

Ecosystem Assessment for Harnessing Digital Agriculture Technologies in Cambodia

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List of Abbreviations and Acronyms

ADB	Asian Development Bank
AI	Artificial intelligence
AIS	Agricultural input suppliers
AIMS	Accelerating Inclusive Markets for Smallholders
AMIS	Agricultural Marketing Information Service
ASEAN	Association of Southeast Asian Nations
ASPIRE	Agricultural Services Programme for Innovation, Resilience, and Extension
CSES	Cambodia Socio-Economic Survey
CF	Contract farming
CT	Consultant team
DAI	Digital Adoption Index
DAP	Digital Agriculture Profile
DAT	Digital agriculture technology
DFS	Digital financial services
GAP	Good agricultural practices
GDP	Gross domestic product
GIS	Geographic information systems
GNI	Gross national income
GPS	Global positioning system
HR	Human resources
ICT	Information and communication technologies
ICT4Ag	ICT for agriculture
IDP	Industrial Development Policy
IFAD	International Fund for Agricultural Development
IoT	Internet of Things
KHR	Cambodian Riel
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economics and Finances
MISTI	Ministry of Industry, Science, Technology and Innovation
MOC	Ministry of Commerce
MPTC	Ministry of Posts and Telecommunications
NBC	National Bank of Cambodia
NIPTICT	National Institute of Posts, Telecommunications, and Information Communication Technology
R&D	Research and development
RGC	Royal Government of Cambodia
SAAMBAT	Sustainable Assets for Agriculture Markets, Business, and Trade
SMEs	Small and medium-sized enterprises
SNEC	Supreme National Economic Council
TSC	Techo Startup Center
TRC	Telecommunication Regulator of Cambodia
UNDP	United Nations Development Program
WB	World Bank

Executive Summary

Digital Agriculture Technologies (DAT) are digital tools and technologies used in agriculture to increase production, market, sustainability, and efficiency. A vast array of technology and techniques are included in it, such as sensors, drones, GPS-guided machinery, precision irrigation systems, market information and technology, data analytics, and machine learning tools. Furthermore, Digital Agriculture Technologies have the potential to enhance trade in agricultural and food products by providing new avenues for private sector suppliers to enter the market, equipping governments with enhanced capabilities to oversee and guarantee adherence to standards and streamlining the necessary border procedures for perishable products. For example, consider the following: 1) a commercial farmer in Cambodia utilizes a drone to spray crops more quickly and cheaply. 2) an increasing number of farmers join together in interest-based groups on social media platforms such as Telegram groups and chats. From there, they can exchange ideas, discuss their experiences, and/or provide digital consultations to one another with minimal financial outlay by exchanging voices, images, and messages in the chat box or over the phone.

Agriculture is a cornerstone of the Cambodian economy, along with garment production, construction, and tourism. It employs over 70 percent of workers and generated over US\$5 billion from exports in 2021. This sector, crucial to the country's growth and prosperity, has proven resilient amid the COVID-19 pandemic, reflecting its importance to Cambodia's economy.

Despite the sector's importance, agriculture faces key challenges like low productivity, inefficiency, and vulnerability to climate change. These challenges stem from most Cambodian farmers' lack of modern technologies, techniques, and decision-support tools to enhance their farming productivity sustainably. Other key challenges along the agricultural value chain include the supply of inputs, farm production, trading, processing, wholesaling/retailing, and consumer relations. Farmers also struggle with access to affordable financing, numerous value chain layers with associated costs, and poor information distribution.

One possible solution to these challenges is digital agriculture technology (DAT). Although DAT is a relatively new and evolving concept, basic tech infrastructure, including mobile and Internet connectivity, is already in place. As of 2016, 88 percent of individuals access the Internet via mobile phones, a marked increase from 71 percent in 2014. By January 2021, Cambodia had 8.86 million Internet users, an uptick of 1.1 million (+14 percent) from 2020, equating to 52.6 percent of the population. Social media use grew by 20 percent between January 2019 and January 2021. This context can facilitate innovative digital solutions for Cambodia's agricultural sector. Implementing DAT solutions enhances efficiency by reducing labor and operational costs, aiding decision-making through data, improving crop quality and yield while reducing losses, and enabling sustainable resource use.

Understanding the key actors—government agencies, development agencies, the private sector, and enablers—is crucial for DAT growth in Cambodia. We can divide those actors into four categories with key roles and responsibilities (table ES1):

Table ES1. Roles and responsibilities of the actors in DATs

Institution	Key Roles and Responsibilities
Government Agencies	
Various ministries, e.g., Ministry of Economics and Finances (MEF), Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Posts and Telecommunications (MPTC), Ministry of Commerce (MOC), Ministry of Industry, Science, Technology, and Innovation (MISTI)	- Formulating policies and strategies for the agricultural sector and specific subsectors. - Managing standards of agricultural production. - Conducting research and development (R&D). - Issuing licenses for agri-businesses to operate. - Supporting the growth of the overall digital infrastructure for DAT. - Developing e-government policies and frameworks - Regulating mobile and Internet connectivity in the country. - Organizing policy, strategy, direction, and overall plans of the royal government in the fields of agro-industry, science, and technology. - Providing comprehensive support for accessing long-term funding and financing for the agriculture sector. - Leading special government projects, e.g., Khmer Enterprise and Techo Start-up Center, related to DAT development and beyond. - Leading efforts to open agricultural markets, establish market linkages, and promote agri-products exports, including bilateral and multilateral free trade agreements.
Development Agencies/Projects	
CAVAC, Oxfam, USAID, International Fund for Agricultural Development (IFAD), Interchurch Coordination Group for Development Cooperation (ICCO), etc.	- Supporting/funding specific agricultural value chains, e.g., the Agricultural Services Programme for Innovation, Resilience, and Extension (ASPIRE) or HARVEST II projects. - Co-designing specific interventions related to agriculture, especially agri-value chains projects or agri-tech projects, e.g., Angkor Salad - Co-funding for the innovative solution with the private sector, e.g., Tonlesap App - Providing long-term loans or grants to the Cambodian government to support agriculture or specific sub-sector or commodity value chains. - Supporting/providing valuable inputs for the government on policies and legal frameworks in agriculture via evidence-based research or expert consultants.
Private Sector	
AgriBee, Agribuddy, AMK Spien, Smart Farm Assistance, AgriOn, Kenko Shoku	- Providing agricultural products and services that support farming productivity, access to finance. - Providing agricultural technical knowledge and agricultural market information, key techniques in farming, livestock, agricultural input

	information, and loan access for business expansion. • Providing farming productivity and services such as a smart irrigation system. • Providing linkage or trading between producers and consumers (B2C model); facilitating direct selling from farm to kitchen. • Providing an ecosystem for a commodity, e.g., rice, where AgriBee provides a holistic approach to the value chains, from farming inputs and financing to buy-back scheme and linking to buyers.
Enabling Actors	
Mobile Operators, Internet Service Providers, and Telecom Regulator of Cambodia	• Mobile Operators: Metfone, Cellcard, Smart Axiata. • Internet Service Operators: Opennet, MekongNet, SINET, EZECOM, NTC, Digi, ONLINE.

Policy

Government policies that bolster a digital economy have led to the introduction of many initiatives, projects, and policies that support the digital economy ecosystem.

The long-term digital technology strategy for the country is in three phases:

- **2021–2025 – Phase 1** – Digital Foundation, i.e., building digital infrastructure and digital trustworthiness
- **2026–2030 – Phase 2** – Digital Adoption, i.e., digital citizens, digital government, and digital business
- **2031–2040 – Phase 3** – Digital Transformation, i.e., a sizable digital economy to be one of the growth drivers
- The Ministry of Agriculture Forestry and Fisheries (MAFF) has implemented the government’s digital technology strategy in its first phase. Though MAFF lacks a dedicated DAT strategy, DAT integration is present in their strategic action plan and execution, as outlined in the Agriculture Sector Development Plan (ASDP, 2019–2023), the draft versions of the Agriculture Development Policy (ADP, 2021–2030), and the Agriculture Sector Master Plan (AMSP, 2021–2030).

Government initiatives and projects related to DAT

The RGC has started several DAT-related initiatives on the supply side, including the following:

- **Techo Startup Center (TSC):** Provides chances for young people, students, and researchers to start new firms related to digital technology (MEF)
- **Sustainable Assets for Agriculture Markets, Business, and Trade (SAAMBAT)** – enhance value chain infrastructure (products): skills, technology, business, and digital platforms (Khmer Agriculture Suite – **KAS**) for the agriculture value chain (MEF and MRD). KAS is part of the SAAMBAT. It is a one-stop platform that provides support in digital outreach activities to test the market in the target location.
- **Khmer Enterprise:** An autonomous government agency under MEF building the entrepreneurship ecosystem, including agri-tech or digital solutions.

- **ASPIRE:** The Chamkar app is a major project under MAFF, funded by IFAD along with the Royal Government of Cambodia (RGC)'s co-investment, and encompasses various initiatives.
- **CAMAgri Market:** This Agricultural Marketing Information Service (AMIS), managed by MAFF's Agricultural Marketing Office, aims to enhance stakeholders' capacity to gather, interpret, and apply market information. This will help optimize responses to market needs by ensuring accurate and timely information distribution to all concerned.¹

DAT ecosystem analysis

Despite enhanced DAT innovation support, analysis shows Cambodia still faces hurdles to macro-environmental growth. We examined and scored six key areas: entrepreneurship (score 3.5), density (2.95), finance and investment (3.35), digital technology's human capital and workforce (2.13), infrastructure (2.8), and regulatory environment (2.65) (figure ES1). The overall average score across these areas was 2.90. Entrepreneurship and finance received the greatest scores, while human capital received the lowest.² The higher scores in entrepreneurship and finance are due to its robust tech hubs aiming to upskill DATs. Despite above-average scores, poor human capital performance highlights the need to improve digital literacy. Table ES2 presents the strengths and weaknesses of DAT in Cambodia.

¹ For details, see the infographic at <https://b2008833.smushcdn.com/2008833/wp-content/uploads/2022/07/SAAMBAT-1-Offer-1.png?lossy=2&strip=1&webp=1>

² The ecosystem analysis approach was adopted from the 2020 World Bank report, "Scaling Up Disruptive Agricultural Technologies in Africa".

