vicinity of Tonle Sap Lake.

Pesticide formulation analysis by NAL: Recent trends in the annual number of pesticide analysis samples are presented in the figure below. NAL analyzed about 200 pesticide samples and about 200 fertilizer samples in 2013, two years after QCAM ended. Since then, these figures have gradually risen until they reached more than 1,000 for pesticides and more than 600 for fertilizers in 2019. These trends are seen as a good sign of improvements in the analytical capacity of NAL.

According to an interview with NAL concerning pesticide analysis, the organization was able to quantify 28 active ingredients before QCAM, but it is now able to quantify 60 active ingredients by gas chromatography (GC) and 75 active ingredients by high-performance liquid chromatograph (HPLC) (60 active ingredients by GC and 15 by HPLC only).

As can be seen in the “Agricultural Sector Strategic Development Plan” section, the analysis of 884 samples was planned for 2018 under the Agricultural Sector Strategic Development Plan 2014–2018. This goal is judged to have been achieved, and NAL is judged to have achieved its capacity goal as a national organization responsible for testing and verifying the quality of pesticides and fertilizers. In a local investigation conducted as part of this project, staff in charge of analysis at NAL also participated and received significant support. The staff are capable of identifying active ingredients from the names of many pesticide products, which also demonstrates that they have participated in the analysis of pesticide formulation on a daily basis. Given the above-mentioned circumstances, it is considered high time that the analysis of pesticide residue be conducted for farm crops in addition to the analysis of pesticide formulations.

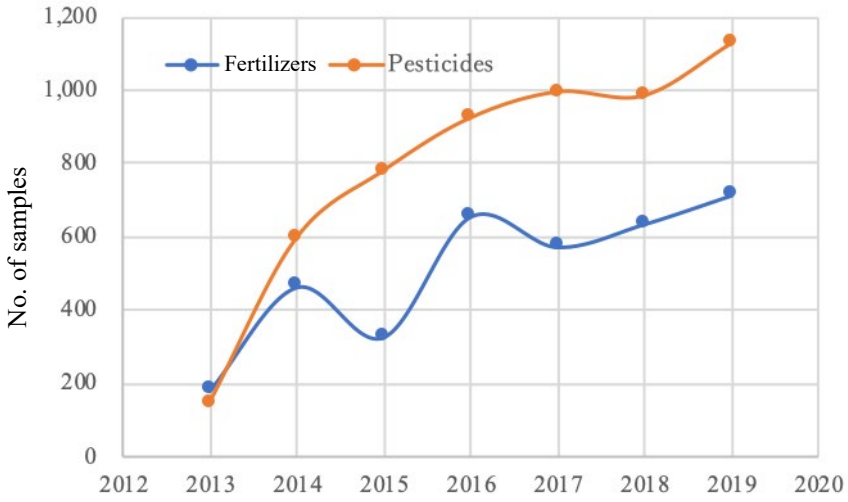


Figure 3-3 Trends in the Number of NAL Analysis Samples

Source: GDA/NAL

Current status of DAL pesticide management

Division of roles between DAL (MAFF) and PDAFF in relation to pesticide management: DAL (MAFF) is obligated to carry out inspections of pesticide traders throughout Cambodia and, in accordance with an authorization letter issued by MAFF, to verify the import volume and quality of pesticides and fertilizers. DAL also provides training for local governments and traders to disseminate government's policies on pesticide management. PDAFF, meanwhile, is responsible for carrying out inspections of stores and transportation in each province and suppressing crime. DAL (MAFF) has 10 officers responsible for pesticide management at its central office and 5 or 6 officers assigned to each of the 25 provinces, including Phnom Penh, throughout the country.

Registration of importers and retailers: Pesticide and fertilizer import firms are registered by DAL (MAFF). However, retailers in the provinces do not need to register their businesses; instead, they have to obtain authorization from PDAFF by sending a letter of request accompanied by various documents to PDAFF and attending training sessions organized by PDAFF or DAL (MAFF).

Number of registered fertilizers and pesticides: According to Statistics on Pesticides and Fertilizers (2018), 1,006 pesticides have been registered by 55 companies. In addition, applications for the provisional

registration of 70 pesticides by 10 companies are being processed. In terms of fertilizers, 459 products have been registered by 77 companies, and 48 products have been provisionally registered by 11 companies.

Table 3-4 Registration Status for Fertilizers and Pesticides (2018)

		No. of companies	No. of products
1	Full registration of pesticides	55	1,006
2	Provisional registration of pesticides	10	70
3	Full registration of fertilizers	77	459
4	Provisional registration of fertilizers	11	48

Source: Statistics on Pesticides and Fertilizers (2018)

Full registration of pesticides: This type of registration is granted for a pesticide if the registration applicant has fulfilled every technical requirement of MAFF. A registration number and certificate are issued to successful applicants by MAFF.

Provisional registration of pesticides: This registration is granted for all categories of pesticides mentioned in the notice of authorization for temporary use issued by MAFF to allow their circulation for sale in the marketplace.

In addition, based on the above-mentioned document, the table below summarizes the approval status for pesticide and fertilizer imports.

Table 3-5 Approval Status for Pesticide and Fertilizer Imports (2018)

		No. of companies	No. of products	Weight (ton)	Volume (L)
1	Pesticides	87	2,440	61,500	1,465,146
2	Fertilizers	143	1,404	1,153,788	75,145

Source: Statistics on Pesticides and Fertilizers (2018)

As mentioned above, 1,076 pesticides and 507 fertilizers are registered at present, including those with provisional status. Pesticide registration requires renewal every three years, so NAL has to analyze 360 products or more per year. As mentioned earlier, given the fact that NAL is now conducting over 1,000 analyses per year, it is judged to have sufficient capacity to perform this duty.

Issues and challenges relating to the enforcement of the Law on the Management of Pesticides and Fertilizers

Multiple registration of similar products: The US pharmaceutical company Merck submitted a patent application for emamectin benzoate, an insecticide derived from Streptomyces avermitilis, in 2001. Seven types of commercial products containing emamectin benzoate, such as Affirm Emulsion, are registered in Japan for use as insecticides with cabbages, Japanese radish, and other such vegetables. Four of these products, including Guardy AL, are also registered as mixtures containing amethoxam difenoconazole (insecticide). Ten products, except for Kadan Plus DX from FUMAKILLA, have been registered by Syngenta Japan.

Widely used in upland crop production in Cambodia, emamectin benzoate is one of the pesticides that was most often mentioned by farmers during the survey. The survey revealed that 27 pesticide products containing emamectin benzoate as their main ingredient have been registered in Cambodia, which is more than double the 11 pesticides registered in Japan. It has been confirmed that a larger number of commercial products are often registered in Cambodia for a single active ingredient, which may have increased the complexity of pesticide management in this country.

NAL staffing: Tables 3-6 and 3-7 below present information on NAL staff who belong to the department responsible for pesticide analysis (excluding the director) and the main analytical instruments used at the laboratory. The majority of NAL staff who underwent training during QCAM have reportedly left the laboratory to find positions elsewhere since QCAM ended, leaving only two officers who have continued working at the laboratory since then. It should be noted that many of the officers there now have a shorter tenure, which accentuates the generation gap in the age structure. Officers with longer tenure are presumably less likely to leave their positions for new jobs outside the laboratory, but they will retire at some point. Therefore, it is necessary to expedite the implementation of a training program for the younger generation in order to ensure that the laboratory will continue to operate seamlessly even when some of the staff retire. In addition, as can be seen from other past projects, it is necessary to give adequate consideration to the risk of trained staff moving to other organizations for new jobs after the completion of a project.

Table 3-6 Current Status of NAL Staffing

No.	Educational background	Years at NAL	Main role at NAL
1	Agricultural science	29	Manager
2	Agricultural science	27	Sample preparation
3	Agricultural science	10	Administration
3	Agricultural science	10	Accountant
4	Agricultural science	25	Sample preparation
5	Chemistry	6	Analyst
6	Biochemistry	6	Analyst
7	Chemistry	6	Analyst
8	Biology	4	Analyst
9	Associate	2	Sample preparation
10	Agricultural science	2	Analyst
11	Agricultural science	2	Analyst

Source: NAL

Table 3-7 Current Status of Main NAL Analytical Instruments

	Manufacturer	Model name	Operational/non-operational?	Reasons for non-operation
GC-ECD/FID/FPD	Thermo	FINNIGAN (Trace GC Ultra)	Non-operational	Heated board since 2015
GC-FID	Agilent	7890B GC System	Operational	
LC/MS	Perkin Elmer	Altus SQ Detector	Operational	
HPLC-UV	Perkin Elmer	UV-VIS Detector	Operational	
UV-VIS spectrophotometer	Perkin Elmer	Lambda 25	Operational	

Source: NAL

Two recent joint prakases between MAFF and MEF (No. 836 MEF P and No. 837 MEF P) allocate funds accrued from fees paid for laboratory services as follows: 40% goes to central government, 1% goes to MEF, and 51% goes to MAFF. Furthermore, the revenue accrued to MAFF is split such that 20% goes to MAFF, 13% goes to GDA, and 67% goes to NAL. These joint prakases also benefit the laboratory officers as they receive rewards for their laboratory services. The total value of the rewards available to the officers reportedly reaches about 60% of base salary, which seems to be serving as a good incentive. Although the length of time that officers can be retained at their workplaces is a pressing issue in many countries, the joint prakases signed in 2019 are expected to help ensure the long-term retention of laboratory officers. However, given that these prakases have only been approved recently, careful consideration must continue to be exerted to encourage the younger generations to remain in work and to ensure their stable retention over the long term.

3.4 Distribution System for Agricultural Materials

3.4.1 Overview of Pesticide Distribution

The following section outlines the sales and distribution of pesticides in Cambodia based on a series of interviews conducted there. At present, the country does not have any registered pesticide producers, so it is reliant on China, Vietnam, Thailand and other such countries for all of its pesticide imports. Although one fertilizer factory (operated by Chung Heng Fertilizer Co., Ltd.) has been registered by the Ministry of Industry, Science, Technology and Innovation (MISTI), the country is also reliant on imports for fertilizers, as well.

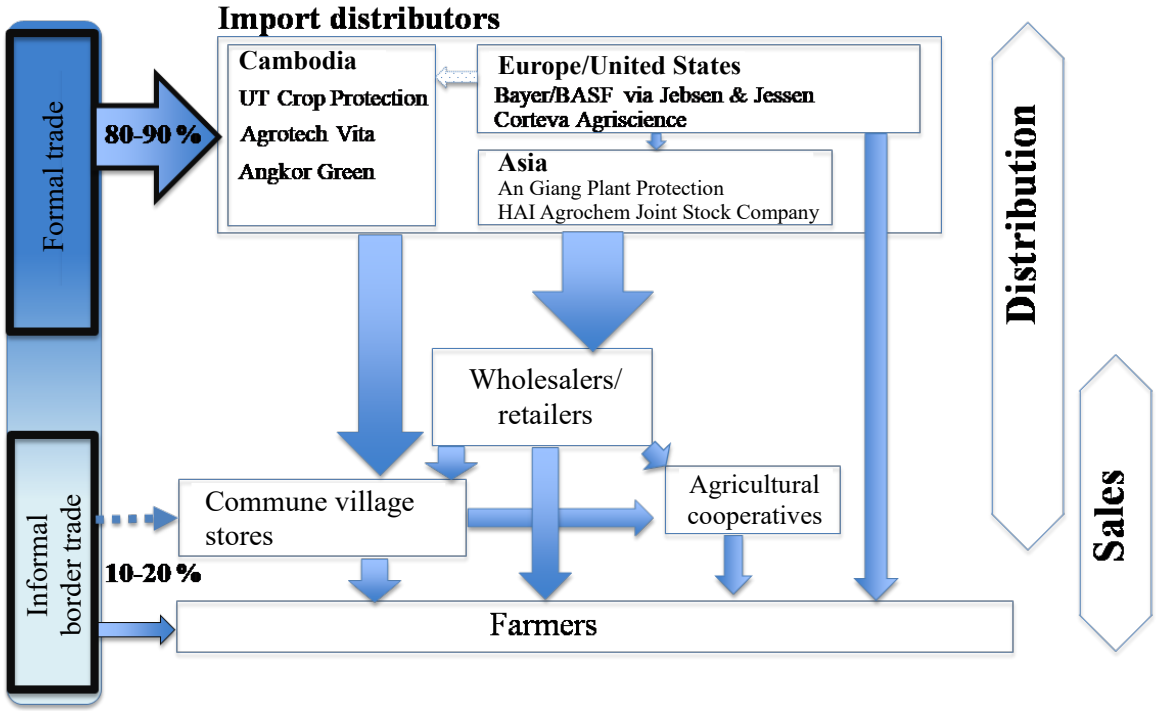


Figure 3-4 Conceptual Illustration of Pesticide Distribution in Cambodia

Source: JICA Study

3.4.2 Informal Imports of Pesticides

As mentioned above, it is estimated that more than 80% (i.e., 80–90%) of pesticide products currently sold in Cambodia are imported and sold through formal channels, with the remaining 20% most likely being imported through illegal channels.

In general, the closer you get to the international border, the more you can find foreign pesticides being imported through illegal channels, which indicates the porous nature of international borders with neighboring countries in relation to the distribution. A field visit that involved a series of interviews was conducted in the K'am Samnar Commune in the Leuk Daek District of Kandal Province. This commune is located close to the border with An Giang Province in Vietnam. Due to its geographical location, this commune serves as an entry point from Vietnam for various products, including pesticides. Neighboring local governments at the commune level in the two countries often enter into agreements on the relatively free flow of people and goods for personal use, suggesting that the use by farmers of pesticides made in Vietnam is not always illegal. In other words, it should be noted that the use of pesticides with foreign language labels by farmers is not always illegal.

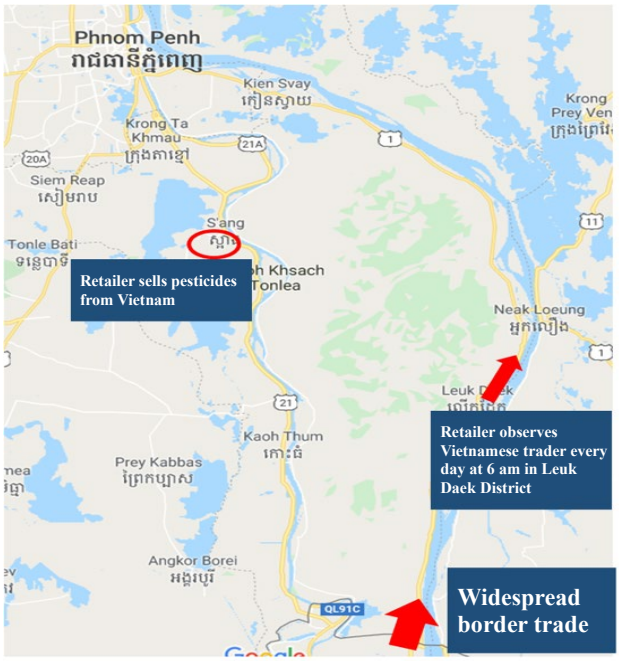


Figure 3-5 Observation Locations of Illegal Pesticide Trade

Nonetheless, informal cross-border trade in pesticides does take place in these areas. A retailer in the Leuk Daek District of Kandal Province claimed that a Vietnamese merchant would pass by on a motorbike at 6:00 am every day to deliver pesticides. Pesticide packages with labels written in Vietnamese were also found at a pesticide wholesaler in the S'ang District, which is located at some distance from the border.

DAL also reported that there have been cases of large-scale plantation operators importing pesticide products illegally and then reselling them to nearby farmers. Furthermore, it seized a group of traffickers in Battambang who had imported 15 tons of fertilizer and pesticides from Thailand in the middle of the night.

According to farmers interviewed in the survey, the reason why they use Vietnamese pesticides is the affordability of the products on the market. According to a PDAFF official in Kandal, demand for smuggled pesticides is responsive to price changes. Therefore, the direction of their distribution may be reversed depending on changes in the relative prices of the pesticides between the two countries, so Vietnamese pesticides will not necessarily flow into Cambodia over the long term.

In Kandal, it was observed that the closer you get to the international border, the more people speak Vietnamese and the more they use the Vietnamese dong as their unit of currency. In contrast, the Thai baht is commonly used in transactions involving the sale of rice to middlemen in Ta Sei Village, which is located in the Ta Meun Commune of the Thma Koul District, Battambang Province.

Figure 3-6 Vietnamese Products Delivered to a Retailer

The widespread informal cross-border trade in pesticides is certainly a major obstacle to promoting the appropriate use of pesticides in Cambodia. However, it is impossible to prevent the distribution of goods across a country's land border due to the porous nature of international borders. Given this, it is not considered reasonable to invest additional funds in prevention efforts. As this issue cannot be settled simply by DAL carrying out on-site inspections, it is necessary to strengthen law enforcement with the involvement of the police and other ministries and agencies, including MOC, to further strengthen national border management.

3.4.3 Formal Imports of Pesticides

1. Importers

All of the pesticide importers operating in Cambodia are officially registered by DAL. As of 2018, 1,006 products were being sold by 55 pesticide importers[84].

The key players in the pesticide import business include UT Crop Protection, An Giang Plant Protection, VFC, and Corteva Agriscience. In an online search, news articles can be found reporting that Western multinational agrochemical corporations once opened branch offices in Cambodia. However, the majority of them reportedly withdrew from direct dealings in the country due to the relatively small scale of the market

[84] Statistics on Pesticides and Fertilizers (2018)

and the nature of the business risks there, which included improper business dealings. Instead, they shifted their main channels to sales through distributors[85]. Table 3-8 below presents some of the leading importers classified according to the following categories: Cambodian capital, Asian capital, and multinational capital. The multinational companies shown in the table are capable of developing and producing new chemicals, while the other companies mainly produce generic products and/or formulations at factories located in neighboring countries.