Table ES2. SWOT analysis of DAT in Cambodia

Strengths	Weaknesses
- As an agrarian economy, Cambodia has many options to test DAT solutions. - Strong government support and initiatives, e.g., the Techo Start-up Center. - Relatively strong ecosystem supporting DAT development, i.e., key actors and physical infrastructure in place. - Donors and developing partners are willing to develop or mobilize support for early-stage DAT solutions, e.g., Angkor Salad supported by ICCO or the Chamkar app supported by IFAD/GIZ. - New DAT solutions are growing and testing their solutions in Cambodia, e.g., AgriBee, AgriOn, Smart Farm Assistance, Khmum.	- DATs are nascent in Cambodia, especially in the private sector, e.g., the average age of start-ups ranges from less than a year to 3 years. - The target user base is quite small (in-country), without a plan to scale to the Association of Southeast Asian Nations (ASEAN) or Asia regional level. - Lack of a coordinating body to implement an effective DAT policy. - Limited actual investment (financial and human resources) into DAT solution development - Skill shortages in DAT solution development. - Lack of seed capital for DAT start-ups.
Opportunities	Threats
- High mobile phone penetration and usage rate and a high level of digital adoption among young people - A long-term digital technology strategy (Phase 1: 2021–2025, Phase 2: 2026–2030, and Phase 3: 2031–2040) COVID-19 provided an opportunity to accelerate digital adoption, especially on DAT-based e-extension services. - Well-connected/integrated to the regional market, infrastructure, human resources, and technology, especially within ASEAN countries	- DAT solutions in Cambodia are perceived as high risk from a private investor's perspective, as the market size/target user base is quite small. - Strong competition from other DAT solutions with more advanced or bigger economies, e.g., Singapore and Indonesia. - Higher failure rate than other digital solutions due to the nature of the agriculture sector, i.e., they are long-term investments, low initial rate of adoption, and low user knowledge.

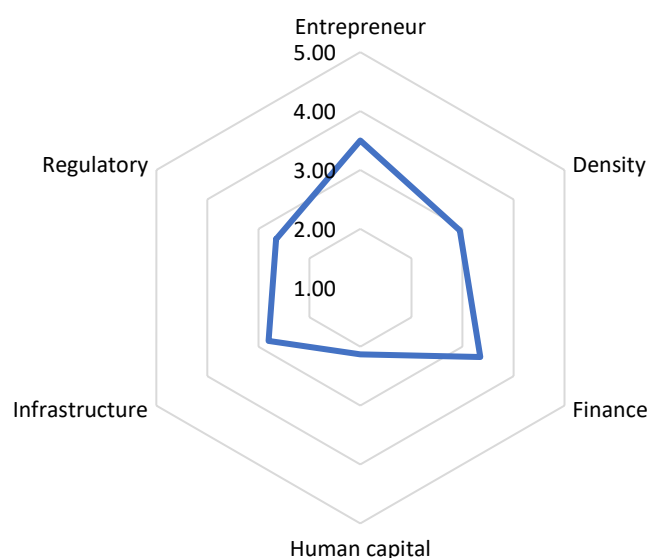


Figure ES1. Overall digital technology ecosystem scores

The application of DAT

According to the assessment, DAT use cases can be divided into three access categories: access to markets, services, and assets (table ES3).

Table ES3. DAT use cases and sub-use cases

Access to Services		Access to Markets		Access to Assets
Digital Advisory Services	Agri Digital Financial Services	Digital Procurement	Agri E-Commerce	Smart Farming
Agri value-added services (Agri VAS)	Credit and loans	Digital records	Inputs	Smart shared assets
Smart advisory	Input financing	Digital records with payments	Outputs	Equipment monitoring
Weather information	Credit scoring	Digital records with traceability	Inputs and outputs	Livestock and fishery management
Pest and disease management	Crowd funding	Digital records with traceability and payments		
Recordkeeping	Insurance Digital agri wallet Accountability tools			

In the Cambodian setting, digital agriculture use cases align well with services provided by donor-funded initiatives. Such initiatives include HARVEST II and ICCO ASPIRE, and private sector entities like AMK, Spien, AgriOn/Kenko Shuku, WING, ACLEDA Toan Chet, Forte Insurance, and Delishop. See table ES4 for selected digital agriculture solutions.

Table ES4. Digital services and platforms in Cambodia

Digital Advisory Services	Digital Platform in Cambodia	Digital Financial Services	Digital Platforms in Cambodia
Agri VAS	Chamkar and Tonlesap App provide daily advice on irrigation and fertilizers, technical knowledge on vegetable cropping, and market information	Credit and loan	The ACLEDA Toanchet smartphone app enables customers to do banking transactions from anywhere, anytime. The AMK mobile app provides a safe, user-friendly mobile banking application with a wide range of functionality to fulfill daily needs.
Smart advisory services	The Angkor Salad app provides customized advisory services to vegetable producers in several provinces on seed choice for specific soil conditions and optimal, precise use of agriculture inputs	Credit scoring	The Credit Bureau app reduces lender risk and lowers the number of non-performing loans within the Cambodian economy

Weather information	The Angkor Salad app has a geo-data-based weather information service that helps Cambodian vegetable farmers increase production, reduce input use, and improve livelihoods	Crowdfunding	The RAI Capital Platform serves as a marketplace platform, enabling users to acquire loans digitally and to onboard suitable investors around the region
Pest and disease management	Angkor Salad and Tonlesap App both provide advice on disease and pest management for crops	Agricultural Insurance	Agribee crop insurance protects against loss of or damage to crops or livestock Forte's in-depth corporate insurance coverage offers solutions tailored to farmers
Farm record keeping	The Angkor Salad app allows users to record their agricultural products, cultivated areas, dates, and locations. Tonlesap App allows users to save, borrow, and pay with AMK bank for income-generating activities to increase food security	Input financing	AgriBee is a technology platform that connects key players to boost value chain efficiency Agribuddy helps farmers utilize their farmland and produce high yields cost-effectively by providing finance, knowledge, goods, and services to their doorsteps
Market linkage platforms	CAMAgri Market and Tonlesap App allow producers to promote and sell their products and services to end-consumers, trader retailers, and wholesalers	Online agri-marketplace platform	Delishop has over 60 partners and over 10,000 products, making it an excellent option for end-consumers looking to acquire their groceries in one place, with free delivery
Product verification	CamGap barcode provides detailed information on production sources and good agricultural practices (GAP) assurance AgriBee App provides a service of agricultural insurance to protect against loss of or	Saving	AMK MFI is a microfinance institution in Cambodia that provides the rural population with tailored microfinance services WING provides every Cambodian with convenient access to financial services
		Digital agri wallet	WING provides convenient access to financial services

	damage to crops or livestock		True Money Wallet is a new exclusive payment method in Cambodia
		Accountability tools	បញ្ជីលុយ (BanhJiLuy) or My Money Tracker is a simple, fast, and secure money tracking app designed to help Cambodians take control of their finances

The digital agriculture transition holds potential for Cambodia’s sustainable economic growth, especially for economic recovery from COVID-19. “The Strategic Framework and Programmes for Economic Recovery in the Context of Living with COVID-19 in a New Normal 2021–2023,” launched by the Ministry of Economics and Finance in December 2021, indicated two factors related to our assessment are digital economy: agri-industry development, and access to financing for SMEs, many of which are agri-food SMEs and agri-cooperatives.

Based on the assessment in this study, three potential digital agricultural solutions could be scaled up:

- Climate-smart solutions:** These solutions could rectify the flawed food system by enhancing productivity and reducing inputs like water, seeds, and fertilizer. They also decrease operation costs, leading to higher-quality and more abundant output due to improved accuracy. Examples include Smart Farm Assistance and Angkor Salad.
- Market linkage, online agri-marketplaces, and agri-tech platforms:** Individuals increasingly seek information and purchase groceries digitally as behavior has shifted towards online activities spurred by COVID-19. Consequently, traditional in-store buying habits have evolved towards online platforms. This shift is not exclusive to Cambodia; it is evident across Asia, particularly among the more technologically adept and affluent younger generation. Consequently, online agri-marketplaces like Khmum, Delishop, Phsar, and others have grown rapidly. Examples include Tonlesap App, CAMAgri Market app, Delishop/Phsar, and AgriOn/AgriBee.
- E-extension services:** Developing partners and government agencies increasingly recognize e-extension services as essential tools for broadening their reach. This shift is due to more farmers/producers accessing mobile Internet via smartphones. Examples include Agribuddy and Chamkar.

This report evaluates Cambodia’s digital agriculture landscape, to identify how it can be mainstreamed. It uses stakeholder insights to assess key value chain players, their struggles, and the potential of technology adoption to overcome these hurdles. This assessment aids in identifying and prioritizing important technologies, thus helping investors maximize their impact by focusing on high-potential opportunities. Once these enabling factors are understood, digital agriculture in Cambodia can be mainstreamed and grow.

Recommendations

For the government

Create an enabling regulatory environment. The government and regulators should establish facilitating regulations to promote financial technology and e-commerce adoption in DAT, agricultural input suppliers (AIS), and among farmers. An instance of this is streamlining the registration and licensing process for e-commerce businesses. Additionally, setting up systems or databases that grant access to digital identity verification and ensuring equitable marketplace competition among all participants, whether official or informal, would be instrumental to success.

Improve supporting digital infrastructure quality and access. The government should continue to invest in digital infrastructure, supporting the expansion of mobile broadband to rural areas and ensuring constant Internet service quality. Collaborating with the private sector, the government should establish a resilient e-commerce ecosystem. By cultivating such an ecosystem and promoting entrepreneurship in the agricultural sector, fresh job creation and economic growth prospects can be unlocked.

Focus on enhancing digital literacy and building digital skills. A public digital literacy framework should be developed to cover Cambodia's entire spectrum of digital literacy development. Inclusive literacy approaches should be examined to ensure everyone has equal and fair access to literacy opportunities regardless of their social, cultural, or economic background. Information literacy and skill in locating, searching, and browsing for digital content and filtering and assessing it should be emphasized inclusively. Public awareness of digital technology and literacy should be improved, particularly in rural regions. The government should complete research on digital skills gaps and digital readiness to assist it in formulating strategic direction and measures to promote e-commerce and digital payment in company operations.

Develop an agriculture e-commerce framework.

The government should develop an agricultural e-commerce framework to enhance the agricultural value chain. This involves revamping agricultural production processes, enhancing trade exchange platforms, and refining online marketing and sales strategies.

Develop a coherent digital strategy. This impacts business processes, human resources (HR) planning, and investments. A digital strategy can enhance collaboration and speed-up goal achievement. It helps businesses prepare for and exploit swift digital changes. Including marketing automation in the strategy can boost efficiency and lead generation.

For the private sector and development partners

Invest in viable services that create impacts. With accessible funding opportunities, it is important to incentivize the private sector to invest in agriculture e-commerce enterprises and start-up initiatives, including app developers with the potential to generate social and economic benefits. These endeavors can directly collaborate with agriculture input suppliers and farmers, facilitating the transfer of skills, technology, experiences, and resources.

Invest more in incubators and accelerator programs. Collaborative efforts between the government, development partners, donors, and the private sector are crucial to drive increased investment and promotion of additional incubators and accelerator programs within this sector. These initiatives will prove instrumental in nurturing aspiring entrepreneurs and innovators, fostering their growth and development. These initiatives will foster tech start-ups in tech innovation, especially in digital financial services and e-commerce sectors. For instance, Tonlesap App was developed by a private microfinance institution, AMK, with funding support from donors such as the Netherlands Development Organization (SNV) and Harvest II projects. This type of initiative will support new start-ups.

Invest in R&D. Development partners and the private and public sectors must innovate and remain competitive. They should increase investment in R&D to advance decision-making, efficiency, and worker productivity, be it decision-making, efficiency, increased worker productivity, and improved products and services.

Utilize government support. Companies and agencies should utilize government aid for tech transfer and skills development by participating in state-funded initiatives. This engagement can be through collaboration on projects with government ministries or through internationally-supported projects from aid organizations like the Asian Development Bank (ADB), World Bank (WB), USAID, IFAD, etc.

Redefine human resource management. Traditional HR management strategies may falter in the digital economy. To attract and retain talent, firms should offer flexibility, encourage creativity, and foster open, conducive work environments. This is significant, given the typical six-day work week. Yet, equipping young graduates with practical experience and essential skills can prepare them for the digital technology sector.

Reskill and upskill. Over 72 percent of employees feel they cannot rely on their companies for upskilling. In a competitive job market, all workers must undertake lifelong learning and career growth.

For agriculture input suppliers (AIS), whether the private sector or agricultural cooperatives

Develop digital skills and improve digital literacy. AIS should engage in digital skills development programs established by relevant ministries, local authorities, and private actors based on their digital skills and literacy level. Inclusive opportunities and specific technical skills should be given based on the actual needs. The improved digital skills and digital literacy will also help increase the adoption of online transactions among AIS.

Participate in public awareness and increase understanding of the benefits of digital payment and e-commerce. AIS have to enhance their grasp of the potential benefits of digital payment and e-commerce together with the increased digital skills and digital literacy. Without understanding the benefits, they may be unlikely to adopt digital payments or participate in e-commerce, even if they have the skills to do so. AIS must actively participate in public awareness initiatives to increase their understanding of potential benefits and related laws and mechanisms. This would also improve AIS's lack of trust in digital business.

Increase trust in adopting digital payment and e-commerce. AIS could achieve this by taking time for the related laws and policies for digital payment and e-commerce. Moreover, trust

will grow as the government and relevant entities rigorously enforce e-commerce and consumer protection laws, extending their outreach to all AIS for enhanced rights and privacy awareness. This process entails establishing secure online transaction mechanisms, efficient resolution procedures for online disputes and fraudulent activities, and bolstering AIS comprehension of digitalized business opportunities for expansion. They should reach out to larger customers through digitalization to improve trust and confidence in the sector.

Chapter 1: Introduction

1.1 Overview of the Agricultural Sector

This study aims to create a Digital Agriculture Profile (DAP) for Cambodia, assessing and pinpointing agriculture policies and investments to bolster Cambodia's DAT growth. The research evaluates the status quo of DATs, key stakeholders, challenges and opportunities while suggesting suitable policies and investments for their development. It explores the powerhouses of digital conversion in agriculture and gauges their impact on productivity, inclusiveness, and climate resilience.

Cambodia's population is growing, its economy is advancing, and poverty rates are declining. As of January 2021, Cambodia's population stood at 16.83 million, with 75 percent living in rural areas (Datareportal 2021). Cambodia aims to reach upper-middle-income status by 2030 and high-income status by 2050. Its economy expanded 7.6 percent annually from 1994–2015, helping it transition to lower-middle-income status. It recorded a Gross National Income (GNI) per capita of US\$1,070 in 2015 and US\$1,530 in 2019, signifying a 10.87 percent increase from 2018. The country's robust economic growth is fueled by exports in textiles, agriculture, and tourism, along with recent contributions from the building and real estate sectors. Total Gross Domestic Product (GDP) increased by 7.1 percent yearly from 2016 to 2019 but dropped to 2.3 percent in 2020 due to COVID-19 (ADB 2020). Cambodia's poverty rate fell from 53.2 percent in 2004 to 13.5 percent in 2014 and 9.5 percent in 2019. Cambodia has one of the most rapid improvement rates in the region's human development index (UNDP 2017).

Despite improvements, almost 18 percent of the population live in poverty, which varies by location. According to the Cambodia Socio-Economic Survey (CSES), in 2020, there were an estimated 3.6 million Cambodian households. GDP per capita climbed to US\$1,694 in 2019, up from US\$1,555 in 2018 (NIS 2020). The report states that Cambodia's national poverty line now classifies those earning under KHR 10,951 daily as poor, using refined calculations and 2019–2020 CSES data. In 2019–2020, roughly 17.8 percent of the population lived in poverty. The poverty rate was 4.2 percent in Phnom Penh, 12.6 percent in other urban regions, and 22.8 percent in rural areas.

Table 1.1. Income composition between 2014–2019/20

Source of Income	CSES, 2014	CSES, 2015	CSES, 2016	CSES, 2017	CSES, 2019/20
Value in KHR Thousands (*)					
Primary income	1,371	1,523	1,666	1,862	2,070
• Wage and salary	642	788	887	1,039	1,243
• Self-employment income	722	727	777	820	825
○ Agriculture	230	238	246	251	264
○ Non-agriculture	378	362	399	438	447
○ Owner-occupied house	115	127	132	131	114
• Property income	7	8	2	3	2
Total transfers received	62	96	111	98	198
Total income	1,434	1,619	1,777	1,960	2,268
Total transfers paid (**)	10	11	11	13	6
Disposable income	1,424	1,608	1,766	1,947	2,262
Share in %					
Primary income	95.6	94.1	93.8	95.0	91.3
• Wage and salary	44.8	48.7	49.9	53.0	54.8
• Self-employment income	50.4	44.9	43.7	41.8	36.4
○ Agriculture	16.0	14.7	13.9	12.8	11.6
○ Non-agriculture	26.3	22.4	22.5	22.3	19.7
○ Owner-occupied house	8.0	7.8	7.4	6.7	5.0
• Property income	0.5	0.5	0.1	0.1	0.1
Total transfers received	4.4	5.9	6.2	5.0	8.7
Total income	100	100	100	100	100
Total transfers paid (**)	0.7	0.7	0.6	0.7	0.3
Disposable income	99.3	99.3	99.4	99.3	99.7

Source: NIS 2020.

Note: CSES – Cambodia Socio-Economic Survey; KHR – Cambodian Riel; (*) Exchange rate in 2020 US\$1 = KHR 4,000;

(**) The comparability between 2012–2013 and prior years is minimal due to a change in questionnaire and assessment methodologies in 2012–2013.

In Cambodia, the agricultural sector employs over 70 percent of the workforce and is one of three priority sectors (figure 1.1). Overall agricultural value, production, and exports have increased. As of 2019, agriculture contributed 20.71 percent of the country's GDP (NIS 2020). It is worth noting that an overall agricultural value accounted for US\$18.06 billion in 2021 (White 2022), which was 43.39 percent higher than in 2020. The total agricultural export stood at US\$5.038 billion in 2021, an increase of 24.78 percent compared to the previous year. Total agricultural production volume stood at 35.97 million tons, an increase of 23 percent compared to 2020. Approximately 54 percent of the agriculture sector's GDP comes from crop production, including vegetables, with fisheries contributing 25 percent, livestock 15 percent, and forestry and logging about 6 percent (figure 1.2). Over the past decade, rice farming has occupied 75 percent of the agricultural land, while other crops and vegetables covered just 25 percent. The cultivated area of rice continues to grow (figure 1.3).

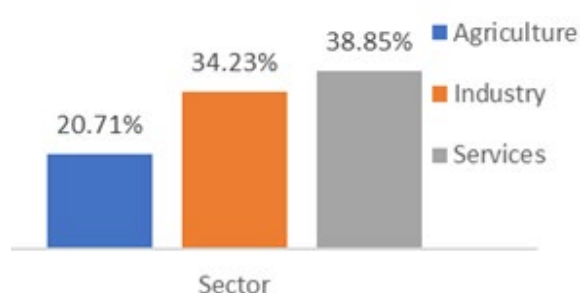


Figure 1.1. Key sectors' contribution to GDP

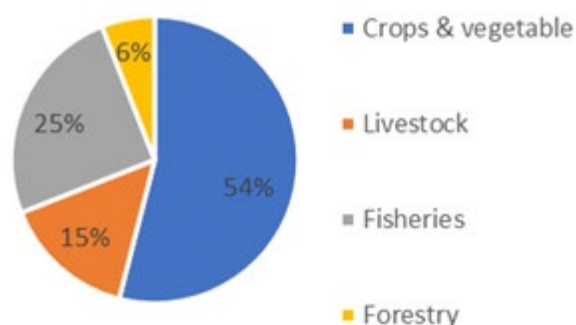


Figure 1.2. Agricultural subsectors' contribution to GDP

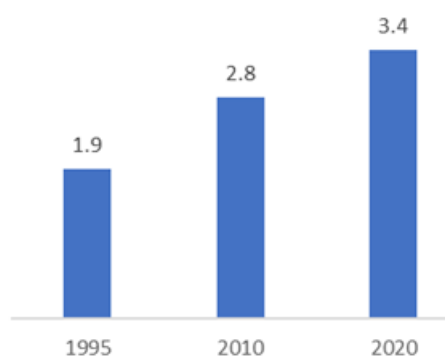


Figure 1.3. Rice cultivated areas over the last 25 years, in million hectares

Despite this improvement, and the fact cultivated land doubled between 2016 and 2018, Cambodia's agricultural sector faces several challenges. Since 2014, cultivated land has experienced significant growth, more than doubling from 97,613 hectares in 2016 to 203,807 hectares in 2018.³ However, many challenges persist, including low productivity, low-quality agricultural products and inputs, limited extension services, limited diversification, food safety, sanitary and phytosanitary concerns, insufficient market access, and low-value addition. MAFF can ensure a reliable and consistent high-quality product for agricultural production and marketing—one of Cambodia's top priorities—by incorporating DAT measures across agriculture chains and providing institutional, technical, and financial support to strengthen productivity.