Table 3-8 Leading Pesticide Importers in Cambodia

Classification	Company name	Description
Cambodian capital	UT Crop Protection Company	This company is reportedly the largest importer of pesticides in Cambodia. Its product line includes fertilizers and plant hormones in addition to insecticides, fungicides and herbicides.
	Agrotech Vita Co., Ltd.	Established in 2001 as part of the Dynamic Group, this company specializes in the import and sale of pesticides and seeds. According to its website, it was the first company to use Khmer language labels for agrochemicals. The Dynamic Group consists of eight group companies, including Dynamic Pharma Co., Ltd. (healthcare), Dynamic Scientific Co., Ltd. (laboratory equipment), Dynamic Distribution Co., Ltd. (dental implants), and Dynamic Argon Co., Ltd. (pharmaceuticals).
	Angkor Green Investment and Development Co., Ltd	In addition to importing pesticides, agricultural machines, irrigation facilities, and animal feed, this company also exports agricultural products. Most of the pesticides registered by the company are biological ones, such as BT and Trichoderma. It operates a demonstration farm in collaboration with Swisscontact in Battambang Province and other locations throughout the country.
Asian capital	An Giang (Cambodia) Plant Protection Co., Ltd.	Part of the Loc Troi Group, this Vietnamese company was spun off from the Plant Protection Division under the Agriculture and Rural Development Department of the An Giang Provincial Government of Vietnam. Since then, it has received a capital injection from Syngenta, a leading multinational agribusiness entity based in Switzerland[86] that operates a global agribusiness specializing mainly in pesticides and seeds. Syngenta sells pesticide products through VFC in addition to An Giang Plant Protection[87].
	SaiGon Plant Protection Joint Stock Company	This Vietnamese pesticide company was spun off from the Sub-Institute of Plant Protection in Ho Chi Minh City in 1989. It was previously a pesticide formulator under contract with Rhone Poulenc. Operating in four Southeast Asian countries with 600 staff and 18 branches, it produces more than 100 pesticide products, foliar fertilizers, and seeds.

[85] Information provided by an NGO officer.

[86] The current principal shareholder is the China National Chemical Corporation.

[87] According to an interview conducted at Corteva Agriscience.

Multinational capital	Corteva Agriscience		Practically the only global agricultural corporation operating at almost full scale in Cambodia, this US pesticide manufacturer was founded through a merger of Dow Agro Science and DuPont. It has factories in the US, Indonesia (insecticides and fungicides), Vietnam (insecticides and herbicides), and Thailand (insecticides). With 10 staff in Cambodia, it operates with a geographical focus on 8 provinces (Takeo, Prey Veng, Battambang, Banteay Meanchey, Kompon Thom, Kampong Speu, etc.).
	Jebsen & Jessen (Cambodia) Co., Ltd		Established in Hong Kong in 1895, this company is managed by members of a single family. Currently based in Singapore with more than 4,000 staff and 50 subsidiaries, it sells Bayer and BASF pesticide products as part of the German Business Group Cambodia.
		Bayer	In 2002, Bayer acquired the agricultural division of Aventis, which had been created through a merger of Rhone-Poulenc (FR), Hoechst Celanese (DE), and Marion Merrell Dow (US) in 1992. Bayer later acquired Monsanto (US) in 2018.
		BASF	One of the oldest comprehensive chemical companies based in Germany, this company acquired the agrochemical business of American Home Products in 2000 and then sold its pharmaceutical business to Abbot Laboratories in 2001.

Most of these importers assign several technical sales agents to each target province, or each area consisting of multiple target provinces, to promote the sale of pesticides, with local wholesalers and retailers as their main targets. The majority of these technical sales agents are graduates of reputable agricultural universities, including the Royal University of Agriculture, Chea Sim University of Kamchay Mear, Prek Leap National College of Agriculture, and Kampong Cham National School of Agriculture, so they have an adequate understanding of agriculture.

The main approach adopted by the technical sales agents of these importers in the promotion of pesticide sales is to establish model farms (described below) that allow them to demonstrate the efficiency and efficacy of their products and consult with retailers and farmers on an individual basis. The technical sales agents provide technical information on their pesticide products to local retailers, who then pass on this information to the farmers. Given this, these agents play a pivotal role in promoting the appropriate use of pesticides in Cambodia.

- Establishment of model farms: Most of the pesticide importers use model farms to demonstrate their products. They usually establish model farms on 1 ha plots of land or larger under contracts with key farmers. They are mostly designed to demonstrate the following: 1) the efficiency of the pesticide products on the target insects/diseases over the short term; and 2) the overall efficiency of agricultural production throughout the growing season over the long term. The terms of the agreements entered

into with farmers for the establishment of model farms may vary, though. For example, a pesticide company may provide 100% or 50% off the price of the products if the farmers agree to conduct demonstrations on their farms, guarantee the farmers target yields, and compensate them if they fail to reach their respective targets.

A spray calendar is a chart that indicates at what time or stage during the development of a crop the farmer should apply pesticide sprays to control weeds, insects and fungi. Some companies use the spray calendar in their sales activities, so it can also be considered an extremely effective sales tool. For instance, Corteva Agriscience conducts its sales activities by using catalogues that contain a spray calendar, which is clearly different from the sales activities conducted by other companies that use simple leaflets. The company's distinctive approach is expected to help farmers understand a suitable spray calendar and select appropriate chemicals with an appropriate timing and appropriate dosage for the practical elimination of pests and the retention of customers. Unlike most other importers, the company does not visit retailers to promote its products. Instead, it targets innovative farmers from among the three classification groups that it employs (innovative farmers, follower farmers, and conservative farmers) by providing them with guidance directly, giving them a thorough explanation of the rationale behind the use of pesticides, and allowing them to purchase products from Corteva Agriscience for themselves at stores.

The establishment of the Crop Protection Association as a tool for promoting communication between pesticide importers and the government has been essential. It acts as a reliable channel of information between the government and the private sector. According to the Terminal Evaluation Report for QCAM, DAL supported the establishment of the Cambodia Agricultural Materials Traders Association (CAMTA), an equivalent to the Crop Protection Association, with the participation of 57 private corporations at the completion of QCAM. However, it has been confirmed that, at present, none of the incumbent DAL officers is aware of the existence of CAMTA, which is supposed to represent the interests of the private sector in transactions involving pesticides and fertilizers.

2. Distributors and Retailers

Pesticide retailers are rooted in local communities at the district and commune levels. Some of these stores deliver products to other retailers, but no clear distinction has been identified between wholesalers and retailers. Most of the technical sales agents of the importers mentioned above, each of whom is placed in

charge of one or more provinces, visit retailers to take orders from them and then have their head office in Phnom Penh deliver the products to the retailers while providing guidance. Some of the importers send their sales agents to retailers in remote villages to develop new sales channels. During the field surveys that we conducted in Battambang Province, it was confirmed that a technical sales agent from GAST Green Agrochemical Co., Ltd. was engaged in sales activities at a retailer in Ansang Sak Village, which is located in the Preaek Norint Commune in the EK Phnom District.

There were university graduates with knowledge of chemistry engaged in wholesaling at the district level, some of whom had completed a Chemical Engineering degree at university and then worked for a family business. However, the majority of retailers in villages only complete a junior high school level of education and acquire their knowledge of pesticides by attending government-sponsored training workshops.

To design approaches for improving pesticide use in Cambodia, it is important to keep in mind that retailers obtain information on pesticide use directly from pesticide importers and then pass it on to the end users. According to Flor et al. (2018), these retailers provide farmers with information on pests and pesticides, provide credits for inputs, and maintain close relationships with farmers. A report by Dinham[9] indicates that farmers have, over the years, increased their dependence on retailers who have access to information on pesticide products through the network that they have formed with pesticide importers, companies, extension staff and dealers.

Farmers from the K'am Samnar Commune in the Leuk Daek District of Kandal Province, which neighbors An Giang Province in Vietnam, often purchase pesticides from retailers in An Giang Province. They then spray the pesticides based on advice provided by the retailers in An Giang. In areas along the national border, neighboring communes enter into agreements on the free flow of people and goods for personal use, so it is possible for pesticides to be purchased for purposes other than sales.

ACs in Japan used to account for 70% of the fertilizer market and 50% of the pesticide market, so they played a vital role in the distribution of fertilizers and pesticides. Due to their high market shares, they had the bargaining power to negotiate with pesticide manufacturers and were able to provide agricultural materials to their members at relatively low prices. In an interview with DACP, one respondent claimed that, although there are a few capable ACs, the majority of them have not matured enough to exert much influence.

At present, there are only a few ACs that negotiate directly with importers in the purchase of pesticide products.

3.5 Current Status of Pesticide Use

3.5.1 Dissemination of Pesticide Use Techniques to Farmers

At present, the government does not engage with farmers directly in promoting the appropriate use of pesticides. DAE currently has 70 officers in central administration and an average of 7 officers for each province. District-level officers were merged with the district government following a recent amendment of the relevant laws, so they are not under the command of DAE (MAFF). At the commune level, contract-based field workers carry out dissemination activities.

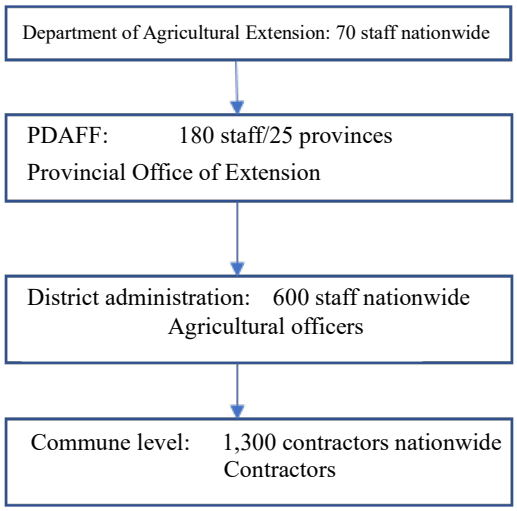


Figure 3-7 System for the Dissemination of Techniques

Source: JICA Study

However, not all of them have knowledge of pesticides, so we cannot expect them to provide guidance on how to use them.

3.5.2 Status of Pesticide Use by Farmers

Investigation method

The current status of pesticide use by farmers was surveyed from January 20 to 23, 2020, in Kandal Province and then from January 27 to 30, 2020, in Battambang Province. Due to time constraints, the survey methodologies required for a large-scale sample of farmers were not adopted for this survey. Instead, a qualitative method was adopted.

The survey was initially conducted by PDAFF to acquire an overview of the province, after which staff visited selected districts and then visited ACs and/or farmers in the company of district officers. Certain farmers were initially visited under the guidance of district officers and then other farmers were chosen as the subjects for interviews about the use of pesticides by using a non-probability sampling method that was applied in conjunction with snowball sampling. The survey was implemented by holding focus group discussions (FGDs) with administrative organs and ACs and conducting semi-structured interviews with farmers about pesticide use.

Table 3-9 Itinerary for the Field Survey and Interviews

Province	Date	Main activities and methodology	Districts, communes and villages visited
Kandal	Jan. 20	✓ FGD	✓ PDAFF
		✓ Individual interviews	✓ Angkor Green ✓ Retailers in S'ang District, Kandal Province
	Jan. 21	✓ FGD	✓ Leuk Daek District Office
		✓ Interviews with cooperative members	✓ Prek Dach Mean Chey Agricultural Development Cooperative ✓ Khpob Ateav Cooperative
		✓ Interviews with individual farmers	✓ Khpob Ateav Commune, Leuk Daek District, Kandal Province
	Jan. 22	✓ Interviews with individual farmers	✓ K'am Samnar Commune, Leuk Daek District, Kandal Province
	Jan. 23	✓ Interviews with individual farmers	✓ Tuek Vil Commune, S'ang District, Kandal Province ✓ Krang Yov Commune, S'ang District, Kandal Province ✓ Tuek Vil Commune, S'ang District, Kandal Province
Battambang	Jan. 27	✓ FGD and Planning	✓ PDAFF
	Jan. 28	✓ Interviews with cooperative members	✓ Ta Sei Samaki Agricultural Cooperative, Ta Sei Village, Ta Meun Commune, Thma Koul District,

			Battambang Province
		✓ Interviews with individual farmers	✓ Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
	Jan. 29	✓ Interviews with individual farmers	✓ Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province ✓ Rohal Suong Village, Preaek Norint Commune, EK Phnom District, Battambang Province ✓ Duong Mea Village, Preaek Norint Commune, EK Phnom District, Battambang Province ✓ Preaek Trab Village, Preaek Norint Commune, EK Phnom District, Battambang Province
	Jan. 30	Interviews with cooperative members	✓ Kampong Preang AC, Os Touk Village, Kampong Preang, Sangkae District, Battambang Province

For these semi-structured interviews with farmers, although the survey formats were not necessarily unified, the cultivation history of the types of crops that had been grown recently by each farmer was checked and the use of pesticides and fertilizers was recorded. Table 3-10 below summarizes information obtained from the investigated farmers by organizing the information according to the type of crop and area.

The subsequent part of the report presents the survey findings supplemented by a document review to complement matters that could not be covered in such a small-scale survey in a short period of time.

Table 3-10 Survey on the Status of Pesticide Use by Farmers

Crops	Address
Bitter melon	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province
Cabbage	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province
Chinese greens	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
Kale	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
Long beans	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
Melon	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province
Mustard greens	Tuek Vil Commune, S'ang District, Kandal Province
Organic cabbage	Ta Sei Samaki Agricultural Cooperative, Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
Organic vegetables	Khpob Ateav Cooperative, Khpob Ateav Commune, Leuk Daek District, Kandal Province
Papaya	Tuek Vil Commune, S'ang District, Kandal Province
Rice	K'am Samnar Commune, Leuk Daek District, Kandal Province
	Kampong Preang AC, Os Touk Village, Kampong Preang, Sangkae District, Battambang Province
	Rohal Suong Village, Preaek Norint Commune, EK Phnom District, Battambang Province
	Duong Mea Village, Preaek Norint Commune, EK Phnom District, Battambang Province
	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province
	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province
Spinach	Preaek Tonloab Commune, Leuk Daek District, Kandal Province
Spring onions	Krang Yov Commune, S'ang District, Kandal Province
Sugarcane	Tuek Vil Commune, S'ang District, Kandal Province
Watermelon	Preaek Trab Village, Preaek Norint Commune, EK Phnom District, Battambang Province

Yard long beans	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province

Investigation results

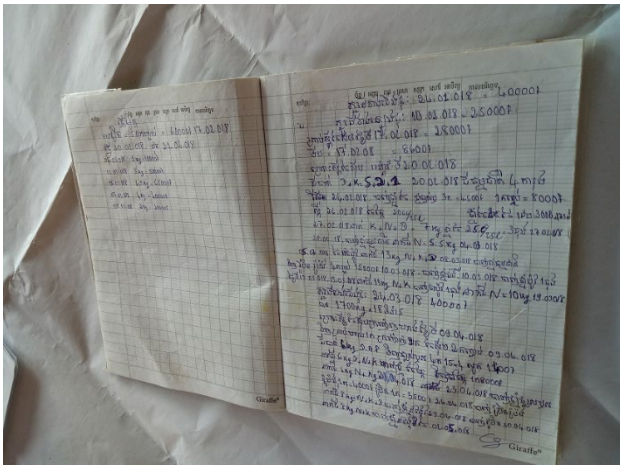


Figure 3-8 Farming Activity Record

Although a few of the interviewed farmers recorded all of their farming activities in notebooks, the majority of them did not keep any records, so pesticide use had to be estimated based on vague information in some cases. It should also be noted that some farmers had significantly reduced their use of pesticides by installing net houses, which may have been introduced under projects such as the one entitled "Building Safe Vegetable Value Chains in Cambodia" (refer to the "Initiatives Adopted by Other Development Partners in the Relevant Areas" section).

Recording of farming activities: Some farmers kept records of their farming activities in notebooks. In the relevant area, an agricultural cooperative that was producing vegetables under a contract with a private firm issued guidance to its members asking them to record their activities. However, one of the interviewed farmers (a young female farmer from Battambang Province) began keeping records even before the guidance was issued by the cooperative. Her sister, who lives in a neighboring district, was also found to have been recording her farming activities.

Economic evaluation of organic farming: During the interview conducted on January 21, 2020, at the Khpob Ateav Cooperative in the Leuk Daek District, a preliminary economic analysis of the production of kale and pak choi using net houses was conducted. The following assumptions were made for this analysis.

1. Labor cost: KHR 23,500/day was adopted as the average value of the reported labor costs in the area as the costs ranged from KHR 22,000 to 25,000/day.
2. Initial investment cost: KHR 16,605,000 was adopted as the initial investment cost based on the fact that, according to the interviews, the cost for the construction of net houses was KHR 14,175,000 while

that for soil amendment was KHR 2,430,000.

3. It was assumed that 8 harvests could be performed in a single year, with 300 kg being harvested in the first production season, 500 kg in the second production season, 700 kg in the third production season (following an improvement of production techniques), and at least 600 kg in subsequent production seasons. Thus, a total harvest of around 3,900 kg was assumed to be possible every year.

4. The farm gate price of kale and pak choi was assumed to be KHR 2,970/kg.

The following assessment was derived from the analysis results.

Under the above assumptions, the investment was judged to be feasible with an IRR of 25% if the project is assumed to run for five years. However, given the durability of net houses, the project life span should ideally be three to four years. IRR for such a scenario was found to drop to 13%. Similarly, the feasibility would be lowered considerably in the event of a replant failure or other such problem.

Table 3-11 Trends in IRR According to Variations in the Assumed Project Period

Years of operation	Base scenario
3 years	-10%
4 years	13%
5 years	25%

Table 3-12 Standard Economic Evaluation for Net House Organic Vegetable Production

Farm income				
	Production season 1		300	kg
	Production season 2		500	kg
	Production season 3		700	kg
	Production seasons 4–8		600	kg
	Total production		3,900	kg
	Farm gate price		3,000	KHR/kg
	Gross annual income		11,700,000	KHR
Production cost				
	Ploughing		30,000	KHR
	Fertilizer application	Fertilizer	220,000	KHR
		Labor cost	117,500	KHR
	Broadcasting	Materials	12,000	KHR
		Seeds	200,000	KHR
		Labor cost	23,500	KHR
	Watering		110,000	KHR

	Harvesting	Labor cost	94,000	KHR
	Packaging	Labor cost	23,500	KHR
	Total cost/crop		830,500	KHR
	Total cost/year		6,644,000	KHR

K2: Organic vegetables

Standard Farm Economy for Organic Kale and Pak Choi Production

Table 3-13 Cash Flow Based on the Assumption of a Five-Year Project

Year	Initial investment	Recurrent cost	Gross annual income	Net flow
1	16,605,000	6,644,000	11,700,000	-11,549,000
2		6,644,000	11,700,000	5,056,000
3		6,644,000	11,700,000	5,056,000
4		6,644,000	11,700,000	5,056,000
5		6,644,000	11,700,000	5,056,000

Unit: KHR

Pesticide purchases through credit transactions: When farmers purchase pesticides from local pesticide stores, they often do so by means of credit transactions. One of the interviewed pesticide importers[88] estimated that only 10% or less of all farmers pay by cash, with the rest choosing to repay their loans after they have harvested and sold their products. The interviews conducted with farmers from Kandal and Battambang revealed that zero interest is charged in many transactions with stores or retailers located in neighboring villages and that the total amount is repaid after the harvest. On the other hand, Flor et al. (2019) report that some retailers do not charge any interest as long as the farmers make a partial cash repayment within 20 days of their purchase, but they charge 2% interest on the remaining amount after the harvest. As such, it seems that there are no standard conditions for the financial arrangements involved in transactions for pesticides between farmers and retailers in villages, and the conditions may vary depending on individual relationships and credibility. It should also be noted that the interest rate of 2% for a period of 20 days is a compound interest rate, so it is not necessarily very reasonable because the rate is equivalent to 42% a year.

Sources of information on pesticide use: In this survey, all of the interviewed farmers used and purchased pesticides based on technical information provided by retailers. Consequently, pesticide retailers located in villages and communes are the most important sources of technical information on the use of pesticides because most farmers purchase pesticides from nearby retailers. If farmers encounter unfamiliar insects

[88] Corteva Agriscience

and/or diseases, they bring photos or plant samples to nearby retailers to acquire technical advice and purchase pesticides. Chhun et al. (2019)[10] report that, in a study of 100 farm households in Battambang Province in 2017, 75% of rice farmers relied on advice from pesticide retailers in the selection and use of herbicides. Meanwhile, Flor et al. (2018)[11] report that, in a survey of 400 farm households in the provinces of Battambang, Kampong Thom, Prey Veng, Pursat, and Takeo, 90% of the farmers surveyed referred to advice from pesticide retailers when making a decision on pest management, with 60% of these farmers purchasing pesticides from local retailers. Flor et al. (2019)[12] also report that, in a survey of 320 farm households, 72% said that they purchased pesticides from nearby village retailers, while 19% said that they purchased them from district or other dealers or sellers located some distance away. The second most important sources of information after pesticide retailers are neighbors in the farming community. Farmers seem to exchange information with each other and obtain important information from local innovative farmers.

Mixture of pesticides: The mixing of multiple pesticide products is generally not recommended as doing so may induce physical and chemical reactions. Such mixtures may reduce or increase the action of the active ingredients and have a harmful effect on crops. Despite this, many farmers in Japan and the rest of the world practice the mixing of multiple pesticide products for labor-saving purposes. In Japan, to help farmers in their decision making, local governments provide technical advice while agricultural cooperatives provide a pesticide mix compatibility chart to provide farmers with guidance on selecting combinations of pesticides that will not have any adverse effects.

In Cambodia too, many farmers practice the mixing of pesticides based on advice from retailers. However, these retailers appear to have no access to correct and scientifically verified information on the mixing of pesticide products; instead, they provide advice on the mixing of pesticides with the sole aim of maximizing their profits over the short term.

A rice farmer from the K'am Samnar Commune in the Preaek Dach District of Kandal Province (Table 3-14) explained that he mixes and applies 6 pesticides (insecticides, herbicides, and a fungicide) plus one foliar fertilizer 60 to 70 days after the sowing of rice seeds. A pesticide retailer in the S'ang District of Kandal Province stated that some rice farmers mix as many as 12 pesticide products. Access to reliable information sources is a significant challenge for farmers selecting pesticides in the rural areas of the country.

Pesticides made in Vietnam: The above-mentioned rice farmer from the K'am Samnar Commune purchases most of his pesticides from retailers in An Giang Province because the commune is located close to the border. This is a legal practice because it is for personal use. However, this practice technically gives rise to various challenges. His decision to mix six chemicals was made based on advice provided by a retailer in An Giang Province. In contrast, a rice farmer from the Kien Svay District produces rice under a contract with a private firm based on technical guidance provided by Vietnamese rice specialists. According to this farmer, the Vietnamese rice specialists have never recommended the mixing of pesticides. Instead, they have advised him to apply the minimum amount of pesticides only when diseases or insects emerge. Part of the Mekong Delta, An Giang Province serves as a production site for rice that is to be shipped to the international market in Thailand. Therefore, it is unlikely that retailers in this area would encourage general Vietnamese rice growers to mix pesticides.

Repeated spraying of the same or similar types of active ingredients: A farmer who produces spring onions (Table 3-15) in the Krang Yov Commune, which is located in the S'ang District of Kandal Province, was found to be mixing two pesticide products: Formectin-Xtra 54EC and Foraim 38EC. The active ingredients of these pesticides are abamectin and emamectin benzoate, both of which act as glutamate-gated chloride channel (GluCl) allosteric modulators. Since they both perform the same action, it does not make sense for them to be used in a mixture. Furthermore, the farmer was found to have repeated the application of the same pesticides every five days. This pattern of pesticide application gives rise to a large risk of the insects developing resistance to the pesticides.

Failure to spray pesticides in accordance with the label instructions: Pesticides are only safe if they are used in accordance with the instructions on the label. However, some farmers were found to have applied the pesticides inconsistently at a level seven times higher than the amount stipulated on the label on some occasions and at half that amount on other occasions.

Limited formulation options: In the field survey, the majority of pesticides were found to be liquid formulations, such as water-soluble chemicals. No powder, granular or other solid formulations were found during the survey. This indicates that farmers in Cambodia have access to a more limited range of formulation options than farmers in Japan do. In the Statistics on Pesticides and Fertilizers (2018), the main formulations included emulsifiable concentrate (EC), wettable powder (WP), soluble concentrate (SL), and oil dispersion (OD). Tablet (TB) formulations are also available, so the Jumbo formulation, which is used in paddy fields in Japan, is assumed to have become more widely available on the market. In Japan, new application methods using diverse formulations have been introduced in response to the growing need for labor saving technologies. These methods include the application of flowable formulations or granular water-soluble formulations at water inlets or the edges of paddy fields and the spraying of flowable formulations or granular water-soluble formulations from ridges. These unique techniques are expected to be applied in Cambodian agriculture in response to the country's need for labor saving initiatives.

Figure 3-9 Engine-Driven Knapsack Sprayer and Tractor-Mounted Boom Sprayer

Limited sprayer options: In the field survey, engine-driven knapsack sprayers were found to be the most commonly used type of pesticide sprayer. No other types of sprayers were found during the field survey. This limited range of sprayer options may be due to the limited range of formulation options. As discussed in the pages with photographs at the beginning of this document, there are various technical issues associated with the use of sprayers, including tractor-mounted boom sprayers. CAVAC has recently tested the use of drones for the aerial spraying of pesticides. This type of method could become widespread in the future.

Table 3-14 Cropping Calendar for Paddy Rice Production

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
0 days	1	Soil preparation and broadcasting	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Seed treatment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Mixture of herbicides	Phu Gia	Propanil	Amide	Inhibition of photosynthesis at PSll - Serine 264 binders	N/A	N/A	N/A
				Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
			CANTANIL 550EC	Propanil	Amide	Inhibition of photosynthesis at PSll - Serine 264 binders	N/A	N/A	N/A
				Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
			Machete 60% EC	Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
8 days	4	Emergence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Insecticide	Padan	Cartap hydrochloride	Nereistoxin analogue	Nicotinic acetylcholine receptor (nAChR) channel blockers	N/A	N/A	N/A
25 days	6	Mixture of unknown insecticide and fertilizer	Unknown insecticide	Mixture of powder and liquid types	N/A	N/A	N/A	N/A	N/A
			Unknown fertilizer		N/A	N/A	N/A	N/A	N/A
40–50 days	7	Unknown pesticide	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60–70 days	8	Mixture of pesticide and fertilizer	V-T 99	N/A	N/A	N/A	N/A	40–50 mL/25 L	N/A
			Tanwin 4.0EC	Emamectin benzoate 4.0%	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	N/A	N/A	N/A
			Philia Sua	Tricyclazole 150 g/L	Triazolobenzothiazole	Systemic fungicide	N/A	N/A	N/A
				Fipronil 15 g/L	Phenylpyrazole	GABA-gated chloride channel blockers	N/A	N/A	N/A

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
			Number 1 200SC	Chlorantraniliprole and chlorfenapyr	Diamide	Ryanodine receptor modulators	N/A	- Rice field 20 mL/25 L (to kill leaffolders) - Rice field 30 mL/25 L (to kill heliothis armigera) - 400–500 L/ha	N/A
					Pyrrole, dinitrophenol, and sulfluramid	Uncouplers of oxidative phosphorylation via disruption of proton gradient	N/A	N/A	N/A
			Hittop/Acdino 350SC	Azoxystrobin	Methoxy acrylate	Cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	N/A	N/A	N/A
				Hexaconazole	Triazole	C14-demethylase in sterol biosynthesis (erg11/cyp51)	N/A	N/A	N/A
				Tebuconazole			N/A	N/A	N/A
			Duca 500EC thuốc trừ sâu rầy mọt đục	Chlorpyrifos ethyl	Organophosphate	Acetylcholinesterase (AChE) inhibitors	N/A	N/A	N/A
				Imidacloprid	Neonicotinoid	Nicotinic acetylcholine receptor (nAChR) competitive modulators	N/A	N/A	N/A
			Chin Chac (foliar feeding for rice)	Total nitrogen: 5% K2O: 15% P2O5hh: 3% Zn: 400 ppm B: 400 ppm pH: 6–7	N/A	N/A	N/A	N/A	N/A
80–88 days	9	Fertilizer	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Irrigation water suspension for ground hardness	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100 days	11	Harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A

K3: Rice (K'am Samnar Commune, Leuk Daek District, Kandal Province)

Total pesticide expenditure during the growing season: USD 450–500/ha for pesticides and fertilizers

Yield: 7 t/ha

Price: KHR 750,000/t

KHR 700–750/kg 2 crops/year

The following information is provided on the label for No. 1.

- Chili plantation: 20 mL/25 L (to kill thrips)
- Long bean plantation: 40 mL/25 L (to kill fruit fly worms)
- Rice field: 20 mL/25 L (to kill leaffolders)
- Rice field: 30 mL/25 L (to kill heliothis armigera)
- Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill corn leaf aphids)
- Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill thrips)
- 400–500 L/ha

Table 3-15 Cropping Calendar for the Cultivation of Spring Onions

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 10, 2019	1	Soil preparation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Herbicide	Super Glykill 36SL 540	Glyphosate	Glycine	Inhibition of enolpyruvyl shikimate phosphate synthase	500 mL/25 L	200–390 mL/25 L water	N/A
	3	Mechanical ploughing to create rows	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 15, 2019	4	Herbicide	Antaxa 250EC	Oxaziazon/ oxadiazon	N-Phenyl-oxadiazole	Inhibition of protoporphyrinogen oxidase	50 mL/ 25 L	30–40 mL/8 L water	N/A
	5	Pump irrigation repeated thereafter	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 25, 2019	6	Seedling transplantation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 25, 2019	7	Mixture of insecticides	Formectin-Xtra 54EC	Abamectin (mixture of avermectins: avermectin B1a and avermectin B1b)	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	50 mL/25 L water	4–5 mL/16 L 800–1,000 mL/ha	N/A
			Foraim 38EC	Emamectin benzoate			50 mL/25 L water	4–5 mL/16 L 800–1,000 mL/ha	N/A
	8	Application of the insecticide mixture (Step 7 above) was generally repeated every five days until February 8, 2020.							
Jan. 15, 2020	9	Fertilizer	Urea and DAP	N/A	N/A	N/A	N/A	N/A	N/A
Feb. 8, 2020	10	No pesticides applied until harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Feb. 15, 2020	11	Harvesting (plan)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A: Not Available K4: Spring onions (based on an interview with a farmer from the Krang Yov Commune in the S'ang District) 870 m^2

Use of protective gear: As some farmers had exhibited symptoms of poisoning caused by exposure to pesticides, the majority of the interviewed farmers were aware of the health risks associated with pesticides. However, the majority of the farmers identified during the field survey at best wore long boots when applying pesticides, and some other farmers sprayed pesticides without wearing any other protective gear. In the Khpob Ateav Commune in the Leuk Daek District of Kandal Province, some farmers wear masks thanks to an information campaign organized by World Vision International and other organizations to encourage the wearing of protective gear to protect against pesticides.

Figure 3-10 Mask Used during the Spraying of Pesticides

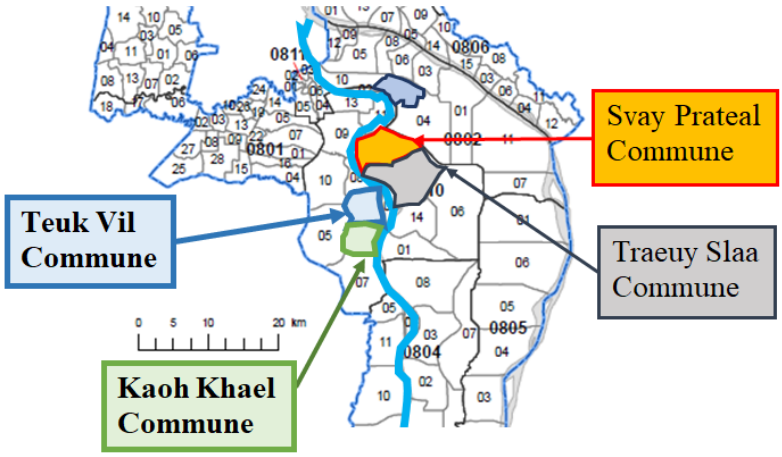
Joint application of pesticides: According to the results of the interviews that were conducted in the field, there were no cases of groups of farmers jointly applying pesticides throughout a wider geographical area. An attempt to apply pesticides jointly was reportedly made in Leuk Daek District, but this attempt failed to introduce the widespread simultaneous application of pesticides throughout the district because the participating farmers could not reach a consensus on doing so. In addition, farmers frequently observe the arrival of insects from neighboring farmlands after the application of pesticides. In fact, some farmers suggested that part of the reason for the application of pesticides in quantities that exceed that stipulated on the product label is the perception of farmers that their farmlands may potentially be infested by insects from nearby farmlands.

3.5.3 Residual Pesticides in Crops

Investigation method

During this survey, 27 crop samples were collected and sent to a private sector laboratory in Ho Chi Minh City for the analysis of about 100 items (active ingredients) by means of a simultaneous multiparameter method using GC-MS/MS.

In the collection of crop samples at each of the selected farms, efforts were made to collect samples that would be representative of the selected farm by collecting them from the entire area and avoiding taking samples from limited



Source: Map 10. Administrative areas in Kandal Province by district *www.stat.go.jp*

Figure 3-11 Main Sampling Locations

roadside areas. The quantity of crop samples collected for vegetables was 1 kg or more, while that for rice was 2 kg or more. For relatively large vegetables (e.g., Japanese radish), five or more individual crop samples were collected.

In the collection of information from farmers on pesticide application, best efforts were made to avoid exposure to high concentrations of pesticides in order to minimize the risk of the samples being contaminated with pesticides. Disposable gloves were used for the collection of samples in the field, and the collected samples were immediately placed in separate polyethylene bags that were then placed inside other polyethylene bags to avoid cross contamination to the extent possible. The samples in these bags were placed in large containers made of Styrofoam. As such, contamination during transportation by vehicle was also avoided as much as possible. The containers were sent to the office of a contractor before 3 pm on the same day as the samples were taken. The contractor then packed the samples in packages containing dry ice and shipped them the following day at 6 am. The samples were analyzed immediately upon delivery to the laboratory in Ho Chi Minh City.

Investigation results

When the 27 agricultural product samples were analyzed for about 100 types of active ingredients, 6 active ingredients that exceeded standard concentrations were detected in some of the samples. The product samples can be broken down as follows: organic agricultural products, agricultural products sold at market, and agricultural products purchased from the farm. Most of the products that contained the detected pesticides were sold at market, and residual pesticides were not detected in organic agricultural products.

3.6 Chemical Analysis Laboratory in Cambodia

3.6.1 Government Sector Laboratory for Chemical Analysis

In Cambodia, there are multiple government laboratories capable of analyzing pesticides, including laboratories under the jurisdiction of MISTI and MOC. Their primary duties are summarized in the table below. Of these Cambodian laboratories, it was recognized that the National Metrology Centre in Cambodia (NMC), which is under the jurisdiction of MISTI, had the greatest relevance and importance in relation to the upcoming project. Ideally, the laboratory measurements and calibrations should be traceable to international standards via NMC. This is especially important for measuring equipment involving parameters such as mass, volume, and density. In some cases, temperature calibration is deemed important, as well.