Cambodia primarily cultivates rice (70 percent), followed by other crops like sugar cane, rubber, and various fruits (30 percent), with an increase in rice cultivation and production in 2020. The 4.5 million hectares of cultivated land consists mainly of rice (70 percent), followed by subsidiary and industrial crops—including non-rice cereals, grains, roots, tubers, legumes, sugar cane, and tobacco—at 20 percent, rubber plantations (7 percent), and permanent or perennial crops like banana, cashew, coconut, coffee, durian, palm oil, mangoes, and oranges (4 percent). The cultivated rice area rose from 3.2 million to 3.4 million hectares between 2017 and 2020 (figure 1.3). The 2020 figure includes 2.807 million hectares for wet-season rice and 0.6 million hectares for dry-season rice. Cambodia's paddy

³ Department of Industrial Crops (DIC/MAFF), as reported by CIRD in their Cashew Field Assessment Report (September 2019).

production, peaking at 538,000 tons in 1979, grew to 10.93 million tons in 2020. Of this, dry-season rice accounted for 2.61 million tons, while rainy-season rice made up 8.31 million tons. Rice farming costs per hectare varied between US\$353 (KHR 1.41 million) and US\$705 (KHR 2.82 million), with a mean cost of US\$470 (KHR 1.88 million).

Corn, cashews, cassava, and mangoes are critical cash crops for thousands of smallholders in Cambodia, but some have an underdeveloped processing industry. In 2021, Cambodian farmers were set to reach an estimated 244,568 tons of cashew nuts, making Cambodia the world's fifth-largest producer (USAID 2019). Despite this, the rise in Cambodia's cashew production has not sparked an equivalent growth in its processing industry due to scarce resources and processors. Consequently, Cambodia exports almost 97 percent of its cashew nuts as raw products to Vietnam for processing.

Cassava production is important to the sector, creating seasonal jobs. Cambodia ranks fourth in Asia and tenth worldwide in cassava production (UNDP 2020a). Over 12 million tons of fresh cassava production harvested in 2020 (IFAD 2020). The sector involves over 90,000 rural households in 13 provinces in cassava cultivation and creates many seasonal jobs for local laborers (MoC 2020). Between 2018 and 2019, cassava was cultivated on nearly 650 thousand hectares, yielding over 14 million tons, and over 3.3 million tons were exported (MoC 2020; Sakhon 2020).

Cashews, cassava, and mangoes can push production, process, and exports, should their chains be developed. Mangoes are grown on over 131 thousand hectares, providing yields of 1,382,414 tons (MAFF 2021). Cashews, cassava, and mangoes become potential commodities to push production, processing, and exports. The top three agricultural products exported between 2015 and 2018 were cassava, with a share of 37 percent; semi-milled or wholly milled rice, with 28 percent; and cashew nuts in the shell at 9 percent (FAO 2020).

The vegetable industry plays a crucial role in Cambodia's agriculture system, providing both food and income for farmers. While vegetable production is trending upwards, it falls short of meeting domestic demand. This situation underscores the potential for substituting imports from neighboring countries such as Thailand and Vietnam. Annually, Cambodia consumes a million tons of vegetables and spends US\$200 million importing vegetables from foreign countries, especially Vietnam, to help meet local needs (Vantha 2020). Crop estimates for 2018 show Cambodia has become a major pepper producer, ranking fifth worldwide. The country cultivated an area of 7,471 hectares. In 2019, it produced nearly 29,880 tons, an average yield of 4 tons per hectare.

The most substantial farming costs were service, chemical input, and seed (figure 1.4). Rice farmers owning or renting land experienced a return on capital ranging from 22–55 percent, averaging 35 percent. When the cost of land (KHR 0.4 million per hectare) was included, the capital return varied from 6 percent to 21 percent, averaging 12 percent. Fragrant rice farming provided the highest capital return. Excluding the land cost, the profit per hectare ranged from US\$136 (KHR 542,000) to US\$233 (KHR 931,000). Renting land could cost approximately US\$100 (KHR 400,000) per hectare each season (Frédéric et al. 2017). Among all farming methods, farmers cultivating early-wet-season non-fragrant variety and using their own machinery reaped the most profit from a hectare of land.

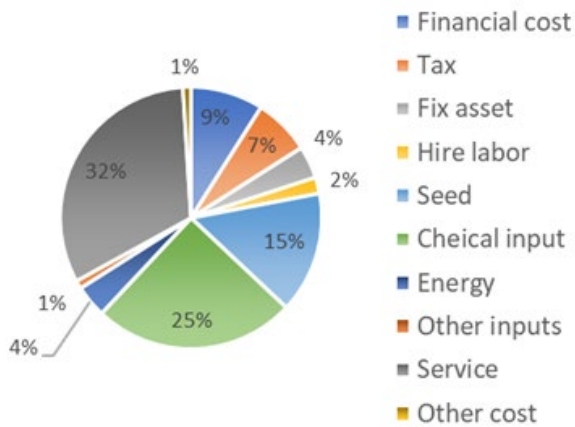


Figure 1.4. Share of rice farming cost, %

The average rural household landholding is just 1.3 hectares. Shrinking farm sizes reduce income. Although enough to yield a surplus for a five-person family, this size falls short of ensuring middle-class status or long-term financial stability. As farms keep being divided among children, the trend of shrinking landholdings will likely persist. Since 2014, 23 percent of rural households are landless, and 15 percent own under 0.5 hectares and mainly depend on farm wage labor. Alterations in farm sizes significantly influence farm earnings (World Bank 2017). The World Bank's 2015 research showed that return on land generally corresponds with farm size, barring maize and dry-season rice production (Eliste & Zorya 2015). Consequently, larger farms result in increased family effort returns and agricultural income. The return on land varies significantly across crops. Vegetable cultivation (US\$1,394 per hectare) and cassava production (US\$506 per hectare) yield higher returns than other crops.

On the other hand, contract farming (CF) in Cambodia has improved the earnings of some small-scale farmers. This approach has various forms, like mouth-to-mouth or signed agreements, encompassing both food and industrial crops, yet the types of CF models remain unclear. However, obtaining and maintaining consistent benefits from these initiatives has been challenging for farmers and contractors. While many CF methods exist, formal and informal contracts are two prominent forms. Formal contracts are agreements between the buyer and producer with government coordination and witness. Informal contracts, on the other hand, do not involve government participation. Though formal contracts have been introduced, informal contracts between parties persist. The CF law is expected to significantly enhance the business landscape, including agricultural diversification, commercialization, and CF itself.

Contract numbers have trended upwards, with rice dominating. The number of contracts started at 62 contracts in 2017, 90 contracts in 2018, 498 contracts in 2019, and 936 contracts in 2020 (MAFF 2021). Rice dominated CF, with farmers signing 186 contracts with a volume of 82,197 tons in 2020. This was followed by cassava, with 26 contracts accounting for 54,272 tons, and cashew nuts, with 9 contracts and 105 tons. Returning to animals, farming contracts for pigs were highest, accounting for 235 contracts at 34,845 tons, followed by chickens with 208 contracts amounting to 2,76,8891 heads and other products. In 2020, farmers signed the most contracts (457) in Kampong Speu; farmers signed between 1 and 74 contracts in 21 other provinces and cities.

1.2 Overview of the ICT Sector's Performance

Stakeholders in Cambodia's agricultural sector must rapidly adapt to changing digital and financial landscapes. Despite not reaching its full potential, agriculture remains a key contributor to the country's economic growth.

Limited digital access to timely agricultural information limits productivity. Around 76 percent of Cambodia's population lives in rural areas (World Bank 2022), with limited access to reliable and timely information to optimize farming operations. Farmers and rural Cambodian communities often struggle with productivity, given that most critical information is written in English, a language many are unfamiliar with.

The number of mobile phones and users in Cambodia rose dramatically in 2019 (figure 1.5), especially among farmers. By October 2021, over 20.03 million mobile phones were circulating among a population of approximately 16 million. As a response, the private sector, MAFF, and NGOs are developing smartphone apps that offer farmers and buyers vital information, advice, alerts, and market prices. Certain NGOs have even introduced platforms in Khmer, like Angkor Salad, that users can access by installing an app and navigating a simple menu to gather necessary information.

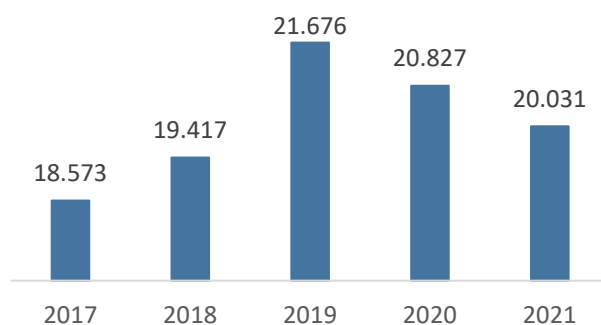


Figure 1.5. Trend of mobile subscribers in Cambodia, millions

Source: TRC 2021.

Note: Figures rounded to nearest hundred thousand.