Table 3-16 Current Status of Leading Government Sector Laboratories

Ministry	Laboratory	Description and relationship with this project
Ministry of Industry, Science, Technology and Innovation (MISTI)	National Metrology Centre in Cambodia (NMC)	NMC was formally established on April 22, 2011. Measurements and calibrations at the laboratory need to be traceable to international standards via NMC. It is particularly important to discuss the need to calibrate measuring equipment involving parameters such as mass, volume, density, and temperature.

Ministry	Laboratory	Description and relationship with this project
	Industrial Laboratory Center of Cambodia (ILCC)	The main role of ILCC is to manage the safety and quality of seasoning products, such as soy sauce, and industrial products, such as processed agricultural products and beverages. The safety and quality of agricultural products in farmlands and those in the market do not fall under the legal mandate of ILCC.
Ministry of Commerce (MOC)	Camcontrol Testing Laboratory (CTL)	CTL, which is under the jurisdiction of Cambodia Import-Export Inspection and Fraud Repression Directorate-General (CAMCONTROL) of MOC, is mandated to test the safety of foods on the market. Agricultural products, if they are traded at a market, are also tested by CTL.
Ministry of Agriculture, Forestry and Fisheries (MAFF)	National Agricultural Laboratory (NAL)	NAL, a laboratory under the jurisdiction of MAFF, mainly conducts tests of fertilizers, pesticides, and soil.
	Laboratory of Agricultural Products and Foods (LAPF)	LAPF, which is under the jurisdiction of DAI, is mandated to test the quality and safety of a broad range of foods. The tests conducted there cover physicochemical and microbiological parameters. Monitoring and surveillance of GMOs also falls under the mandate of LAPF.
	National Veterinary Research Institute (NaVRI)	NaVRI is primarily responsible for monitoring animal health by analyzing serological, histological and bacteriological characteristics. The analysis of food no longer falls under the mandate of NaVRI.
Ministry of Environment (MOE)	Environmental Laboratory	This laboratory, which is under the jurisdiction of the Department of Environmental Pollution Control, mainly monitors pollutants in environmental media such as air and water. Since 1996, it has mainly been supported by UNDP and EU.
Ministry of Health (MOH)	National Health Products Quality Control Centre	This laboratory, which is under the jurisdiction of MOH, mainly implements drug quality controls using instrumental analysis. To some extent, it is also involved in analyzing samples from poisoning outbreaks.
Other	The Pasteur Institute	As an international NGO, this institute maintains a large-scale laboratory complex in Phnom Penh and is home to a number of specialized laboratories, including a food microbiology and water laboratory. Since its establishment in 1996, the food microbiology and water laboratory has provided routine analysis services in three fields: 1) contamination of water by microorganisms; 2) food microbiology and environmental sampling; and 3) chemical parameters of water.

3.6.2 Private Sector Laboratory for Chemical Analysis

During this survey, four leading private sector laboratories having offices in Cambodia were consulted and considered. However, it was confirmed that they did not have adequate facilities to undertake pesticide residue analysis.

The main findings for three of the laboratories (SGS, Bureau Veritas and Intertek) were as follows: 1) they maintain large-scale laboratories to provide testing services for the garment sector; 2) they operate laboratories also in Thailand and/or Vietnam; and 3) only Bureau Veritas is capable of undertaking simultaneous multiparameter pesticide residue analysis by using GC-MS/MS at its laboratory in Ho Chi Minh City. It has been confirmed that Acta Bio subcontracts pesticide residue analysis to Eurofins Scientific in Vietnam for its contract with CAVAC.

Table 3-17 Leading Private Sector Laboratories in Cambodia

Company	Description
SGS (Cambodia) Ltd.	Headquartered in Switzerland, this multinational company provides inspection, verification, testing, and other services. 1. One laboratory in Bangkok 2. Three laboratories in Vietnam (Hai Phong, Cam Pha, and Ho Chi Minh) Website: https://www.sgs.com/
Bureau Veritas (Cambodia) Ltd.	Headquartered in Paris, this company is one of the world's largest certification companies. Website: https://bureauveritas.com
Intertek Cambodia	Headquartered in London, this company is one of the world's largest certification companies. 1. Twelve offices/laboratories in Thailand, with two of them specializing in agriculture and one of them specializing in foods. 2. Twelve offices/laboratories in Vietnam, with a laboratory specializing in petroleum/agriculture located in Ho Chi Minh and one specializing in foods/agriculture located in Can Tho in the Mekong Delta. Website: https://www.intertek.com/
Acta Bio Co., Ltd.	Website: https://www.actabio.com/

3.6.3 Current Status of Analysis Equipment and Reagents

A summary of the leading suppliers for laboratory operations is provided in the table below. It has been confirmed that following are available through suppliers located in Phnom Penh: 1) high-purity solvents, such as acetone, for the extraction of chemicals; 2) standard pesticide reagents; and 3) various carrier gasses for gas chromatography. It should be noted, however, that each company has different arrangements for its delivery services. For instance, the operating instructions for analytical instruments produced by Agilent Technologies, Inc. would be supported by a company based in Malaysia. Furthermore, Dynamic Scientific Co., Ltd. does not engage in small-lot sales of chemicals at present. The recent global shortage of helium gas means that early planning and ordering would be required.

Table 3-18 Leading Suppliers of Analysis Equipment and Reagents

Company	Overview	Main products related to residual pesticides
DKSH (Cambodia) Ltd.	DKSH is a trade company dedicated to research materials. Based in Switzerland, its office in Phnom Penh is located close to NAL. DKSH acquired Eurocontinent, the sales agent of Agilent Technologies, two years ago, so it can now supply Agilent instruments. However, technical guidance on and operation and maintenance services for Agilent instruments are provided by Perfect Analytical Measurements (PAM), a company based in Malaysia. http://www.pamsea.com/ Website: https://www.dksh.com/kh-en/home	1. GC-MS 2. ICP-MS 3. LC-MS 4. Chemical weighing scales 5. Homogenizer 6. Stirrers, etc.

Company	Overview	Main products related to residual pesticides
X-Lab Co., Ltd.	A sales agent for SHIMADZU and HORIBA, this company offers a product line that includes GC and other such instruments. Under SATREPS, it did business with X-Lab. The carrier gas used for GC is procured via Air Liquide S.A. in Vietnam or from another channel via Singapore. Acetone and other high-purity solvents are procured from Merck and Scharlab (via Vietnam and Thailand). Website: http://www.x-lab.asia/	1. Filter units 2. General glassware 3. Pure water system 4. SHIMADZU's GC, GC-MS, LC-MS, etc. 5. Rotary evaporators 6. Standard pesticide reagents 7. Carrier gasses for GC 8. High-purity solvents
Dynamic Scientific Co., Ltd.	Part of the Cambodia-funded Dynamic Group, this supplier specializes in the provision of laboratory equipment. Its product line includes products supplied by Millipore and PerkinElmer. Dynamic Scientific no longer engages in the sales of reagents because it does not meet the floor area requirements for storage that are necessary to acquire ISO certification. The company is able to supply reagents manufactured by Merck and other manufacturers only for large-scale bids at present. It does not supply reagents in small lots at this point because of the costs associated with importing them. Agrotech Vita is a pesticide dealing company in the same group. Website: https://www.dynamic.com.kh/	1. Rotary evaporators 2. Chemical weighing scales 3. Pipettes 4. Stirrers 5. HPLC 6. GC-MS 7. ICP-MS
Cambodia Scientific Co., LTD.	Established in 2010, this company provides medical and laboratory equipment and chemicals, etc. Website: http://www.cambodiasci.com	1. HPLC

Note 1: A group company of Gulf Bio Analytical LLC (GBA), which is based in Dubai.

Note 2: No. 155, Street 134, Sangkat Mitapheap, Khan 7 Makara, Phnom Penh, Cambodia

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sales@x-lab.asia/sales.xlab@gmail.com

www.x-lab.asia

Although X-Lab is the formal sales agent for SHIMADZU and HORIBA, it can be assumed that companies such as Dynamic Scientific are also capable of providing goods from these two companies. If equipment needs major repairs, the X-Lab office in Singapore or Thailand undertakes the work.

Table 3-19 Leading Japanese Manufacturers of Laboratory Equipment in Neighboring Countries

Japanese company	Branches near Cambodia
SHIMADZU CORPORATION	This company has an office in Singapore. Website: https://www.shimadzu.com.sg/
HORIBA, Ltd.	This company has an office in Bangkok. Website: https://www.horiba.com/sg/

For the supply of reagents, Sigma-Aldrich and Merck have established branch offices in neighboring countries. However, reagents may also be acquired through local suppliers operating in Phnom Penh.

Table 3-20 Leading Reagent Suppliers in Neighboring Countries

Reagent supplier	Branches near Cambodia
Sigma-Aldrich Pte. Ltd.	This company has an office in Singapore. Website: https://www.sigmaaldrich.com/singapore.html
Merck	This company has offices in Vietnam (Ho Chi Minh and Hanoi). Website: https://www.merckgroup.com/en

3.6.4 Disposal Methods and Facilities for Chemical Waste

Laws and regulations concerning the disposal of chemical waste

MOE is now amending the Sub-Decree on Water Pollution Control, which is expected to be approved by December 2020. The latest version of this sub-decree does not contain any significant changes in the pertinent articles on laboratory waste (No. 27 ANRK.BK). In principle, the discharge of wastewater that does not meet the applicable standards is not permitted, as stipulated in Article 6 of the sub-decree.

Article 6: The discharge of wastewater from any sources of pollution that is not consistent with the standards for effluent discharge as mentioned in the article 4 and article 5 of this sub-decree shall be strictly prohibited.

The current practices for laboratory wastewater management subject to this article have been confirmed, and they are summarized in the table below.

Table 3-21 Status of Wastewater Treatment at Laboratories

Laboratory	Wastewater treatment method	Issue
MOE laboratory	Wastewater from the laboratory is disposed of by handing it over to a third party (Sarom Trading Company).	Appropriate treatment by the third party is a prerequisite.
MAFF/NAL laboratory	In accordance with instructions issued by a Philippine specialist during QCAM, organic solvents are collected in glass bottles and then kept in an outdoor storage facility so that they can vaporize into the air. After use, the glassware and bottles are crushed and then handed over to CINTRI CAMBODIA Co. Ltd. together with other solid waste.	After vaporization, chemicals may become concentrated and remain on the internal surface of the glassware or bottles. Therefore, the collection service involves the risk of exposure to chemicals. As the services provided by private companies are limited, no other options are available.
Private sector laboratory in Ho Chi Minh	Wastewater from the laboratory is usually kept in 30 L plastic containers. A contractor collects them for final disposal.	The legal framework is different.

Article 8 of the latest version of the sub-decree, which is expected to be approved by the end of 2020, contains the following stipulation, and there is still room for improvement in relation to the handling of wastewater from laboratories.

Article 8: The disposal of solid waste or any garbage containing hazardous substances into public water areas or into public drainage system shall be strictly prohibited.

The storage or disposal of solid waste or any garbage and hazardous substances that lead to the pollution of water of the public water areas shall be strictly prohibited.

As of February 2020, the General Directorate of Environmental Protection of MOE is holding discussions with the relevant ministries and agencies to finalize matters such as the water discharge criteria and penalties, so the standard values and other such information cannot be presented in this report.

Figure 3-12 Glassware for Outdoor Wastewater Storage (Photograph from NAL)

3.7 Initiatives Adopted by Other Development Partners in the Relevant Areas

The table below summarizes three projects.

Table 3-22 Status of Initiatives Adopted by Other Development Partners in the Relevant Areas

Main project	Overview
Cambodia Agricultural Value Chain Program (CAVAC)[1)] Phase I: 2010–2015 $60,000,000 (evaluation completed December 2017) Phase II: 2016–2021 $89,720,000 ✓ AusAID	To increase the productivity and incomes of small-scale farmers in Cambodia, the following areas are supported: 1) productivity and diversification; 2) irrigation and water management; and 3) milling and exports. To address 1), the project is engaged in the dissemination of agricultural techniques, particularly those related to fertilizers and pesticides. Specifically, measures such as the provision of training for pesticide retailers, promotion of the use of adjuvants, and promotion of aerial pesticide spraying using drones have been implemented.
Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE)[2)] ✓ 2015–2021 ✓ USD 52,500,000 ✓ IFAD	The objective of ASPIRE is to improve technique dissemination services that can be used by small-scale farmers, and its goal is to transform agriculture into a resilient and profitable business in cooperation with poor and vulnerable small-scale farmers. To this end, ASPIRE has developed effective policies, strengthened its dissemination services, and helped in the construction of infrastructure that supports climate-resistant agriculture.
Higher Education Improvement Project (HEIP)[3)] ✓ 2018–2024 ✓ USD 92,500,000 ✓ WB	The objective of HEIP is to improve the quality of higher education and research, encourage organizations to cooperate with each other in STEM and agriculture fields of the targeted higher education institutions, and improve governance in this area. In an attempt to improve the system capacity and learning capabilities at higher education institutes, HEIP has also improved the quality of research through the provision of subsidies for research programs and strengthened the systems of higher education departments.

Source: 1) https://www.dfat.gov.au/sites/default/files/cambodia-cavac-2-investment-design-document.pdf
2) https://www.dfat.gov.au/sites/default/files/cambodia-cavac-2-investment-design-document.pdf
3) https://projects.worldbank.org/en/projects-operations/project-detail/P162971?lang=en (accessed March 4, 2020)

3.8 Agriculture-Related Initiatives in Educational Institutions

3.8.1 Royal University of Agriculture

During the survey, consultations were held with the Division of Research and Extension at the Royal University of Agriculture (RUA). It was confirmed that the division had recently engaged in the following projects related to safe vegetable production and AVCs.

1. Building Safe Vegetable Value Chains in Cambodia
2. Project for Agricultural Development and Economic Empowerment (PADEE)
3. Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE)
4. Higher Education Improvement Project

The Higher Education Improvement Project was particularly closely related to this survey. Under this project, GC-MS/MS was to be provided and two or three researchers were to be dispatched to the University of the Philippines Los Baños (UPLB) to participate in a training program on the analysis of residual pesticide. Although it has yet to be confirmed, they were to be dispatched to the National Crop Protection Centre under UPLB through the coordination of SEARCA[89].

Two recent studies conducted by this division are summarized in the table below. These studies also indicate that the division has an extremely deep relationship with this survey.

[89] The Southeast Asian Regional Center for Graduate Study and Research in Agriculture https://www.searca.org/ (accessed February 23, 2020)

Table 3-23 Overview of Recent Publications by the Interviewees

Key literature	Description
Schreinemachers, P., Grovermann, C., Praneetvatakul, S., Heng, P., Nguyen, T.T.L., Buntong, B., Thinh, L.N., and Pinn, T.: "How much is too much? Quantifying pesticide overuse in vegetable production in Southeast Asia," *Journal of Cleaner Production*, Oct. 5, 2019	This study quantifies the extent of pesticide overuse in vegetable production systems in Southeast Asia. Pesticide overuse is defined in this publication as the levels of use in excess of the economic optimum, and the following Cobb–Douglas production function is used to estimate the damage abatement with an exponential term. $Y_i=F(Z_{ij})G(X_i)$ - where, Y_i is the output value for farmer *i*, Z_{ij} is the value of regular input *j* (land, labor, seeds, and fertilizer) applied by farmer *i*, and X_i is the value of pesticide expenditure. $G(X_i)$ is a cumulative distribution function that takes on a value between zero and one to represent the effectiveness of damage abatement methods in limiting yield losses. The data used came from representative samples collected from 1,000 farmers producing leaf mustard and yard long beans in Cambodia, Laos, and Vietnam. The results show that 100% of the sampled farmers in Vietnam overused pesticides, compared to 70% in Cambodia and 59% in Laos. Pesticide overuse was positively associated with the following factors: "men being in charge of pest management decisions," "farmers seeking advice from pesticide sellers," and "a strong belief that pesticides are effective." It was negatively associated with the "use of non-chemical methods of pest control." These results imply that farmers in Southeast Asia spray pesticides excessively and inefficiently and that they could actually increase their profits by applying pesticides in smaller quantities.
Schreinemachers, P., Chen, H., Nguyen, T.T.L., Buntong, N., Bouapao, L., Gautam, S., Le N.T., Pinn, T., Vilaysone, P., and Srinivasan, R.: "Too much to handle? Pesticide dependence of smallholder vegetable farmers in Southeast Asia," *Science of the Total Environment* 593–594 (2017) 470–477	This study is aimed at understanding the knowledge, attitudes, and practices of farmers in regard to agricultural pest management and pesticide use in Southeast Asia. The data used came from 900 farm households producing leaf mustard and yard long beans in Cambodia, Laos and Vietnam. The farmers were heavily dependent on synthetic pesticides as their main method of pest control. Most farmers were aware of the adverse effects associated with pesticide use and covered their body parts while spraying, but they also considered pesticides to be highly effective and indispensable farm inputs. The farmers were largely unable to distinguish between common beneficial and harmful arthropods. Greater knowledge of this was associated with less pesticide use, while greater awareness of pesticide health risks was associated with fewer observed poisoning symptoms. Although various factors are involved, it was found that, among average farmers, the quantity of pesticides used by those who sought advice from friends and neighbors was 45% lower, while the quantity used by those who sought advice from pesticide sellers was 251% higher. Furthermore, pesticide use was 45% lower if a woman was in charge of pest management and 31% lower if the farmer had adopted biopesticides. These findings are expected to provide solutions to the pesticide dependence of farmers.