Recently, the RGC has integrated digital technology into several government strategies, emphasizing blockchain, the Internet of Things, artificial intelligence (AI), and virtual reality. Digital technologies like mobile advances, remote sensing services, and distributed computing have swiftly transformed various industries in Cambodia, notably enhancing smallholder farmers' access to information, inputs, and markets in the agriculture and food sectors. Moreover, digital networks like websites, smartphones, social media (Facebook, Twitter, etc.), podcasts, and blogs are a few examples of prominent digital information networks supporting the agricultural sector in Cambodia.⁴ Digital networks offer vital information to users with smartphones, PCs, or tablets anytime, anywhere, often free or affordably. DAT allows creators to alter or update content swiftly and benefits users, industries, reporters, and the environment by cutting down on paper and chemical usage.

⁴ See Cambodia 4.0 Center for further information: <https://cambodia4point0.org/kh#.YdFpbWhBy5c>

As of January 2021, there were 8.86 million Internet users (demand customers) in Cambodia; users increased by 1.1 million (+14 percent) between 2020 and 2021. Internet penetration in Cambodia stood at 52.6 percent in January 2021, with 12 million social media users. The number of social media users in Cambodia increased by 2.3 million (+24 percent) between 2020 and 2021 and was equivalent to 71.3 percent of the total population as of January 2021. There were 21.18 million mobile connections in January 2021, 189,000 more (+0.9 percent) than in January 2020. The number of mobile connections in January 2021 was equivalent to 125.8 percent of the total population (Datareportal 2021).

The number of Internet users increased significantly amid the COVID-19 pandemic, creating increased demand and opportunities for, among others, online purchases and education, according to a senior official at the MPTC. For instance, people accessed the Internet for work, daily COVID-19 updates, and leisure during the lockdown. Digital technology significantly impacts communications and businesses, evidenced by the growing number of apps and platforms. These platforms bolster job opportunities, reduce health risks, and save time and cost. The ongoing situation has strengthened existing platforms and created others, such as Nham 24 and Foodpanda. Many believe that during the pandemic, ICT, including DAT and various applications, enhanced its relevance by providing efficient support to Cambodians.

Similarly, in Southeast Asia, COVID-19 caused a massive digital adoption surge. Over one-in-three digital services consumers were new to the service, and over 90 percent intended to continue post-pandemic.⁵ Forty million new Internet users were added in 2020, bringing the total to 400 million users. Now, 70 percent of the region is online.⁶

1.3 Government Policies and Strategies Toward Digital Technology

Since the early 2000s, Cambodia has launched several digital policy initiatives, incorporating information and communication technologies into development plans. The past decade witnessed a rise in technology interest, with significant e-commerce and digital payment regulations implemented. It formulates possible targets for these by 2040, including 100 percent public service digitalization, 60 percent digital literacy, 70 percent digital adoption by firms, 4 percent employment in the ICT workforce, 100 percent urban and 70 percent rural high-speed Internet coverage, at least one smart city, and several other targets. The strategy focuses on five key areas: digital infrastructure, digital government, digital business, and trustworthiness.

Cambodia's fourth Rectangular Strategy (RGC, 2018) prioritizes technology and ICT in diverse sectors. It also targets digital economy and Industry 4.0 readiness for economic diversification and exploring fresh growth avenues.

The Industrial Development Policy (IDP) 2015–2025, launched in 2015, outlined Cambodia's vision to evolve “from a low-skilled economy to a skill-based, technology-based, and

⁵ According to research by Bain, Google, and Temasek based on Kantar data covering Singapore, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. See <https://www.phnompenhpost.com/opinion/how-covid-19-pandemic-will-drive-southeast-asias-internet-economy> for further details.

⁶ Ibid.

knowledge-based economy”. The IDP aims to foster the digital economy and digitalization of enterprises. However, despite ICT being a priority, there is no clarity on how the IDP will promote it.

The Ministry of Posts and Telecommunications (MPTC) established the National Institute of Posts, Telecommunications, and Information Communication Technology (NIPTICT) to offer formal ICT training, research, and education in the country. In 2016, the RGC launched an online single window and business registration platform to facilitate market access for businesses. NIPTICT united local and international experts to encourage Cambodian enterprises to embrace digital technologies. The RGC further aids SMEs in boosting their digital integration.

The Ministry of Industry and Handicraft initiated an SME and tech-startup center to establish a Data Management Center and push for a digital ecosystem legislative framework, leading to the creation of the Cambodia e-Government Master Plan 2017–2022. The plan aims to support the digital sector’s infrastructure, develop an e-payment system, logistics network, and digital platform. It further encourages government digitization, entrepreneurship, digital literacy, and public access to open data. The Cambodia e-Government Master Plan 2017–2022 resulted in two e-government apps: the Government Administration Information System (GAIS) and the implementation of the Cambodia e-Government Master Plan 2017–2022. Cambodian people can use the GAIS system’s online services to access applications and logging systems without having to deal with government employees in person. Around 27 ministries, state secretariats, and municipalities are connected through Internet applications. The electronic approval, real estate, resident, and vehicle registration systems are all digital applications. These allow for cost-effective and time-efficient sharing, authorization, storage, and transmission of information. However, challenges persist, including inadequate ICT infrastructure, policy shortcomings, poverty, insufficient human capital and funding, and a lack of enthusiasm.

Alongside the Royal Government of Cambodia’s (RGC) strategies, international development partners are also keen on bolstering Cambodia’s digital economy. In 2018, in cooperation with the International Labor Organization, the United Nations Development Program (UNDP) held a workshop in Cambodia focusing on the Fourth Industrial Revolution, also known as Industry 4.0. The objectives were to pinpoint crucial policy gaps and suggest plans for Cambodia’s transition to Industry 4.0. The workshop addressed technology access improvement, enabling industries to leapfrog old, non-digital methods and employment challenges like sustaining high job rates amid promoting less labor-intensive manufacturing. Moreover, organizations, including Spien, Agribuddy, AMK, Konrad Adenauer Stiftung, Oxfam, HARVEST II, IFAD, CAVAC, and USAID, represent a mix of private sector entities, development partners, and NGOs. They are all advancing e-commerce and digital payment use in Cambodia’s agribusiness sector. Various institutions present digital payment gateways and e-commerce platforms, while key Internet players assure top-notch Internet services.

A concerned RGC aims to leverage Industry 4.0. At the 2018 ASEAN World Economic Forum in Hanoi, Cambodia’s Prime Minister expressed concern about digitalization and automation potentially affecting low-skilled jobs in his country. In response, the RGC aims to enhance worker skills, increase ICT investment, and bolster private sector support to leverage competitive advantages afforded by Industry 4.0.

MAFF has discussed the general adoption of ICT through the Agriculture Sector Development Plan (2019–2023), the Draft Agricultural Development Policy (2021–2030), and other strategic approaches. These aim to improve agricultural productivity towards nutrition security and market orientation with the assistance of development partners, the private sector, NGOs, and other stakeholders. However, MAFF's focus on using DAT to boost agricultural productivity, value chains, and enterprises has constrained progress in other areas: improving infrastructure and empowering agricultural stakeholders with ICT for agriculture (ICT4Ag).

1.4 Opportunities and Challenges in the Agricultural Sector

1.4.1 Opportunities

An agricultural recovery plan for 2021–2023 is in place, while the New Investment Law aims to incentivize agri-industries. The need for a greater variety of food and non-food products keeps rising due to population and income growth, as does the need for more resources. Responding to this, the RGC MEF has established a financial recovery plan for 2021–2023. They have allocated US\$250 million for direct loans via state-owned SME Bank and ARDB Bank at an average rate of 5.5 percent for important sectors like agriculture and ecotourism. Under the New Investment Law enacted in October 2021, the government prioritized and incentivized industries, including agri/agro-processing. The investment aids in agri-value chain financing for cashew, cassava, and rice, warehouse and cold chain development for fresh agri-produces, establishing agro-processing and production zones, and introducing agri-tech platforms, environmental and social governance, and impact financing.

Entrepreneurs are now providing affordable solutions to small-scale Cambodian farmers. Real-time crop management can be achieved through satellite or drone aerial images, weather forecasts, and soil sensors. Automated systems analyze soil data such as temperature and nutrient content, assisting farmers with appropriate fertilization and irrigation. Such systems use big data and analytic capabilities to help farmers become more knowledgeable and increase productivity through precise insights. Compared to other countries, productivity is low. Farmers must respond to evolving economic demands and expectations of regulators, customers, food processors, and merchants. While modern agriculture provides ample choices, the outcomes vary, owing to differences in landscapes, soils, technology, and potential yields.

DAT, including production and sensor technology and market information, can aid the government and farmers in making better decisions to improve farm performance. This is a critical enabler for attracting and retaining local populations, start-ups, and other businesses. Production, sensor technology, and market information are key to digital agriculture. Remote sensors deployed on farms gather data such as temperature, rainfall, humidity, wind speed, livestock movement, and health status of plants and animals. These insights support farmers by reducing manual monitoring, saving time and money, enhancing farm productivity, and fostering better decision-making. Such digital technology can entice younger generations to engage with rural agriculture.

1.4.2 Challenges

Farmers must adjust to ever-changing economic demands and the expectations of regulators, consumers, food processors, and merchants. There are many challenges (figure 1.6) in the agricultural sector, plus others discussed below.

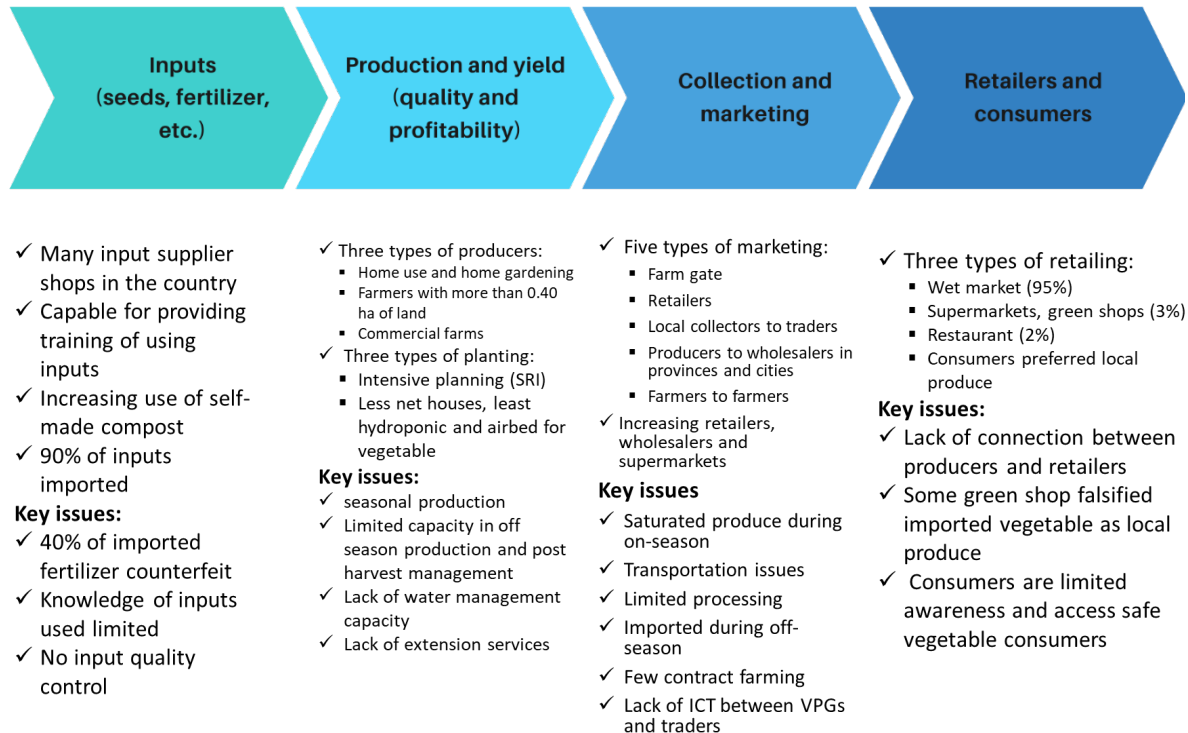


Figure 1.6. Key challenges along the agricultural value chain

Rising climate change, biodiversity loss, evolving consumer food preferences, and production concerns: These factors are straining the food system. Recent obstacles to agricultural growth include climate change, pest invasions, new pests, and generational shifts that have altered affluent consumers' food tastes and product quality demands. Farmers must embrace innovation and digital technology to acquire essential knowledge, counter these challenges, and seize development opportunities.

The migration of farm labor: The number of workers forced to seek non-farm occupations in the cities has grown, affecting agricultural production in Cambodia's rural areas. Due to increased input costs and low profitability, farms with limited production do not generate sufficient household income and have difficulty dealing in the market. Some small-scale farmers sold their farms and relocated to cities for non-farm employment. The new trend of real estate development, city expansion, and construction has converted productive agricultural farmland into housing buildings, factories, and city markets. Landowners have shifted to non-farm jobs.

Weak agricultural extension services: Appropriate modern and smart agricultural technology transfers are still limited and do not meet the current needs of farmers, particularly in terms of agricultural inputs, machine repair and operation technology, and post-harvest technologies, among others. These obstacles have resulted in low productivity, high selling prices, and severe market competition. COVID-19 led to a surge in agricultural input prices. Some farmers misuse chemical fertilizers and pesticides, adversely affecting consumer health,

especially in highly toxic vegetable and fruit crops. Currently, agricultural extension lacks sufficient HR, capacity, and materials to enhance productivity. Farmers struggle to market their products and compete in a free market economy.

Weak linkages: These exist among actors in the value chain, including input providers, producers, processors, logistics operators, financial institutions, traders, and exporters (figure 1.6). Public-private partnerships in agriculture are sparse, while organizations, cooperatives, and CF have not achieved the necessary scale to establish organized value chains. The government aims to enhance market information and linkages, enforce CF regulations, and bolster sanitation, phyto-sanitation, and food safety measures for public health.

Limited value addition within the Cambodian agrifood system: Notably, crucial products like paddy, cassava, cashew, mango, rubber, and cattle are exported in their raw states. This lack of processing impedes the progress of rural non-farm activities such as agro-processing, logistics, financing, business services, cold chains, and agricultural mechanization.

Limited range of value chain financing products: Farmers primarily access financing via microfinance institutions, offering a narrow array of products, mainly short-term seasonal production loans. Small and medium-sized enterprises (SMEs) encounter stringent collateral prerequisites. Various financial options, including medium- and long-term credit, inventory financing, factoring, trade finance, leasing, credit guarantees, and insurance, are still in their early or experimental phases.

Nascent quality and safety assurance systems: Over the past decade, several programs and projects in Cambodia have aimed at building the capacity of institutions to provide quality and safety assurance. The policy and regulatory system to establish standards in production and postproduction have improved. Still, both Cambodian consumers and exporters face difficulty accessing safe food that complies with sanitary and phytosanitary requirements or national, regional, and international standards.

Weak transport and logistics infrastructure: Despite considerable progress in developing transport corridors linking Cambodia to other countries in the Greater Mekong Subregion, a deficient rural road network, a lack of an effective system of warehouses, and cold storage limit farmers' connectivity to markets.

Limited agriculture diversification: In terms of cultivated area, use of irrigated water, and investment, diversification is limited. Although rice has a key role in food security, other crops and livestock, fishery, and agroforestry products could contribute to the higher income of farmers and agro-based enterprises. Agricultural diversification is still at a very modest level in Cambodia despite the presence of several products for which there is a comparative advantage.

Limited agribusiness investment: There are few competitive SMEs and cooperatives. Apart from the rice sector, organized agro-industry is sparse, and the level of investment in agribusiness falls short of Cambodian agriculture's potential. The business and policy environment does not effectively attract new investment or facilitate the growth of competitive agro-enterprises and cooperatives.

Lack of agricultural wholesale markets: Most agricultural products are distributed through wet markets, which are usually poorly organized, lack hygienic conditions, have very few quality and safety controls, and have poor transport and logistics infrastructure. Consequently, traditional channels, primarily managed by traders and transporters, dominate the aggregation of agricultural supplies. These channels lead to significant intermediary costs, substantial post-harvest losses, and deficiencies in maintaining product quality.

Limited financial services: Producers and traders need access to financial services and tools to invest in enhancing the efficiency of their production and market systems. However, only a few financial institutions in the country serve small business owners (e.g., AMK, Amreth, ACLEDA, etc.). Those that do offer loans and credit lines do so at expensive interest rates (often between 1.2 and 2.0 percent). Several digital innovations, such as alternative credit scoring systems, use data acquired via mobile applications and app usage behavior as a proxy to measure non-payment risk. Despite being a significant challenge, digital financial services, like alternative credit scoring, have produced digital profiles for Cambodian farmers and traders. However, due to digital limitations, financial difficulties persist for these individuals in supporting their investments.

Weak adaptation and mitigation capacity to climate change: The country is one of the most disaster-prone countries in Southeast Asia and is affected by floods and droughts on a seasonal basis. Climate change, rising temperatures, and unpredictable precipitation are exacerbating these events. Poor infrastructure, weak adaptive capacity, and limited institutional capacity intensify the country's vulnerability to climate variability.

Limited application of farm mechanization and ICT: The country's low on-farm mechanization and information and communication technologies (ICT) use has been a major challenge. ICT is pivotal in revolutionizing agricultural mechanization, a change that could enhance smallholder agriculture in Cambodia. Although mechanization is currently limited, there's a noticeable demand for services like tractor hire, especially among smallholder farmers. Responding to this demand, tractor owners have established private job markets to fulfill these needs. However, in these privately managed markets, issues occur. The main issue is high transaction costs, which farmers incur as a result of information distortions regarding the availability of tractor hire services and how to access them, and by tractor owners as a result of difficulties locating farmers in need of their services and aggregating demand long-term, smallholder farm plots. Using ICT technologies in tractor rental services may address some of these issues.

Poor Internet access in some areas: Although mobile phone service is becoming more widely available, many rural and farming communities still lack Internet access. The Internet is slow and unpredictable in some locations in the country; app loading can take several minutes or perhaps fail.

Lack of physical digital infrastructure: Cambodia's ICT system has evolved rapidly in recent years. The lack of infrastructure to support DAT, reliability and confidence, knowledge, skills, and digital leadership challenges Cambodia's readiness to embrace the digital sector. Physical infrastructure is one aspect of the digital agriculture transformation. Another is building interconnections to enable scalability and success. The bottleneck for digital agriculture is not physical infrastructure but the interconnections necessary to capture, store, and analyze data from various sources to develop value-added services; the current ICT4Ag physical system is fragmented.

Lac of education and ICT literacy: Their educational level influences farmers' capacity to understand and utilize the app and send an SMS. Lack of formal education may harm agricultural technology adoption; educated farmers are more open to utilizing mobile technology to find agricultural technologies, market information, and hire mechanized services. Table 1.2 provides the strengths and weaknesses of DAT in Cambodia.

Table 1.2. SWOT analysis of DAT in Cambodia

Strengths	Weaknesses
- As an agrarian economy, Cambodia has many options to test DAT solutions. - Strong government support and initiatives, e.g., the Techo Start-up Center. - Relatively strong ecosystem supporting DAT development, i.e., key actors and physical infrastructure in place. - Donors and developing partners are willing to develop or mobilize support for early-stage DAT solutions, e.g., Angkor Salad supported by ICCO or the Chamkar app supported by IFAD/GIZ. - New DAT solutions are growing and testing their solutions in Cambodia, e.g., AgriBee, AgriOn, Smart Farm Assistance, Khmum.	- DATs are nascent in Cambodia, especially in the private sector, e.g., the average age of start-ups ranges from less than a year to 3 years. - The target user base is quite small (in-country), without a plan to scale to the Association of Southeast Asian Nations (ASEAN) or Asia regional level. - Lack of a coordinating body to implement an effective DAT policy. - Limited actual investment (financial and human resources) into DAT solution development. - Skill shortages in DAT solution development. - Lack of seed capital for DAT start-ups.
Opportunities	Threats
- High mobile phone penetration and usage rate and a high level of digital adoption among young people. - A long-term digital technology strategy (Phase 1: 2021–2025, Phase 2: 2026–2030, and Phase 3: 2031–2040). COVID-19 provided an opportunity to accelerate digital adoption, especially on DAT-based e-extension services. - Well-connected/integrated to the regional market, infrastructure, human resources, and technology, especially within ASEAN countries.	- DAT solutions in Cambodia are perceived as high risk from a private investor's perspective, as the market size/target user base is quite small. - Strong competition from other DAT solutions with more advanced or bigger economies, e.g., Singapore and Indonesia. - Higher failure rate than other digital solutions due to the nature of the agriculture sector, i.e., they are long-term investments, low initial rate of adoption, and low user knowledge.