Both publications can be downloaded from the following links (accessed March 6, 2020).

https://www.researchgate.net/publication/336308557_How_much_is_too_much_Quantifying_pesticide_overuse_in_vegetable_production_in_Southeast_Asia

https://www.sciencedirect.com/science/article/pii/S0048969717307027

3.8.2 Institute of Technology of Cambodia

The Institute of Technology of Cambodia (ITC) participates in a JICA-funded program entitled

"Establishment of Environmental Conservation Platform of Tonle Sap Lake" (SATREPS[90])[91]. SHIMADZU's GC-MS TQ8040, a triple quadrupole GC/MS/MC, was installed in the laboratory. According to the results of an interview, however, it is currently being used as GC/MS. For it to be used as MS/MS/MS, follow-up training would be necessary. It was also reported that there was room for improvement in terms of data QC/QA. Despite the technical challenges involved in the operation of the laboratory, ITC researchers are, as of February 2020, capable of conducting a series of analysis tasks on pesticides in the environment and obtaining the required results. However, it has been difficult to procure consumable crops so, in this project for example, standard chemicals are being transported from Japan. ITC was willing to provide pesticide residue analysis services in the future although it had no previous experience in this area.

[90] Science and Technology Research Partnership for Sustainable Development (SATREPS) is a joint research program led by the Japanese Government for addressing global issues.

[91] For correspondence with staff, e-mails should be addressed to Dr. Siev Sokl (sievsokly@yahoo.com), who represents the ITC team for SATREPS, and CCed to Dr. Seingheng.

Chapter 4 Policies for JICA Initiatives (Summary)

4.1 Summary of Study Results

Through this survey, information on AVCs and agricultural administration in Cambodia has been collected and organized. The following is a summary of the most important findings.

By promoting the country's industrial development, the Cambodian government aims to promote the creation of added value and further strengthen the agricultural sector by making VCs for agricultural products more robust. Given this, MAFF is promoting and developing AVCs, including those aimed at improving food safety and promoting exports of processed agricultural products, as a priority initiative while also strengthening ACs and CF. Meanwhile, the limited formation of markets for agricultural products with high added value and the insufficient development of technologies and infrastructure for post-harvest treatment and processing are acting as a bottleneck to achieving the above-mentioned political goals in Cambodia. Of the three commodities that were selected as the target commodities for this survey (i.e., vegetables, pepper, and cashews), pepper and cashews are produced on the assumption that they will be processed at a later date, in addition, markets that seek products with high added value are being formed in countries that could be trade partners in the future, mainly neighboring countries. Therefore, those two commodities are considered to have good growth potential for the development of AVC.

Under the government system for the development of AVCs, MAFF plays the role of main actor primarily in relation to the production of agricultural products. However, in the establishment of standards and regulations concerning food safety and quality, multiple ministries and agencies, including MOC and MOH, need to be involved. In addition, while DAI, which forms part of MAFF, generally undertakes the development and strengthening of AVCs, some of its roles overlap with those of other MAFF departments. Therefore, the future roles of DAI need to be further clarified, and advisors who are to be dispatched by JICA in the future will provide advice on this matter.

In terms of pesticide administration, the country's pesticide registration system has been strengthened and the formulation analysis conducted by NAL has been improved through the implementation of QCAM (2009–2012). Meanwhile, owing to the enforcement of the Law on the Management of Pesticides and Fertilizers, about 90% of pesticides have now been registered and the number of pesticide analyses conducted by NAL has risen to more than 1,000 per year. ADB and other development partners also provide support in relation to this field, including assistance in infrastructure development. Furthermore, as stated in Chapter 2, rapidly increasing consumer needs for the assurance of food safety mean that this field needs to be strengthened, particularly in terms of pesticide residue analysis. In response to these needs, JICA is planning to provide technical cooperation for the strengthening of pesticide residue analysis. On the other hand, given that pesticides are still often used inappropriately on the production side and in light of the need to ensure food safety going forward by implementing measures such as the establishment of food safety standards, the Cambodian government must tackle this issue from a long-term perspective. When JICA starts providing technical cooperation in the future, it will need to proceed with its cooperation while sharing its mid- to long-term vision with the Cambodian government.

4.2 Points to Note in Relation to Initiatives for Strengthening Agricultural Value Chains

In Chapter 2, VCs for vegetables that will mainly be consumed domestically as well as VCs for peppers and cashews that will mainly be exported are assessed and a discussion is conducted with a particular focus on the role of government.

4.2.1 Approach to Strengthening Vegetable VCs

- Due to steady economic growth, the country's middle-income group is expanding. Predominantly in this group, a vague feeling of anxiety about food safety is spreading, a large part of which involves concerns about the safety of imported vegetables and expectations for domestic vegetables. However, although this anxiety is often covered by the mass media, the information provided is not necessarily based on actual data because the government has not yet developed a system for monitoring the safety of agricultural products.
- While these expectations for domestic vegetables continue to grow, the main challenge faced at production sites is that, due to the restrictions imposed by Cambodia's meteorological and topographic conditions (i.e., high temperatures and humidity during the rainy season and water shortages during the dry season), there is insufficient production to satisfy domestic demand. In reality, then, this means that Cambodia is reliant on imports from neighboring countries for 60 to 70% of its vegetable supply.
- Furthermore, in a conventional distribution system centered on local markets, the country's price formation process lacks transparency as a transaction system capable of assessing and reflecting quality in prices has yet to be developed so negotiation transactions are mainly conducted. Therefore, many challenges still need to be overcome in terms of modernizing the distribution and transaction systems, including the following: 1) market signals often fail to reach the producers; 2) large losses are suffered after harvesting because the means of packaging and transportation are not suited to maintaining freshness; 3) waste is not disposed of properly and products are not always handled hygienically; and 4) urban markets are not capable of handling the increasing transaction amounts, thereby preventing reasonable and efficient freight collection and sorting.
- For markets to respond to the growing awareness of food safety mainly among the rich and middle classes, the country needs to establish safety standards, create a monitoring and inspection system, and develop a regulatory and guidance system for the prevention of infringement cases. However, systems such as these for the protection of food safety, which includes assigning roles to the relevant ministries and agencies, are still in the development stage.
- As the actual conditions of these conventional markets are not compatible with modern distribution channels (e.g., high-end supermarkets, which have recently increased in number in urban areas), high-quality shops that target the wealthy and foreign nationals enter into contracts with farmer groups and form independent VCs in which products do not pass through conventional markets so that they can respond to recent changes in demand, thereby expanding their businesses (dual-structure VC).
- Based on the above-mentioned conditions relating to VCs for domestic and imported vegetables, possible approaches to the short-term and mid- to long-term initiatives to be taken are as follows.

Short-term initiatives

- To modernize a conventional VC, initiatives that include an institutional design, organizational development, and infrastructure development must be implemented in stages according to a long-term roadmap encompassing more than 10 years at least. Given this, from a short-term perspective, the issues facing concerned parties will be solved and support for the expansion of VC will be provided by focusing on VCs centered on CF, which has already been expanding under private sector initiatives. Such efforts are considered meaningful as pioneering initiatives for the modernization of conventional VCs. The specific matters to be focused on in these activities include the following: 1) establishment of food safety standards; 2) clarification of roles among concerned ministries and agencies to ensure food safety throughout the entire VC; 3) improvement of inspection capabilities, including food hygiene inspections and pesticide residue inspections; 4) development of information networks, including in terms of the production, consumption, and price of agricultural products; 5) support for business matching; and 6) provision of support packages, including those for improving production techniques and quality management through measures such as the promotion of farmer groups and GAP and strengthening the capabilities of farmer groups in relation to the implementation of CF.
- The most significant factor contributing to the gap in the supply and demand for domestic vegetables is the production environment. In other words, Cambodia's high temperatures and humidity during the rainy season and its water shortages during the dry season impose substantial restrictions on production. It is difficult for these environmental restrictions to be overcome completely, but it is considered meaningful to discuss feasible technical options in order to address the potential preference for domestic products. These options include the promotion of suitable cultivation in suitable locations through the mapping of the production environment, the use of embanked cultivation, ridged cultivation, and rain protected cultivation, the selection of crop varieties that are resistant to humidity, and the adoption of production methods using simple pumps during the dry season.

Mid- to long-term initiatives

- In terms of mid- to long-term initiatives, it is necessary to modernize conventional VCs, which account for the majority of food distribution, and proceed with the phased implementation of initiatives aimed at establishing a system that can respond to possible changes in eating habits and the future growth of food-related industries. These initiatives specifically include the following: 1) introduction of a price formation system with high transparency and fairness (discussion of options such as auctions, consignment sales, and the unification of classifications and standards); 2) development of a market information collection and sharing system; and 3) development of wholesale markets (efficient collection/shipping systems, hygienic environments, operation standards, etc.). Many of these activities will require a great deal of time and human resources, but they may have a considerable impact on existing VCs. Therefore, it is necessary to start by preparing a roadmap for VCs centered on wholesale markets and then proceed with the phased implementation of these initiatives by involving development partners and private enterprises.

4.2.2 Approach to Strengthening VCs for Commodities Exported as Raw Materials

- Vietnam, a country neighboring Cambodia, is one of the world's largest exporters of agricultural products and it holds top-ranked positions in the export of many commodities, including rice, coffee, and cashews. In reality, however, it is well known that a large amount of raw materials exported from Cambodia through unofficial trade channels are exported from Vietnam as products labelled "Made in Vietnam." Although Vietnam plays an important role for Cambodian agriculture as a stable sales channel, it can also be argued that, since the value added to these raw materials rises greatly at the time of export, a large amount of profit is currently being lost in comparison with the export of final products from Cambodia. MAFF aims to resolve this issue gradually and to expand the country's channels for selling agricultural products on the international market. Rice exports, for example, increased rapidly from 1,000 tons to 520,000 tons during the ten years from 2007 to 2016.
- In terms of the cashew VC, this survey checked the domestic processing facilities for cashews and the flow of raw material exports to Vietnam, revealing an extremely large difference in the scale and style of raw material transportation as well as the scale of processing facilities. The results of a comparison of final products that have undergone post-harvest treatment, processing and packaging in Cambodia with those produced in Vietnam indicate that Cambodian products cannot be expected to be competitive in terms of price, at least over the short term. However, in a comparison of their quality as raw materials, Cambodian varieties tend to be larger in size and highly appreciated by Vietnam business operators. According to the results of another interview, although Cambodian mangoes are high quality in terms of their use as a raw material, they are currently not exported due to a lack of infrastructure for processing and storage after harvesting as well as delays in the development of fumigation facilities for exports to advanced countries.

Short-term initiatives

- For items that have become commodities, such as cashews and cereals, it is difficult to compete with the developed distribution/shipping systems of leading export countries over the short term. However, from a short term perspective, it is considered to be practical to extract some commodities that will be able to exhibit Cambodia's own added value and advantages and form an export model targeted at niche markets in cooperation with private enterprises.
- To satisfy requirements related to matters such as food hygiene and plant quarantine for exports, support from the administration side is also indispensable, and it is necessary for farmer organizations, distributors, and administrative organs to engage in cooperative initiatives as a team from the planning stage onward. For the time being, the activity goals are likely to involve discussions on the formation of a platform for these initiatives and a strategy for exporting through this platform (i.e., narrowing down of commodities and production sites, matching between production sites and actual consumers, attraction of investment from the public and private sectors, and details of services that the administration should offers).

Mid- to long-term initiatives

- The direction of Cambodia's shift from an exporter of raw materials to an exporter of products with high added value is reasonable to a certain degree, but the phased implementation of comprehensive

initiatives will have to be undertaken by both the public and private sectors for this shift to be achieved, which will necessitate a long-term strategy, an institutional design, and investment. Although it is difficult to discuss a specific deadline and input scale at this point, the most likely key challenges to be tackled are listed below.

- The advantages enjoyed by Cambodia are that it has large agricultural areas and that it exports commodities (e.g., rice, cashews, mangoes, and pepper) that are competitive with those of the leading production countries in terms of quality. However, the country also faces significant challenges in terms of quality degradation and cost increases arising from low productivity associated with the use of conventional farming techniques and delays in the development of infrastructure and logistics related to post-harvest processes. While the resolution of issues associated with factors such as agricultural land, roads, water, electricity, post-harvest treatment facilities, and storage facilities must be prioritized, they all require massive investment so it is necessary to evaluate their cost performance carefully in consideration of the mid- to long-term trends of the export markets, select areas and commodities for preferential investment by involving private enterprises as well, and conduct intensive investment.
- When commodities are exported, the importing counties require Cambodia to meet various quality standards. However, another significant issue faced by Cambodia is that a series of institutional quality management systems has yet to be developed, including systems related to the establishment of unified quality standards that are compatible with the applicable standards, the monitoring of markets and stores in accordance with these standards, and the provision of guidance to business operators and producers who handle or produce products that fail to comply with these standards. Although export markets are different from domestic markets, the reality is that a failure to develop domestic institutional systems is linked to the difficulties associated with the implementation of quality management when commodities are exported.
- An exporter that was interviewed pointed out that the procedures required to obtain the various permits and licenses required for exports and/or imports encompass multiple ministries and agencies and that the procedures are unclear and complicated. Having recognized these issues, the government is working to make improvements and its efforts are expected to be further accelerated.
- Rice produced in Cambodia is highly rated around the world, and it is a driving force behind the country's exports. Other export commodities are also highly rated by business operators, but this recognition is not necessarily widely known. It is necessary to increase international awareness of not only rice but also other products made in Cambodia and to proactively engage in efforts aimed at expanding the markets for such products as a matter of national policy.

4.3 Points to Note in Relation to Cooperating in the Provision of Support for Agricultural Administration

As explained in Chapter 3, Cambodia used less chemical pesticides than other Southeast Asian nations during the 1980s and 1990s. However, the country's rapid economic growth during the 2000s accelerated a transfer of labor from the agricultural sector into other sectors, which induced a transformation of the rural socioeconomic structure. The resultant labor shortages in rural areas meant that farmers had to use chemical pesticides to remove weeds and control pests. Cambodia aims to become an upper-middle-income country

by 2030 and a high-income country by 2050, so it will need to undergo further industrial advances in the coming decades, which may worsen labor shortages in rural areas. Therefore, it is presumed that the increased use of chemical pesticides may be unavoidable and irreversible.

According to the results of a study conducted in 2011 by CEDAC in areas located in Takeo Province near the national border with Vietnam and in Pailin Province near the national border with Thailand, it was found that only 18% of the pesticide products displayed in the stores there had labels written in Khmer, while 58% had them written in Vietnamese, 23% in Thai, and the remaining 1% in languages such as Chinese, Arabic, and English.

Between March 1, 2009, and March 31, 2012, which is before CEDAC conducted its survey, MAFF implemented QCAM and then, by leveraging the momentum generated by the project's implementation, drafted and enacted the Law on the Management of Pesticides and Fertilizers in January 2012. In the following decade, domestic pesticide management improved significantly.

It is said that more than 80% (i.e., 80–90%) of pesticide products sold in Cambodia are currently imported and sold through formal channels. The expert judgement issued by MAFF officers agreed almost completely with the observations made during the field surveys that were conducted in the provinces of Kandal and Battambang (January and February 2020) by visiting various retailers and farm households. This demonstrates two fundamental facts: 1) DAL has made ceaseless efforts to implement measures such as on-site inspections; and 2) MAFF has allocated financial and human resources to support these efforts.

It has been confirmed that, in accordance with the Agricultural Sector Strategic Development Plan 2014–2018, NAL's capacity to analyze formulations had been increased every year and the number of pesticide samples that were analyzed had reached 1,076 by 2018, which exceeded the initially planned value. Thus, MAFF steadily strengthened pesticide management and reached its goal. Given the above-mentioned facts, the preconditions for NAL to conduct pesticide residue analysis for farm crops, as agreed in September 2019, have been satisfied.

Nonetheless, the survey team was disappointed to find that there were numerous problems relating to the actual use of pesticide by farmers. Following advice from pesticide stores, farmers often applied unnecessary pesticides and repeatedly sprayed the same or similar types of chemical pesticides, which gives rise to a large risk of the insects developing resistance to the pesticides.

In addition, RUA also has a concern in pesticide use in Cambodia other than MAFF. RUA is engaged in a wide range of major programs on pesticides, from basic research to the provision of extension services, and has participated in important projects concerning pesticide use in recent years. The Institute of Technology of Cambodia has also started to analyze pesticides in environmental media recently. In the coming years, universities are also expected to become major players capable of carrying out pesticide residue analysis.

Based on the findings summarized above, the following proposals are made for the technical cooperation project that JICA plans to implement in the future with the aim of securing continuous access to the market.

Short-term actions

1) Pursue synergy by exploring mutual learning opportunities in relation to pesticide analysis with RUA, ITC, and other relevant institutes.

Under the Higher Education Improvement Project, several researchers from RUA will be sent to the University of the Philippines Los Baños (UPLB) for training on pesticide analysis. In the implementation of the project, it is also important to use foreign resources to lower the project's total cost and enhance its efficiency. As the National Crop Protection Centre of UPLB is capable of dispatching human resources in the corresponding areas, it is recommended that SEARCA, UPLB's coordination institution, be utilized to seek the various human resources by, for example, discussing staffing matters related to guidance on pesticide residue analysis.

For the project, the possibility of providing the younger generation of NAL with opportunities to review the basics of analytical chemistry as part of their continuing education is being considered. This would be equivalent to undergraduate level education, and the project's efficiency is expected to be improved by employing staff from ITC instead of Japanese staff.

2) Support the dissemination of information to farmers on the correct use of pesticides by conducting on-site inspections for retailers to provide them with information on the effective and responsible use of pesticides.