Chapter 2: DAT Assessment

2.1 The Digital Technology Landscape: Mapping Key Actors and DAT Development

2.1.1 The digital technology landscape

Trends of Internet users in Cambodia

The country's urban areas have a higher Internet penetration rate. Mobile Internet access is the most common among Cambodians, with 17,349,261 subscribers, whereas fixed home Internet connection has only 304,071 (figure 2.1). For more information, please refer to section 1.2.

Businesses are willing to develop young Cambodian professionals, with DAT benefits flowing to farmers. According to the team of consultants' interviews, many businesses are willing to provide hands-on, real opportunities to mentor, develop, and grow young Cambodian professionals to shape their own success and the success of digital technology in Cambodia. DAT development will provide smallholder farmers with much-needed innovative solutions for low agricultural yield, poor quality, high agricultural input prices, and lack of market information. In this situation, digital technology can assist in meeting these needs.

Digital connectivity

Digital technology can boost agricultural productivity and alleviate poverty, but Internet connectivity in rural areas hinders enterprise. Digital technology also boosts economic efficiency, encourage agricultural diversification, and create jobs in rural areas, all of which will help alleviate poverty. Challenges like digital literacy must be addressed to ensure technology is harnessed for positive outcomes. This involves enhancing farmers' access to technology, markets, pricing power, and finance in Cambodia through internet-based platforms, utilizing web and mobile applications. Digital technology can ease and support agricultural production procedures, technologies, and marketing, such as mobile solutions for advice on production-related problems, producers' links to the market, and consumers through mobile phones. Apps such as Angkor Salad and Tonlesap App help farmers improve production and market linkages and provide technical advice. However, the shortage of Internet connectivity in remote rural areas and limited high-speed Internet access hampered the entry of new enterprises. It forced many others, such as Angkor Salad and Smart Farm, to scale back operations.

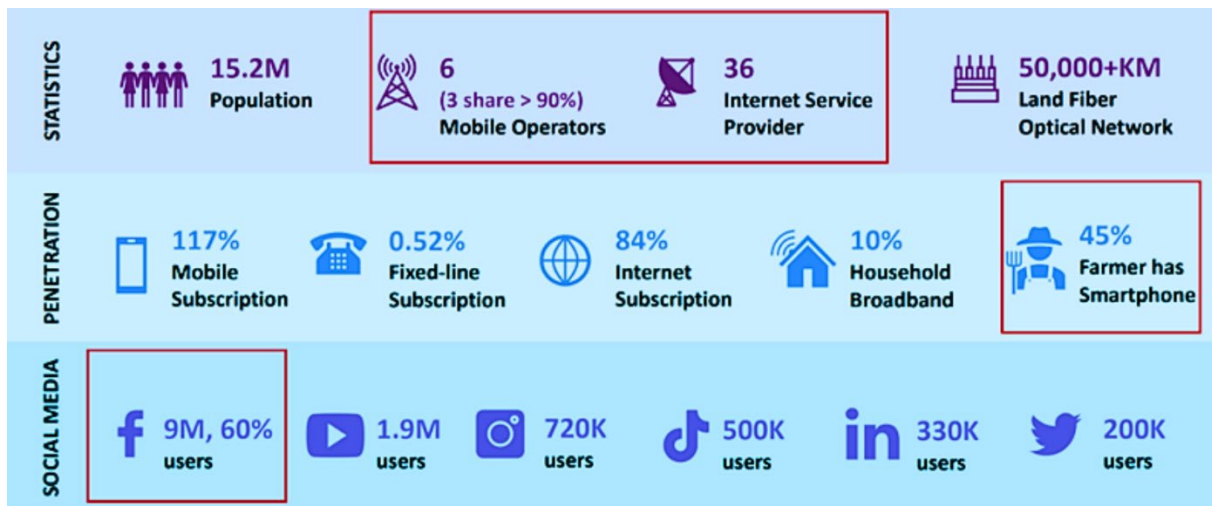


Figure 2.1. The social media, penetration, and statistics of ICT users in Cambodia⁷

Excluding in rural areas, Internet connection is reasonably common in Cambodia, with most cafes, restaurants, and public places providing free Wi-Fi. There are many options for selecting Internet service providers for installing Wi-Fi in-house or in offices with an asymmetric digital subscriber line (ADSL) and fiber optic. These include Opennet, Cambodia's leading Internet provider, plus MekongNet, SINET, EZECOM, NTC, Digi, and ONLINE (COGETEL Ltd.).

Six mobile providers are equipped with mobile Internet in Cambodia. According to the Telecommunication Regulator of Cambodia (TRC), these are Cellcard, Smart Axiata, Metfone, Seatel, Cootel, and QB. Metfone, Cellcard, and Smart serve 90 percent of the subscribers. Metfone, Cellcard, and Smart Axiata Co. also provide mobile Internet services, including 3G and 4G.

Internet and mobile service providers have supported the current digital platforms offering various services. These include food delivery, e-commerce, infrastructure support (e.g., Bakong, traceability, agri-tech), and policy support (e.g., Industrial Revolution 4.0, Cambodia ICT Masterplan 2020, Cambodia Digital Economy and Society Policy Framework 2021–35 or Cambodia's Science, Technology and Innovation Roadmap 2030) (figure 2.2).

⁷ See MPTC (2019), National Census (2019), and Hootsuite (2019) for further information.

Government Institution/Regulators	
Infrastructure-Telecoms	
Infrastructure-Internet provider	
Banks with payment gateway	
TTP & Stored Value Cards/Money Transfer	
Specialized Banks	
Intermediary-Agent	

Figure 2.2. Key actors supporting digital technology

Source: Sophal et al. 2020.

The requirement of digital technology

Large investments in digital solutions are required to expand the scope and impact of digital agriculture. Growing agri-tech investment as a percentage of overall agricultural investment highlights the potential to deploy commercial digital agriculture solutions that address the agriculture sector's pain concerns. Donors, innovation hubs, and individual and social impact investors have all helped agri-tech start-ups get started, and the funding landscape has gotten increasingly competitive.

The demand for digital technology is increasing, and content, social, and cognitive abilities must be mentored, developed, and supported in Cambodian society and culture. Additional prerequisites within Cambodia must be addressed for Cambodia to adopt digital technology, in addition to seizing the momentum and much-needed "soft" skills:

- **Labor market lacking:** Foreign language, technical and practical abilities, customer service, oral communication, problem-solving, and teamwork skills are all in great demand but may be difficult to find in today's labor market.
- **Managing online information:** The ability to use the Internet to find, identify, evaluate, and send information is lacking.
- **Online collaboration:** The ability to use tools like cloud storage, productivity applications, calendars, web meetings, and learning environments is lacking.
- **Analytics:** The ability to produce, format, manipulate, and visualize data using advanced spreadsheet formulas and functions to extrapolate trends and patterns.

Producing digital jobs helps develop the country's technology industry and provides a more ethical, economic, and personal business model.

The digital transformation in Cambodia entails adopting and maximizing the benefits of ICT and digital technology advances. Doing so will boost national economic growth, increase productivity and economic efficiency, and build a more inclusive, civilized society. Cambodia's biggest economic challenge over the next decade will be to create an environment where the private sector can produce enough jobs to meet the demands of a growing working population. Most university graduates still lack the technical and soft skills required by top companies, as evidenced by employees considering their ICT capabilities basic in the KAS research (IFAD 2019; MRD 2021).⁸

2.1.2 Mapping key actors

We collaboratively mapped actor roles along the value chain. Key stakeholders and actors from government institutions, the private sector, development partners, and NGOs actively mapped actor roles and responsibilities along the value chain (as shown in figure 2.3) for both primary and supporting operations, beginning with inputs and concluding with customers.

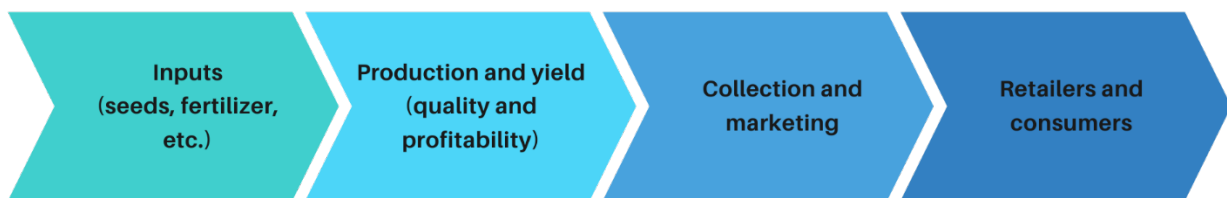


Figure 2.3. The mapping process of actors' roles and responsibilities along the agricultural value chain

Table 2.1 shows the roles and responsibilities of the key value chain actors in digital technology.

⁸ Project and activities under sub-component 2.2.

Table 2.1. Key stakeholders, actors, and their responsibilities in digital technology

Institution	Role and Responsibility
Government	
MAFF	- Formulates policies and strategies for market development and the agricultural marketing system. - Manages standards of agricultural products, leading to the export of agricultural products. - Studies and implements agricultural market development activities. Provides market information and services and guides farmers on agricultural marketing and economy. - Gives licenses to AIS, leads policy-making groups on agricultural modernization, and organizes forums that bring information on agricultural modernizations for input suppliers and farmers. - The Department of Planning and Statistics provides agricultural market information and online product displays to connect farmers, wholesalers, and consumers through its website and app (CAMAgri Market).
MPTC	- The lead regulator in ICT and Internet development will provide an enabling environment for digital implementation. - Manages the post, telecommunications, and ICT sectors based on free market and social equity principles. - Will further modernize the post, telecommunications, and ICT sectors with high-quality, affordable prices and nationwide service coverage. - Will develop e-government at the national and sub-national levels to improve administrative management of the government institutions and to enhance timely, transparent, effective, safe, and economically-sound public services. - Will mainstream awareness on the use and the benefits of ICT through wider dissemination, training, and capacity building for officials, students, and the private sector. - Encourages post, telecommunications, and ICT operators to comply with relevant regulations, ensuring fair competition and protecting the consumers' rights.
MISTI	- Organizes policy, strategy, direction, and overall plans of the royal government in the fields of industry, science, technology. - Leads, coordinates, and monitors the implementation of policy, strategy, direction, and development plans in industry, science, technology, and innovation. - Promotes and supports innovative technology, invention, and all initiative ideas, including entrepreneurship in the fields of industry science, technology, and innovation. - Cooperates with regional countries, institutions, national and international organizations, and private sectors to promote the development of the fields of industry, science, technology, and innovation.
Ministry of Economics and Finances (MEF)	Establishes and leads the national committee on digital economy development and manages agricultural diversification projects. TSC: - Start-up development: A specialized training program relating to entrepreneurship, business development, pitching for funding, and marketing strategy. - Mentorship: Offers start-ups direction and management skills. - Technical assistance: Providing TA as prototyping new services and products of a start-up.