A variety of serious problems were identified in relation to the actual use of pesticides by farmers in Cambodia. This is one area where support has not been sufficiently provided. The project is designed to focus on DAL and NAL as the major direct beneficiaries. However, simply strengthening the capabilities of these two entities will not provide a direct means of ensuring the safety of agricultural products, and it is also considered necessary to tackle the use of pesticides by farmers. Therefore, it is advisable for on-site inspections of retailers to be carried out by DAL so that information on the effective and responsible use of pesticides can be disseminated to farmers. Going forward, it will be necessary to continue discussions on the development of a system for providing effective support.

Long-term actions

3) Integrate a component aimed at promoting the effective and responsible use of pesticides and, where possible, position it as the main activity in order to guide and assist farmers in increasing their productivity and help them secure access to the international market.

It is important to integrate a component aimed at promoting the effective and responsible use of pesticides by farmers and, in the long run, to position it as the main activity in order to support farmers. It is also necessary to consider the appropriate assignment of roles between the private and public sectors in delivering such a service in consideration of the fact that, in Japan, agricultural cooperatives and other entities in the private sector often play key roles in this area of activity.

Technical recommendations pertaining to Proposals 2) and 3) above

Specific actions to be taken with regard to Proposals 2) and 3) above were discussed as described below. In principle, they are provided separately as short-term actions and long-term actions, but they are not necessarily presented in accordance with these classifications.

Technical recommendations (short- to mid-term)

2).1 Hold seminars on Japan's pesticide application techniques (short-term)

There may be many opportunities for Japan's pesticide application techniques, particularly those related to paddy rice production, to be applied in Cambodia. Unlike other rice growing countries such as the United States and Australia, Japan has undergone rapid industrialization and rapid aging of its rural communities, resulting in a diminishing number of workers from the younger generations engaging in farming work. Due to its socioeconomic context, Japan has had to develop unique labor-saving technologies that may also be useful in various agricultural settings in Cambodia[92]. Prospective participants in these seminars include Japanese manufacturers (pesticide producers, agricultural machinery manufacturers producing pesticide sprayers, etc.[93]) that are interested in the subject matter and Cambodian importers and private companies, such as Angkor Kasekam Roongroeung Co., Ltd. In these seminars, the introduction of labor-saving dusting powders and sprayers that are commonly used in Japan is assumed.

2).2 Analyze the main factors in case studies of excessive pesticide residue

In this survey, 27 crop samples were collected and analyzed to identify contamination by residual pesticides, and it was found that some of the samples contained pesticides at concentrations in excess of the standard levels. Based on this result, it is extremely important to investigate and analyze, in cooperation with the Department of Sanitary and Phytosanitary, what cultivation method was used on what crops under what environmental conditions to identify the cause of these excess concentrations and then utilize the investigation and analysis results for future guidance. It is recommended that discussions be held with MAFF to develop a mechanism that will facilitate surveillance, factor analysis, and the provision of on-site technical guidance to farmers.

2).3 Develop a pesticide registration database and apply it in pesticide management

Since the number of pesticides registered with DAL has now exceeded 1,000, it is important to develop a database on registered pesticides, update the database periodically, and discuss promoting its use so that it can be used to improve the management of pesticides in Cambodia going forward.

[92] Statistics on Pesticides and Fertilizers (2018) contains information on two pesticides that appear to have been produced by Japanese companies: Oshin 20WP (AI: Dinotefuran), manufactured by Mitsui Chemicals, Inc., and Fuji-One 40EC (AI: Isoprothiolane), manufactured by NIHON NOHYAKU CO., LTD. at a factory in China.

[93] Pesticide producers in Japan include the following: Sumitomo Chemical Co., Ltd., KUMIAI CHEMICAL INDUSTRY CO., LTD., Nissan Chemical Corporation, HOKKO CHEMICAL INDUSTRY CO., LTD., Nippon Soda Co., Ltd., and ISHIHARA SANGYO KAISHA, LTD., NIHON NOHYAKU CO., LTD., and Mitsui Chemicals, Inc. Japanese agricultural machine manufacturers include Maruyama Mfg Co., Inc. and YAMABIKO CORPORATION.

For instance, information on pesticides (e.g., codes, commercial names, common names of active ingredients, and types of suitable crops) may initially be compiled as a computerized database, after which a prototype of the database may be established and then published online. Such a database could also help farmers avoid using combinations of pesticides that contain the same active ingredients but bear different product names in a single growing season.

In the future, a database that can be used in combination with RAC codes[94] may be utilized to develop a tool that will prevent insects from developing resistance to pesticides. This information can be used for reference in the dissemination of information on the appropriate use of pesticides to farmers. It is advisable that the SHIBUYA INDEX[95], which is a handbook that compiles a diverse range of information on pesticides that is useful for pesticide researchers around the world (e.g., commercial names, common names, pesticide development codes, producers, chemical structures, major formulations, and toxicological information), be referred to in the development of this database.

2).4 Disseminate techniques through the use of spray calendars

A spray calendar is a chart that indicates at what time or during what stage of a crop's development, what pesticide should be applied, and it is very helpful for farmers in selecting the appropriate pesticide. It is worth using as it is an effective tool for ensuring the rationale use of pesticides by farmers. The implementation of the project requires the participation of and close collaboration with the Plant Protection Sanitary and Phytosanitary Department.

2).5 Provide farmers with guidance through the use of pesticide mix compatibility charts

It was found that many farmers mix pesticide products. Therefore, it is also important to discuss the preparation of pilot versions of pesticide mix compatibility charts for major crops and major areas. It is advisable to start by conducting pesticide mixing tests in the pesticide formulation analysis laboratory operated by NAL with reference to a simple physical examination method[96] that can be found on the website of the Food and Fertilizer Technology Centre for the Asian and Pacific Region.

2).6 Select the target crops

This survey was conducted as part of strengthen AVC in the future, and it focused on vegetables, particularly leafy ones, and rice as important crops. However, it may also be worthwhile including maize as an important crop from the viewpoint of pesticide usage amounts[97].

[94] Useful links include the following: 1) https://www.irac-online.or; 2) https://www.hracglobal.com; and 3) https://www.frac.info (accessed March 4, 2020).

[95] Shigeyoshi Shibuya: "Evolution of pesticide information handbook," SHIBUYA INDEX, Journal of Information Processing and Management, 51(1):041-054, 2008 (in Japanese)

[96] For details, refer to the following URL: http://www.fftc.agnet.org/library.php?func=view&style=type&id=20110714094712

[97] Corteva Agriscience focuses on maize as the main target crop from the viewpoint of the amount of pesticide sales.

Technical recommendations (mid- to long-term)

3).1 Provide farmers with guidance through the use of spray records

A spray record[98] is used to record where and at what time or during which stage of a crop's development a particular pesticide spray was applied to it and in what amount or at what concentration (dilution strength), so it can be used as evidence of food safety. It is advisable to discuss requiring farmers to keep spray records as a precondition for analyzing the pesticide residue in agricultural products. As the on-going GAP program may also involve similar activities, we will discuss the policy by examining its content. This information may be used to interpret the results of the pesticide residue analysis as well as providing farmers with guidance on promoting the appropriate use of pesticides.

3).2 Disseminate pesticide use techniques widely

This survey focused on pesticide products, but there are other important factors to consider when using pesticides (e.g., the use of adjuvants[99] and the use of appropriate sprayers and nozzles) to help determine the efficacy of pesticide spraying. It is particularly noteworthy that CAVAC has promoted the use of adjuvants and contributed to a reduction in pesticide use.

- In the field survey, the majority of pesticides in Cambodia were found to be liquid formulations. Other types of formulations were rarely found during the survey. While, in Japan, there has been a growing number of options for formulations, especially herbicides for rice production, in recent years. Many labor-saving dusting powders, including 1-kg granules, Jumbo formulations, and small quantity dispersion granules, have been developed. It is also important to consider the need to facilitate the registration of such formulations in Cambodia in order to enhance the safety of agricultural products there.

- In Japan, a Pan-Ride Cruiser, which is a vehicle for paddy management that is equipped with a boom sprayer, is designed to spray pesticides from nozzles that are set immediately above the rice plants. Meticulous adjustment of the nozzle position minimizes the risk of pesticide drift and maximizes efficiency. Although information on the efficiency of spraying pesticides from drones is not available, it seemed a promising option with good controllability, low initial costs and a minimal risk of pesticide drift. In the near future, the dissemination of pesticide application techniques using drones will play an important role. In fact, the use of drones may increase the possibility of introducing joint pest controls and, in terms of pesticide application, this option will reduce the possibility of pest infestations from neighboring agricultural land and contribute to a reduction in the quantity of pesticide sprayed.

[98] For details, refer to the following URL:
http://www.ib.zennoh.or.jp/contents/make/einou/2416.pdf

[99] Surfactant, the main component of adjuvants, reduces the surface tension of a sprayed chemical and improves the spread of the chemical over the crop leaves, thus improving its attachment to the target plants.

3).3 Discuss measures that will contribute to reduced pesticide use and improved productivity through the dissemination of comprehensive pest control techniques

For farmers, the selection and application of pesticides is only a part of the series of decision-making processes involved in production activities. There is a limit to the amount of guidance that can be given with a focus on pesticides only, and the uniform dissemination of appropriate techniques is not easy. In light of this, the experience that the Plant Protection Department of An Giang (AG) Province, Vietnam, has gained in the course of promoting the alternate wetting and drying (AWD) technology, which contributes to a reduction in greenhouse gases, can provide insights and suggestions. AG Province reportedly spread the use of AWD technology quickly by packaging the introduction of high-quality seeds, mechanization, and other key technologies while also adopting the basic approaches of employing excellent farmers, constructing an easy-to-access model paddy, and grouping neighboring farmers[100]. Although this survey was conducted with a focus only on pesticides, it is important when disseminating information on the appropriate use of pesticides to farmers to discuss a cross-sectoral approach that includes the use of agricultural machinery and an agronomic approach from multiple viewpoints by referring to the experience of AG Province. To this end, it is considered necessary to secure the cooperation of other MAFF departments, such as the Department of Sanitary and Phytosanitary and DAE, as well as MOWRAM and the Ministry of Rural Development.

An interview with a farmer revealed that rice farmers in Cambodia experience problems in relation to basic fertilization techniques, including the disuse of basal fertilizers. Although the conducted interviews confirm that some farmers were aware of the significance of basal fertilizers in rice production, they did not practice their use because they had observed that the emergence of weeds prevented the rice plants from growing faster once they had been sprayed with these fertilizers before broadcasting. Due to time constraints, not much information is available on fertilizer products, but it is presumed that certain fertilizer products, including slow-release nitrogen fertilizers, may not be available on the market in Cambodia. It is therefore advisable, in discussions of a cross-sectional approach, to consider promoting the appropriate use of fertilizers together with the above-mentioned mechanization, the use of high-quality seeds, and the introduction of various pesticide formulations.

4.4 Points to Note in Relation to JICA Initiatives for Strengthening Food Value Chains

Since the start of Hun Sen's second coalition government in 2005, the Cambodian economy has continued to enjoy rapid economic growth at over 7%, except during the 2009 global recession (referred to in Japan as the "Lehman shock"). Furthermore, the circumstances surrounding food, agriculture, and villages have been changing because people have moved from villages to urban areas, the populations in villages have aged, consumption trends have changed in line with economic growth, and foreign capital companies have proactively entered the Cambodian food industry. The agricultural cooperation provided to Cambodia via

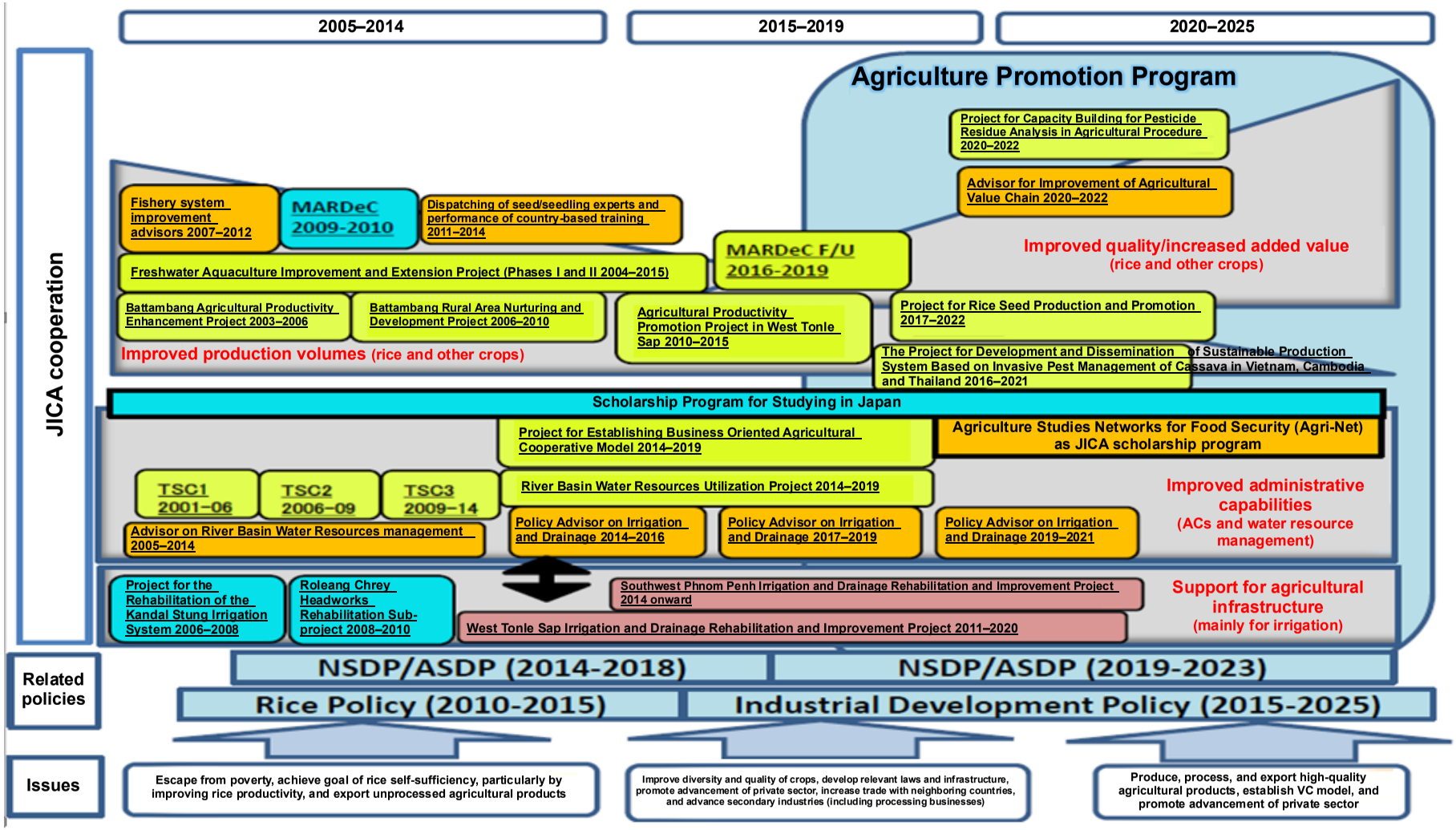
[100] Miyashita, et al.: "Assessment and Analysis of the Reality in Diffusion of Water-Saving Irrigation Technology and the Constraints in Diffusion of Alternate Wetting and Drying in An Giang Province, Vietnam," (J. JASS), 32(2), 2016

JICA can be roughly broken down as follows: 1) improvements to production capacity; 2) strengthening of administrative capabilities; and 3) support for agricultural infrastructure. These initiatives can be summarized as shown in the figures below. In terms of improving production capacity, JICA has provided technical support mainly aimed at improving basic techniques that are primarily related to productivity improvements with a focus on rice, which supports the Cambodian diet, and marine products, which provide 60% or more of animal protein. Furthermore, to promote irrigation development, which serves as the most important foundation for agricultural production, JICA has continuously provided support for irrigation development, maintenance, and management. From the viewpoint of developing and establishing individual cooperation as part of a national system, JICA has dispatched policy advisors to key ministries and agencies. Meanwhile, the circumstances surrounding Cambodian agriculture have changed greatly as people have moved out of villages and foreign capital companies have entered the food industry due to the country's constant economic growth and the proactive introduction of foreign investment. Against this background, JICA's provision of support with a focus on strengthening FVCs, including in terms of improving quality and increasing added value, is considered to be more important going forward.

In light of the above-mentioned recent circumstances concerning agriculture, issues related to AVCs and pesticides in particular have been investigated and discussed in this survey. Sections 4.2 and 4.3 summarize these issues, leading to the conclusion that, for horticulture products for domestic consumption, it is necessary to provide support for the establishment of a system aimed at facilitating production and distribution that address market needs (quality and standards) through support for the formation of VCs centered on CF in the short term and support for the modernization of more general distribution systems in the mid to long term. Since exports require comprehensive long-term support, including the development of infrastructure and the assurance of production volumes, the conclusion was reached that it is important to make efforts that start with the development of niche markets for Cambodian commodities, such as pepper and cashews, for which proactive actions have already been observed at the private sector level.

To support this approach, JICA is determined to strengthen the role of government, which supervises AVCs as a whole, and to dispatch policy advisors to DAI of MAFF to support the establishment of a suitable business model through effective coordination with parties involved in the relevant AVC (i.e., farmers, private enterprises, and relevant ministries' officials). In addition, technical cooperation aimed at strengthening the country's ability to address the issue of residual pesticide, which acts as a bottleneck to the distribution of agricultural products, particularly for products to be exported and or sold in domestic high-end markets, is expected to be provided at NAL. It is necessary to strengthen AVCs while also correctly identifying market trends and combining production techniques, strengthening infrastructure, and improving institutional systems, including in terms of the application of criteria and standards, in a timely manner. It is not realistic to expect all of the above goals to be achieved over the short term, so it is necessary to address them in units of decades. To ensure that limited resources are used effectively, JICA is also required to promote cooperation with the government as well as other development partners and to proactively cooperate with private business enterprises, including through the utilization of JICA-private sector initiatives aimed at appropriately designing projects by combining the establishment of short-term business models with mid- to long-term support for the establishment of institutional systems.

Figure 4-1 Overview of Cambodian Agriculture Promotion Program (Source: JICA Cambodia Office)



Annex

Cultivation Calendar (Broadcasting Calendar)

List of Crops Targeted for Recording of Farming Activities

Code	Crops	Address	Date
K1	Spinach	Preaek Tonloab Commune, Leuk Daek District, Kandal Province	Jan. 21
K2	Organic vegetables	Khpob Ateav Cooperative, Khpob Ateav Commune, Leuk Daek District, Kandal Province	Jan. 21
K3	Rice	K'am Samnar Commune, Leuk Daek District, Kandal Province	Jan. 22
K4	Spring onions	Krang Yov Commune, S'ang District, Kandal Province	Jan. 23
K5	Papaya	Tuek Vil Commune, S'ang District, Kandal Province	Jan. 23
K6	Mustard greens	Tuek Vil Commune, S'ang District, Kandal Province	Jan. 23
K7	Sugarcane	Tuek Vil Commune, S'ang District, Kandal Province	Jan. 23
B1	Rice	Kampong Preang AC, Os Touk Village, Kampong Preang, Sangkae District, Battambang Province	Jan. 30
B2	Cabbage	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B3	Rice	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B4	Melon	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B5	Bitter melon	Ansang Sak Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B6	Rice	Rohal Suong Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B7	Rice	Duong Mea Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B8	Watermelon	Preaek Trab Village, Preaek Norint Commune, EK Phnom District, Battambang Province	Jan. 29
B9	Kale	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28
B10	Yard long beans	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28
B11	Chinese greens	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28
B12	Long beans	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28
B13	Organic cabbage	Ta Sei Samaki Agricultural Cooperative, Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28
B14	Rice	Ta Sei Village, Ta Meun Commune, Thma Koul District, Battambang Province	Jan. 28

The record of Farmer K2 (organic vegetables, Khpob Ateav Cooperative, Khpob Ateav Commune, Leuk Daek District, Kandal Province; interview conducted on January 21) is presented in the main text.

K1: Spinach Preaek Tonloab Commune, Leuk Daek District, Kandal Province

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
0 days	1	Ploughing	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7 days	2	Raw	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7 days	3	Broadcasting	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	4	Insecticide	Cylux	Trichlorfon 485 g/L	Organophosphate	Acetylcholinesterase (AChE) inhibitors	50 mL/25 L water	40 mL/16 L 320–400 L/ha	N/A
				Fipronil 15 g/L	Phenylpyrazole	GABA-gated chloride channel blockers			
N/A	5	Insecticide	No. 1	Chlorantraniliprole 50 g	Diamide	Ryanodine receptor modulators	20 cc/25 L 400–500 L/ha	- Chili plantation: 20 mL/25 L (to kill thrips) - Long bean plantation: 40 mL/25 L (to kill fruit fly worms) - Rice field: 20 mL/25 L (to kill leaffolders) - Rice field: 30 mL/25 L (to kill heliothis armigera) - Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill corn leaf aphids) - Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill thrips) - 400–500 L/ha	N/A
				Chlorfenapyr 150 g	Pyrrole, dinitrophenol, and sulfluramid Chlorfenapyr, dnoc, and sulfluramid	Uncouplers of oxidative phosphorylation via disruption of proton gradient			
N/A	6	Insecticide	Cylux	Trichlorfon 485 g/L	Organophosphate	Acetylcholinesterase (AChE) inhibitors	30 cc/25 L 400–500 L/ha	40 mL/16 L 320–400 L/ha	N/A

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
				Fipronil 15 g/L	Phenylpyrazole	GABA-gated chloride channel blockers			
N/A	7	Insecticide	No. 1	Chlorantraniliprole 50 g	Diamide	Ryanodine receptor modulators	20 cc/25 L 400–500 L/ha	- Chili plantation: 20 mL/25 L (to kill thrips) - Long bean plantation: 40 mL/25 L (to kill fruit fly worms) - Rice field: 20 mL/25 L (to kill leaffolders) - Rice field: 30 mL/25 L (to kill heliothis armigera) - Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill corn leaf aphids) - Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill thrips) - 400–500 L/ha	N/A
				Chlorfenapyr 150 g	Pyrrole, dinitrophenol, and sulfluramid	Uncouplers of oxidative phosphorylation via disruption of proton gradient			
N/A	8	Insecticide	Cylux	Trichlorfon 485 g/L	Organophosphate	Acetylcholinesterase (AChE) inhibitors	20 cc/25 L 400–500 L/ha	40 mL/16 L 320–400 L/ha	N/A
				Fipronil 15 g/L	Phenylpyrazole	GABA-gated chloride channel blockers			
N/A	9	Harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A

a: Glyphosate (70,000/5 L)

K3: Rice K'am Samnar Commune, Leuk Daek District, Kandal Province

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
0 days	1	Soil preparation and broadcasting	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Seed treatment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Mixture of herbicides	Phu Gia	Propanil	Amide	Inhibition of photosynthesis at PSII - Serine 264 binders	N/A	N/A	N/A
				Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
			CANTANIL 550EC	Propanil	Amide	Inhibition of photosynthesis at PSII - Serine 264 binders	N/A	N/A	N/A
				Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
			Machete 60% EC	Butachlor	α-Chloroacetamide	Inhibition of very long-chain fatty acid synthesis	N/A	N/A	N/A
8 days	4	Emergence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Insecticide	Padan	Cartap hydrochloride	Nereistoxin analogue	Nicotinic acetylcholine receptor (nAChR) channel blockers	N/A	N/A	N/A
25 days	6	Mixture of unknown insecticide and fertilizer	Unknown insecticide	Mixture of powder and liquid types	N/A	N/A	N/A	N/A	N/A
			Unknown fertilizer		N/A	N/A	N/A	N/A	N/A
40–50 days	7	Unknown pesticide	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60–70 days	8	Mixture of pesticides and fertilizers	V-T 99	N/A	N/A	N/A	N/A	40–50 mL/25 L	N/A
			Tanwin 4.0EC	Emamectin benzoate 4.0%	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	N/A	N/A	N/A
			Philia Sua	Tricyclazole 150 g/L	Triazolobenzothiazole	Reductase in melanin biosynthesis	N/A	N/A	N/A
				Fipronil 15 g/L	Phenylpyrazole	GABA-gated chloride channel blockers	N/A	N/A	N/A
			Number 1 200SC	Chlorantraniliprole	Diamide	Ryanodine receptor modulators	N/A	- Rice field: 20 mL/25 L (to kill leaffolders)	N/A

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
								- Rice field: 30 mL/25 L (to kill heliothis armigera) - 400–500 L/ha	
				Chlorfenapyr	Pyrrole, dinitrophenol, and sulfluramid	Uncouplers of oxidative phosphorylation via disruption of proton gradient	N/A	N/A	N/A
			Hittop/ Acdino 350SC	Azoxystrobin	Methoxy acrylate	Cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	N/A	N/A	N/A
				Hexaconazole	Triazole	C14-demethylase in sterol biosynthesis (erg11/cyp51)	N/A	N/A	N/A
				Tebuconazole			N/A	N/A	N/A
			Duca 500EC thuốc trừ sâu rầy mọt đục	Chlorpyrifos ethyl	Organophosphate	Acetylcholinesterase (AChE) inhibitors	N/A	N/A	N/A
				Imidacloprid	Neonicotinoid	Nicotinic acetylcholine receptor (nAChR) competitive modulators	N/A	N/A	N/A
			Chin Chac (foliar feeding for rice)	Total nitrogen: 5% K2O: 15% P_2O_5hh: 3% Zn: 400 ppm B: 400 ppm pH: 6–7	N/A	N/A	N/A	N/A	N/A
80–88 days	9	Fertilizer	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Irrigation water suspension for ground hardness	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100 days	11	Harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A

K3: Rice K'am Samnar Commune, Leuk Daek District, Kandal Province

Total pesticide expenditure during the growing season: USD 450–500/ha for pesticides and fertilizers

Yield: 7 t/ha

Price: KHR 750,000/t

KHR 700–750/kg 2 crops/year

The following information is provided on the label for No. 1.

- Chili plantation: 20 mL/25 L (to kill thrips)
- Long bean plantation: 40 mL/25 L (to kill fruit fly worms)
- Rice field: 20 mL/25 L (to kill leaffolders)
- Rice field: 30 mL/25 L (to kill heliothis armigera)
- Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill corn leaf aphids)
- Water melon, cucumber, and pumpkin plantation: 20 mL/25 L (to kill thrips)
- 400–500 L/ha

K4: Spring onions (based on an interview with a farmer from the S'ang District, Krang Yov Commune) 870 m²

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 10, 2019	1	Soil preparation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Herbicide	Super Glykill 36SL 540	Glyphosate	Glycine	Inhibition of enolpyruvyl shikimate phosphate synthase	500 mL/25 L	200–390 mL/ 25 L water	N/A
	3	Mechanical ploughing to create rows	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 15, 2019	4	Herbicide	Antaxa 250EC	Oxaziazon/oxadiazon	N-Phenyl-oxadiazolone	Inhibition of protoporphyrinogen oxidase	50 mL/25 L	30–40 mL/ 8 L water	N/A
	5	Pump irrigation repeated thereafter	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 25, 2019	6	Seedling transplantation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec. 25, 2019	7	Mixture of insecticides	Formectin-Xtra 54EC	Abamectin (mixture of avermectins: avermectin B1a and avermectin B1b)	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	50 mL/25 L water	4–5 mL/16 L 800–1,000 mL/ha	N/A
			Foraim 38EC	Emamectin benzoate			50 mL/25 L water	4–5 mL/16 L 800–1,000 mL/ha	N/A
	8	Application of the insecticide mixture (Step 7 above) was generally repeated every five days until February 8, 2020.							
Jan. 15, 2020	9	Fertilizer	Urea and DAP	N/A	N/A	N/A	N/A	N/A	N/A
Feb. 8, 2020	10	No pesticides applied until harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Feb. 15, 2020	11	Harvesting (plan)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

K5: Papaya Tuek Vil Commune, S'ang District, Kandal Province

Date		Farm work	Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Early April	1	Ploughing by tractor and subsequently by cow	N/A	N/A	N/A	N/A	N/A	N/A	
	2	Fertilizer	DAP	Diammonium phosphate	N/A	N/A	N/A	N/A	
	3	Mulching	N/A	N/A	N/A	N/A	N/A	N/A	
	4	Seedling transplantation	N/A	N/A	N/A	N/A	N/A	N/A	
14 days after transplanting	5	Fertilizer	Urea	N/A	N/A	N/A	N/A	N/A	
28 days after transplanting	6	Fertilizer	Urea	N/A	N/A	N/A	N/A	N/A	
45 days after transplanting	7	Herbicide	Groundup 480SL	Glyphosate[a]	Glycine	Inhibition of enolpyruvyl shikimate phosphate synthase	250 mL/25 L 100 L/2,000 m^2	- Thatch: 200–250 mL/ 20 L - Jungle rice: 160–200 mL/ 20 L - Grass crop: 100–140 mL/ 20 L	
90 days after transplanting			One side	Banned by VN					
			Ambush 200 WP	Isoprocarb	Carbamate	Acetylcholinesterase (AChE) inhibitors		Rice: 1.2–1.5 kg/ha; 25–30 g/8 L (400 L/ha) Vegetables: 1.25 kg/ha; 20–25 g/8 L (400 L/ha)	
				Fenobucarb					
			Anmantox 3.8EC	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators		Rice: 3–5 mL/16 L (0.5–0.7 L/ha) Vegetables: 3–5 mL/16 L (0.5–0.7 L/ha) Industrial crop:	

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
								5–8 mL/16 L	
120 days after transplanting		Fertilizer	15-15-15	N/A	N/A	N/A	N/A	N/A	
130 days after transplanting		Fertilizer	DAP	N/A	N/A	N/A	N/A	N/A	
150 days after transplanting		Harvest	N/A	N/A	N/A	N/A	N/A	N/A	

a: Glyphosate (70,000/5 L)

K6: Mustard greens Tuek Vil Commune, S'ang District, Kandal Province

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 1	1	Soil preparation	N/A	N/A	N/A	N/A	N/A	N/A	
	2	Cow dung application	N/A	N/A	N/A	N/A	N/A	N/A	
	3	Fertilizer	15-15-15	N/A	N/A	N/A	N/A	N/A	
	4	Herbicide	Groundup 480SL[a]	Glyphosate 480 g/L	Glycine	Inhibition of enolpyruvyl shikimate phosphate synthase	200 mL/20 L 20 L/600 m^2	- Thatch: 200–250 mL/ 20 L - Jungle rice: 160–200 mL/ 20 L - Grass crop: 100–140 mL/ 20 L	
Dec. 15	5	Seed broadcasting	N/A	N/A	N/A	N/A	N/A	N/A	
Dec. 30	6	Insecticide	One side[b]	Banned by VN			50 mL/20 L 20 L		
	7	Insecticide	Anmantox 3.8EC[c]	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	30 mL/20 L for 600 m^2	15–20 mL/ 20 L for 400 m^2	
Application of the insecticide (Step 7 above) was repeated every week thereafter, but a 10-day interval was secured before harvest.									
Feb. 6	8	Harvest							

a: KHR 70,000/4.5 L

b: KHR 10,500/100 mL

c: KHR 37,000/500 mL

Yield: 15 t/ha

Price: KHR 500–700/kg

K7: Sugarcane Tuek Vil Commune, S'ang District, Kandal Province

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
May	1	Soil preparation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Ploughing and cow dung application	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jun. 20	3	Sugarcane planting	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jul. 20	4	Herbicide	Maizin 55SC[a]	Atrazine	Triazine	Inhibition of photosynthesis at PSII - Serine 264 binders	200 mL/20 L for 1,600 m^2	100–150 mL/ 25 L 1–1.5 L/ha	N/A
				Mesotrione	Triketone	Inhibition of hydroxyphenyl pyruvate dioxygenase			
Jul. 25	5	Insecticide	Mekomectin[b]	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	50 mL/20 L for 700 m^2 (?) 500 L/ha		N/A
Aug. 20	6	Fertilizer	Urea	N/A	N/A	N/A	N/A	N/A	N/A
Dec.	7	Harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A

a: KHR 27,000/500 mL bottle

b: KHR 39,000/500 mL

Labor cost: KHR 22,000–25,000/day

Yield: 100 t/ha

Price: KHR 600,000/t

B1: Rice **Kampong Preang AC, Os Touk Village, Kampong Preang, Sangkae District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Sept. 1	1	Soil preparation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sept. 8	2	Broadcasting	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14 DAB	3	Mixture of herbicides	Smao Srov 99	Bispyribac sodium	Pyrimidinyl benzoate	Inhibition of acetolactate synthase	10 mL/25 L water 200 L/ha	10 mL/25 L water	N/A
			N/A	2,4-D	Phenoxy carboxylate	Auxin mimics	N/A	N/A	N/A
18 DAB	4	Pre-mixed fertilizer	Pre-mixed fertilizer	NPK 15:15:15			75 kg/ha		N/A
25 DAB		Tailoring stage							N/A
30 DAB	5	Insecticide	Pest-Stop				1 package/20 L 200 L/ha		N/A
		Fertilizer	9 star NPK						N/A
45 DAB	6	Fertilizer	27-5-27				75 kg/ha		N/A
60 DAB		Fertilizer	9 star NPK						N/A
	7	Insecticide	Unknown						N/A
65 DAB		Heading stage	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100 DAB	8	Harvest	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DAB: Days after broadcasting

Fragrant rice

Yield: 4 t/ha

Price: KHR 1,000,000/t (USD 10/ha)

Land area: 1,300 ha

60% of pesticides are supplied based on an AC's recommendation.

B2: Cabbage Ansang Sak Village, Preaek Norint Commune, EK Phnom District

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Jan. 13	1	Planting							
Jan. 20	2	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	40 mL/25 L water 100 L/4,800 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	KHR 4,600/500 mL
Jan. 23	3	Herbicide	Bayon Smav 12EC	Quizalofop-p-ethyl	Aryloxyphenoxy propionate (FOP)	Inhibition of acetyl-CoA carboxylase	50 mL/30 L 150 L/4,800 m^2	- 3–4 leaf-grass: 40 mL/25 L - 5–10 leaf-grass: 50–60 mL/25 L 375 L/ha	KHR 25,000/500 mL
Jan. 27		Fertilizer	Urea				90 kg/4,800 m^2		KHR 170,000/100 kg
Feb. 1	4	Insecticide	Banan 30SC	Teflubenzuron 30%	Benzoylurea	Inhibition of chitin biosynthesis, type 0	40 mL/30 L water	- Rice: 10 mL/16 L/500 m^2 - Cabbage, collard greens, and tomatoes: 10–15 mL/16 L/500 m^2 - Water melons and cucumbers: 5 mL/16 L/500 m^2 - Beans and tobacco: 10–15 mL/16 L/500 m^2 - Non-timber forest products: 10 mL/16 L	KHR 61,000/500 mL
		Fungicide	Henvil 200	Hexaconazole 20%	Triazole	Sterol biosynthesis in membranes	30 mL/120 L water	50 mL/25 L 250 L/ha	KHR 30,000/500 mL
Feb. 6	5	Insecticide	Banan 30SC	Teflubenzuron 30%	Benzoylurea	Inhibition of chitin biosynthesis, type 0	40 mL/30 L water	- Rice: 10 mL/16 L/500 m^2 - Cabbage, collard greens, and tomatoes: 10–15 mL/16 L/500 m^2	KHR 61,000/500 mL

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
								- Water melons and cucumbers: 5 mL/16 L/500 m^2 - Beans and tobacco: 10–15 mL/16 L/500 m^2 - Non-timber forest products: 10 mL/16 L	
Feb. 11	6	Fungicide	Henvil 200	Hexaconazole 20%	Triazole	Sterol biosynthesis in membranes	30 mL/120 L water	50 mL/25 L 250 L/ha	KHR 30,000/500 mL
Feb. 16	7	Insecticide	Hen Angkor	Emamectin	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	40 mL/25 L water 100 L/4,800 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	KHR 4,600/500 mL
Feb. 25	8	Harvest							

Total land area: 4,800 m^2

Yield: 21 t/4,800 m^2

Price: KHR 600–1,000/kg

B3: Rice **Ansang Sak Village, Preaek Norint Commune, EK Phnom District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Oct. 25	1	Broadcasting							
10 DAB	2	Herbicide	Bayon Smav 12EC	Quizalofop-p-ethyl	Aryloxyphenoxy propionate (FOP)	Inhibition of acetyl-CoA carboxylase		- 3–4 leaf-grass: 40 mL/25 L - 5–10 leaf-grass: 50–60 mL/25 L 375 L/ha	
11 DAB	3	Herbicide	Kingkiller 168WP	Metsulfuron methyl 70 g/kg	Sulfonylurea	Inhibition of acetolactate synthase	100 g/90 L water Total: 600 L for 16,000 m^2	30–40 g/25 L/1,000 m^2	KHR 10,000/100 g
				Pyrazosulfuron ethyl 148 g/kg	Sulfonylurea	Inhibition of acetolactate synthase			
16 DAB	4	Fertilizer	Urea 75 kg						KHR 12,000/100 g
			DAP 75 kg						
24 DAB	5	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	40 mL/30 L water 600 L	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
40 DAB	6	Fertilizer	Urea	50 kg					KHR 120,000/50 kg
			DAP	25 kg					KHR 120,000/50 kg
			K	25 kg					KHR 120,000/50 kg

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
60 DAB	7	Insecticide	Bayon Smav 12EC	Quizalofop-p-ethyl	Aryloxyphenoxy propionate (FOP)	Inhibition of acetyl-CoA carboxylase	40 mL/30 L water 600 L	- 3–4 leaf-grass: 40 mL/25 L - 5–10 leaf-grass: 50–60 mL/25 L 375 L/ha	KHR 30,000
90 DAB	8	Harvest							

Yield: 5 t/16,000 m^2

Price: KHR 710,000/t

Land area: 16,000 m^2

B4: Melon Ansang Sak Village, Preaek Norint Commune, EK Phnom District

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Nov. 8	1	Soil preparation							
Nov. 15	2	Seeding							KHR
Nov. 22	3	Fertilizer	16:16:16				20 kg/3,800 m^2		KHR 150,000/ 50 kg
	4	Insecticide	Prevathon 5SC	Chlorantraniliprole	Diamide	Ryanodine receptor modulators	100 g/pack 100 g/25 L water 250 L/total land	- Rice: 300–400 mL/ 250–320 L/ha - Vegetables: 600 mL/ 350 L/ha - Catjang: 600–1,200 mL/ 500 mL/ha - Soybeans: 600–800 mL/ 500 L/ha	KHR 3,500/pack
Nov. 29	5	Fertilizer	16:16:16				20 kg/3,800 m^2		KHR 150,000/ 50 kg
	6	Insecticide	Fipronil	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	30 mL/25 L 250 L/total	Thai language	KHR 60,000/bottle
Dec. 6	7	Fertilizer	16:16:16				20 kg/3,800 m^2	Thai language	KHR 150,000/ 50 kg
	8	Insecticide	Prevathon 5SC	Chlorantraniliprole	Anthranilic diamide insecticide	Control Lepidoptera and other Coleoptera, Diptera, and Isoptera species	100 g/pack 100 g/25 L water 250 L/total land	- Rice: 300–400 mL/ 250–320 L/ha - Vegetables: 600 mL/ 350 L/ha - Catjang: 600–1,200 mL/ 500 mL/ha - Soybeans: 600–800 mL/ 500 L/ha	KHR 3,500/pack

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 13	9	Fertilizer	16:16:16				20 kg/3,800 m^2	Thai language	KHR 150,000/ 50 kg
	10	Insecticide	Fipronil	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	30 mL/25 L 250 L/total	Thai language	KHR 60,000/bottle
Dec. 20		Fertilizer	16:16:16				20 kg/3,800 m^2	Thai language	KHR 150,000/ 50 kg
	11	Insecticide	Prevathon 5SC	Chlorantraniliprole	Anthranilic diamide insecticide	Control Lepidoptera and other Coleoptera, Diptera, and Isoptera species	100 g/pack 100 g/25 L water 250 L/total land	- Rice: 300–400 mL/ 250–320 L/ha - Vegetables: 600 mL/ 350 L/ha - Catjang: 600–1,200 mL/ 500 mL/ha - Soybeans: 600–800 mL/ 500 L/ha	KHR 3,500/pack
Dec. 25	12	First harvest							
Jan. 8	13	Fertilizer	16:16:16				30 kg/3,800 m^2	Thai language	KHR 150,000/ 50 kg
	14	Harvest for 1 month							

Yield: 3 t/ha

Price: KHR 400–500/kg

Land area: 3,800 m^2

B5: Bitter melon **Ansang Sak Village, Preaek Norint Commune, EK Phnom District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
	1	Soil preparation							
Nov. 28	2	Planting							
Dec. 5	3	Fertilizer	16:16:16				5 kg/ 1,600 m^2	Thai language	
	4	Insecticide	Prevathon 5SC	Chlorantraniliprole	Diamide	Ryanodine receptor modulators		- Rice: 300–400 mL/250–320 L/ha - Vegetables: 600 mL/350 L/ha - Catjang: 600–1,200 mL/500 mL/ha - Soybeans: 600–800 mL/500 L/ha	
	5								
Dec. 12	6	Insecticide	Fipronil	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	30 mL/ 25 L 250 L/total	Thai language	
Dec. 19	7	Fertilizer	16:16:16				10 kg/ 1,600 m^2	Thai language	
	8	Insecticide	Prevathon 5SC	Chlorantraniliprole	Diamide	Ryanodine receptor modulators		- Rice: 300–400 mL/250–320 L/ha - Vegetables: 600 mL/350 L/ha - Catjang: 600–1,200 mL/500 mL/ha - Soybeans: 600–800 mL/500 L/ha	
Dec. 26	9	Insecticide	Fipronil	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	30 mL/ 25 L 250 L/total	Thai language	
Jan. 7	10	Harvest							
Jan. 21	11	Fertilizer	16:16:16				15 kg	Thai language	
Feb. 6	12								

Area: 1,600 m^2

Yield: 2 t

Price: KHR 700–800/kg

B6: Rice **Rohal Suong Village, Preaek Norint Commune, EK Phnom District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Nov. 15	1	Soil preparation							
Nov. 18	2	Germination					20 kg		
Dec. 18	3	Fertilizer	NPK 15:15:15						
Jan. 2	4	Insecticide	Abamectin Mamechtin 38EC	Abamectin	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	480 mL/240 L	- 5–10 mL/ 16 L/ 500 m^2 - 150–250 mL/ 400–500 L/ha	KHR 50,000/bottle
Feb. 16	5	Harvest							

Area: 6,400 m^2

Yield: 2 t

Price: KHR 800,000/t

B7: Rice **Duong Mea Village, Preaek Norint Commune, EK Phnom District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Oct. 30	1	Broadcasting							
Nov. 2	2	Drainage							
Nov. 29	3	Insecticide	Unknown						
	4	Herbicide	Sunai				40 mL/25 L water 150 L		
Dec. 14	5	Urea	N46%				25 kg		KHR 2,000/kg
Jan. 13	6	Harvest							

Area: 64,000 m^2

Yield: 1.5 t/4,000 m^2

Price: KHR 700,000/t

B8: Water melon **Preaek Trab Village, Preaek Norint Commune, EK Phnom District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
	1	Soil preparation							
Nov. 7	2	Planting							
Nov. 14	3	Germination							
Nov. 14	4	Insecticide	Rambo 18SC	Emamectin benzoate 3%	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	40 mL/30 L 390 L/ha	15–25 mL/ 25 L 400–500 L/ha	
				Fipronil 5%	Phenylpyrazole	GABA-gated chloride channel blockers			
				Chlorfenapyr 10%SC	Pyrrole, dinitrophenol, and sulfluramid	Uncouplers of oxidative phosphorylation via disruption of proton gradient			
			Korklong						
Nov. 21	5	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		
Unknown	6	Fertilizer	Urea				75 kg 100 kg/ha		
			Korklang				50 mL/30 L water 390 L/ha		
		Five other pesticides were used in combination, but the interviewee could not remember them.							
The interviewee explained that he repeated Step 6 of the farm work every week. This information is not recorded below because his recollections were vague and ambiguous.									
Nov. 28	7	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 5	8	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		
Dec. 12	9	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		
Dec. 19	10	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		
Dec. 26	11	Mixture of fungicides	Pistil	Mancozeb 80%	Dithiocarbamate and relatives	Chemicals with multi-site activity	2 spoons/30 L water 390 L/ha		
			Luxedndazime 50SC	Carbendazim 50%	Benzimidazole	Cytoskeleton and motor proteins	100 mL/30 L water 390 L/ha		
The interviewee claimed that he did not apply pesticides one week before the harvest.									
Jan. 3		Harvest							

Price yield: KHR 6–7 million/ha

Land area: 3 ha

B9: Kale **Ta Sei Village, Ta Meun Commune, Thma Koul District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 26	1	Soil preparation							
Dec. 29	2	Planting							
		Germination							
Jan. 2	3	Fertilizer	DAP				0.5 kg		
			Urea				0.5 kg		
	4	Insecticide	Hen Angkor 40	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	10 mL/15 L 4 L/15 × 15	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	KHR 48,000/500 mL
Jan. 9	5	Fungicide	Mancozeb				50 g/25 L water 4 L for 15 × 15		KHR 5,000/100 g
	6	Hand-made organic material applied every 3 days	Ginger chili				Ginger: 1 kg Chili: 1 kg 0.5 L/16 L water 4 L for 15 × 15 m		
Jan. 16	7	Fungicide	Mancozeb				50 g/25 L water 4 L for 15 × 15		KHR 5,000/100 g
Jan. 24	8	Harvest							

Land area: 225 m^2

Price: KHR 1,500/kg

Yield: 250 kg

Yard long beans **Ta Sei Village, Ta Meun Commune, Thma Koul District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Feb. 3	1	Soil preparation							
Feb. 8	2	Seed planting							
Feb. 11	3	Germination							
	4	Fertilizer	Urea				1.5 kg/1,000 m^2		KHR 90,000/50 kg
			DAP				1.5 kg/1,000 m^2		KHR 120,000/50 kg
			K				1.5 kg/1,000 m^2		KHR 120,000/50 kg
Feb. 19	5	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Feb. 22	6	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber	

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
								forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Feb. 25	7	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Feb. 28	8	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Mar. 3	9	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl)	15 mL/25 L water 50 L/1,000 m^2		

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
						allosteric modulators			
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Mar. 6	10	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Mar. 9	11	Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
		Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Mar. 12		Insecticide	Hen Angkor	Emamectin benzoate	Avermectin and milbemycin	Glutamate-gated chloride channel (GluCl) allosteric modulators	15 mL/25 L water 50 L/1,000 m^2	- Rice, tobacco, and onions: 10 mL/16 L (32 L/1,000 m^2) - Cabbage, tomatoes, cucumbers, and beans: 15 mL/16 L - Cashew nuts and non-timber forest products: 10 mL/16 L	
	12	Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii	Entomopathogenic fungus species		25 g/25 L water × 2/1,000 m^2		KHR 3,500/pack 50 g/pack
Mar. 15	13	First harvest							
Apr. 29	14	Last harvest							

Land area: 1,000 m^2

Price: KHR 2,500–3,000/kg

Yield: 1,300 kg/1,000 m^2

Chinese greens Ta Sei Village, Ta Meun Commune, Thma Koul District

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Nov. 6	1	Land preparation							
Nov. 13	2	Planting							
Nov. 15	3	Organic fertilizer	Rice and maize cooked like porridge				500 mL/25 L		
Nov. 20	4	Urea	N: 46%				5 kg/1,200 m^2		KHR 87500/50 kg
Nov. 19	5	Organic fertilizer		Rice and maize cooked like porridge			500 mL/25 L		
Nov. 24	6	Organic fertilizer		Rice and maize cooked like porridge			500 mL/25 L		
Nov. 25	7	Insecticide	Unknown (Thai)	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	40 mL/25 L water 50 L/1500 m^2		KHR 53,000/500 mL
		Mixture of fungicides	Robin 750WDG	Azoxystrobin 250 g/kg	Methoxy acrylate	Respiration	1 packet of Robin and 2 spoons of Romong/25 L water 50 L/1500 m^2	15 g/25 L 150–225 g/ha	
				Tebuconazole 500 g/kg	Triazole	Sterol biosynthesis in membranes			
			Romong 800WP	Mancozeb 800 g/kg	Dithiocarbamate	Non-systemic fungicide with multi-site protective action on contact.		80–100 g/20 L for xxx 50–60 g/20 L for 20 L Non-vegetables	KHR 10,000/pack 1 kg/pack
Nov. 28	8	Fertilizer	Urea				10.5 kg		
			DAP				10.5 kg		KHR 118,000/50 kg
	9	Insecticide	Unknown (Thai)	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	40 mL/25 L water 50 L/1500 m^2		KHR 53,000/500 mL

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Dec. 3	10	Fertilizer	Urea				10.5 kg		
			DAP				10.5 kg		KHR 118,000/50 kg
Dec. 8	11	Insecticide	Unknown (Thai)	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	40 mL/25 L water 50 L/1500 m^2		KHR 53,000/500 mL
Dec. 9	12	Organic fertilizer		Rice and maize cooked like porridge			500 mL/25 L		
Dec. 16	13	Insecticide	Unknown (Thai)	Fipronil	Phenylpyrazole	GABA-gated chloride channel blockers	40 mL/25 L water 50 L/1500 m^2		KHR 53,000/500 mL
Dec. 24	14	Harvest							

B12: Long beans **Ta Sei Village, Ta Meun Commune, Thma Koul District**

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Sept. 30	1	Planting							
Oct. 3	2	Fungicide	Bhoomika Perfect 11WP	Trichoderma viride			20 g/20 L 50 L/1,200 m^2	20 g/20 L 50 L/1,200 m^2	USD 10/kg
Oct. 4	3	Fertilizer	Urea				2 kg		THB 710/50 kg
			DAP				1.5 kg		THB 910/50 kg
			K				1.5 kg		THB 690/50 kg
Oct. 13	4	Fungicide	Unknown (Angkor Green)	Trichoderma harzianum			20 g/20 L 50 L/1,200 m^2	20 g/20 L 50 L/1,200 m^2	USD 10/kg
Oct. 14	5	Fertilizer					7 kg		
Oct.	6		Sdech Neak Tekkork	Lecanicillium lecanii			200 g/40 L water/1,200 m^2		KHR 10,000/200 g/pack
Oct.	7		Sdech Neak Tekkork	Lecanicillium lecanii			200 g/40 L water/1,200 m^2		KHR 10,000/200 g/pack
Oct.	8		Sdech Neak Tekkork	Lecanicillium lecanii			200 g/40 L water/1,200 m^2		KHR 10,000/200 g/pack
Nov.	9		Sdech Neak Tekkork	Lecanicillium lecanii			200 g/40 L water/1,200 m^2		KHR 10,000/200 g/pack
Nov.	10		Sdech Neak Tekkork	Lecanicillium lecanii			200 g/40 L water/1,200 m^2		KHR 10,000/200 g/pack
Nov. 28	11								

Land area: 1,200 m^2

B13: Cabbage (organic) **Ta Sei Village, Ta Meun Commune, Thma Koul District**

Time period	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
25 days	1	Seedling with BT	BT						
0 days	2	Planting							
15 days	3	Assessment and BT	BT						
19 days	4		Prevathon 5SC	Chlorantraniliprole	Diamide	Ryanodine receptor modulators		- Rice: 300–400 mL/ 250–320 L/ha - Vegetables: 600 mL/ 350 L/ha - Catjang: 600–1,200 mL/ 500 mL/ha - Soybeans: 600–800 mL/ 500 L/ha	

B14: Rice Ta Sei Village, Ta Meun Commune, Thma Koul District

Date	Farm work		Chemical application						
			Commercial name	Active ingredients	Chemical class	Action	Application rate		Price
							Farmer's practice	Label instructions	
Sept. 5	1	Broadcasting							
Sept. 12	2	Insecticide	Sdech Neak Tekkork	Lecanicillium lecanii			40 mL/25 L 250 L/ha		KHR 42,000/500 mL
Sept. 25	3	Fertilizer	Urea				50 kg/ha		
Oct. 5	4	Herbicide		Bispyribac sodium	Pyrimidinyl benzoate	Inhibition of acetolactate synthase	2 sets/ha 2 sets/250 L water		KHR 30,000/set
Nov. 5	5	Fertilizer	Topone				50 kg/ha		THB 880/50 kg
Nov. 19	6	Fungicide	Dr. Hexa 50SC	Hexaconazole	Triazole	Sterol biosynthesis in membranes	50 g/L 250 L/ha	50–60 mL/25 mL water 320 L/ha	
			Unknown						
Unknown	7	Fertilizer	Topone				50 kg/ha		THB 880/50 kg
Dec.	8	Harvest							

Land area: 10 ha

Yield: 2 t/ha

Price: THB 7,500/t

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