	• Talent accelerator: Lifts young people's capability in emerging tech through project-based and research-based learning. • Link To Talent: Develops and seeks the best tech talents, creating a resource pool for high-potential start-ups. • Link to Investment: Connects start-ups to the available fund source from pre-seed to Series A to allow scaling Khmer Enterprise was established as an Entrepreneurship Development Fund implementation unit to implement the support programs and directly work with partners and beneficiaries. Its goal is to mobilize, invest, and manage resources from various sources to support a dynamic entrepreneurial ecosystem. It offers financial and non-financial aid to entrepreneurs, innovative start-ups, potential SMEs, and partner institutions that innovate and add creative value to Cambodia's economy. Khmer Enterprise operates according to the following principles: • Synergically supports entrepreneurship ecosystem building. • Provides financial and non-financial support to start-ups and SMEs. • Encourages and stimulates growth in prioritized sectors. • Encourages local and international venture capitalists/investors to invest in Cambodia's entrepreneurship ecosystem
Ministry of Commerce (MoC)	• Leads in developing policy/regulation on e-commerce and consumer protection laws. • Implements and contributes to government policy, including the jurisdiction and responsibilities of the ministry: maintenance of market prices and intervention in the markets. • Oversees international trade and finds overseas markets for local products and services. • Registers companies and issues licenses.
Developmental Agencies	
Oxfam	• Developed BlockChain for the project of Livelihoods for Organic Cambodian Rice (BlocRice) that introduced cashless payments to farmers.
Feed the Future of Cambodia HARVEST II	• Provided co-funding support to AMK Microfinance Institution Plc. for operating the 'E-Farmer Support App Activity' through Tonlesap App. • Promoted a market-led approach by connecting farmers to buyers.
IFAD	• Provided funding to NGOs and the private sector to promote modern agriculture.
CAVAC-II	• Provided funds through the government to modernize the agricultural value chain in Cambodia.
ICCO/Angkor Salad	• Introduced new payment systems for rural communities in partnership with financial institutions. A geodata-based agricultural information service that helps Cambodian vegetable farmers in 16 target provinces increase their production, reduce inputs, and improve their livelihood.
Private Sector	
Agribuddy	• Provides agricultural services and inputs to farmers' communities through rural credit to improve their income generation and livelihood.
Tonlesap App	• Provides agricultural technical knowledge and agricultural market information, key farming and livestock techniques, information on agricultural inputs, and loan access for business expansion.
Spien	• Connects agricultural products to consumers and wholesalers' shops through product display on the website. Focuses on product promotion through website and Facebook page. Targets B2B (business to business); the next step is targeting individual consumers.
Smart Farm Assistance	• Controls the watering system through app and SMS – saves water, time, and effort, and fulfills crop requirements. • Electronic station, a mobile SIM card, and a solar panel.

Kenko Shoku	- The system uses 30 to 40 percent less water. Kenko Shoku is working in three areas: - Market access (B2C) – KenkoShoku App - Farmer Registration, partnering with CropIn technology, India - Shared logistics: Cold storage and filled trucking for return using AI and Global Positioning System (GPS) technologies.
Enabling Actors	
Mobile operators	- Metfone - Cellcard - Smart Axiata
Internet service providers	- Some actors: - Opennet - MekongNet - SINET - EZECOM - NTC - Digi - ONLINE
Telecommunication Regulator of Cambodia (TRC)	- Implements the National Broadband Policy and the Strategic Action Plan to be adopted by the RGC. - Promotes public understanding and ensures acceptable telecommunications services for all. - Provides transparent regulatory processes and guidance. - Enforces regulations for fair competition and efficiency in telecommunications. - Follows international standards and practices, which contribute to the modernization of services and infrastructure. - Consults regularly with consumers and service providers and facilitates telecommunications industry collaboration.

2.1.3 DAT development

Conveying key agricultural information to small-scale subsistence farmers is challenging. In the current environment, conveying information on seeds, fertilizers, technologies, markets, and other aspects to or from farmers and other commercial producers has been difficult. This fact compounds basic infrastructure issues, including access to inputs, markets, funding, and training. Small-scale farmers practice agriculture at the subsistence level, using traditional methods with low productivity.

Recently, Cambodia has developed many policies and strategies to capture digital technology momentum (see section 1.4). Cambodia has seen growth in the use of mobile/ICT tools for agricultural services, which is crucial for improving the livelihoods of smallholder farmers. This trend has been facilitated by the growing use of mobile phone services in the country (figure 1.5). Mobile technologies, remote sensing data, and distributed computing and storage capabilities allow smallholder farmers to integrate more into the larger agricultural food system (see chapter 3). The magnitude of these changes suggests that Cambodia may see another agricultural revolution in the future.

A range of agri-tech initiatives is already used in agriculture, as indicated in table 2.2 (see chapter 3), including Agribuddy. This initiative was launched in late 2016 with the slogan “Changing agriculture in Cambodia”. Using Agribuddy’s mobile app, the social enterprise system collects data from linked farmers, agricultural traders, and others in the local agribusiness value chain to address issues directly affecting their local agriculture economy. Collective intelligence evolves as a result of this. The app’s ‘buddies’, or smallholder farmers, can communicate, access information, and interact to build a credit score profile allowing them to receive microloans and credits. Cambodia’s agricultural industry is being modernized by bringing all stakeholders together in a unified framework.

In another example, Oxfam works with small-scale rice farmers in Preah Vihear province, who are empowered with information about their supply chain and by electronic verification of their contract terms (Oxfam 2018). The project involved testing a digital contract between primary producers in an agricultural cooperative, a Cambodian rice exporter, and a Dutch manufacturer. The aim was to enhance farmers’ livelihoods and supply chain conditions. An electronic user platform with an application was also designed, to offer complete value chain transparency and traceability. This platform serves the cooperative, exporter, importer (figure 2.4), and end-consumers.

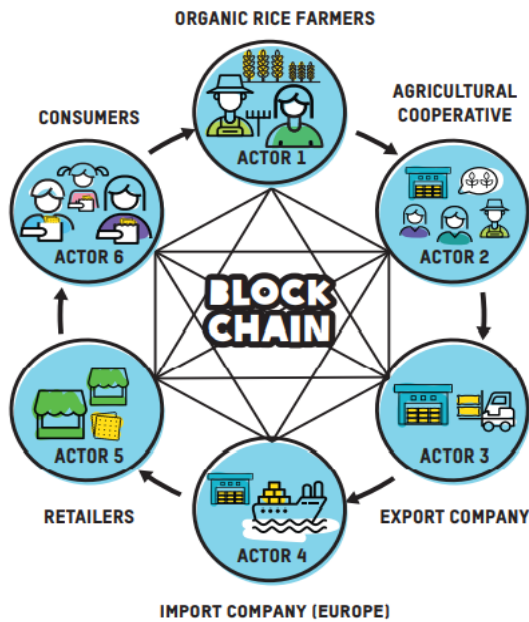


Figure 2.4. The blockchain for organic rice export

Source: Oxfam 2018.

Another project run by IFAD in Cambodian rice involves using sensors and data for crop mapping. The GPS and optical sensors are used to track changes in surface roughness, soil tillage, and crop-specific field activities, allowing identification of where focused agricultural practice interventions are needed. Crop yields were precisely measured in this experiment. Big Data allowed for the creation of index insurance products to help farmers hedge their risks. Table 2.2 summarizes agricultural technology types and position in the value chain.

Intel's Grameen Social Business has pushed precision agriculture using digital soil-testing for small-scale farmers (ODI & CDRI 2020). The E-Agro suite farming app has been rolled out in 210 locations in Cambodia. The digital test analyzes soil samples, GPS, and environmental data for real-time suggestions. Doing so saves farmers time and money compared to traveling off-site for soil information. Intel plans to enhance its "connected logistics system" to reduce shipping costs by detecting lost products and cargo damage early, which is vital for Cambodian rice. Atom processor technology enables Cambodian shippers to automate tracking, enhance shipment visibility, and cut costs by sending location updates to packagers.

Table 2.2. Agricultural technology project, types, and position in the value chain

Agri-Tech Projects	Type of Agri-Tech				Position in Value Chain
	Ag-Platform	Data-Connected Optimization (e.g., sensors, video imaging)	BlockChain	Robotics, AI, and automation	
Blocrice: Oxfam	Connecting importers, exporters, processors of rice, and farmers. Generating data to gauge the creditworthiness of farmers		Smart contracts for transparency and traceability of organic standard		Full value chain: production to retail
RIICE IFAD	Connecting to input suppliers	SR sensor to capture crop structures. Facilitates optimization of yields and aggregating data for insurance products			Production and processing node of value chain Supporting FinTech: insurance providers
e-Agro Suite, Intel Grameen Social Business		Aggregating and big data analytics of information collected on soil characteristics. Data stored in the Intel cloud and analyzed			Production node
Intel Connected Logistics Platform				Systematizing and simplifying the traceability of free-on-board products using big data analytics and radio frequency identification (RFID)	Export logistics of the value chain
AI and disease identification: Nuru	Connecting to experts on the field to verify and monitor disease control measures through Plant Village	Video imaging data collected		AI machine learning algorithms are used to teach the mobile app to identify cassava diseases	Production node

2.1.4 Policies, technologies, and human capital readiness in DAT

The RGC has established a thriving digital economy and society by promoting digital adoption and transformation among all stakeholders - the state, citizens, and businesses (figure 2.6). This drive aims to expedite novel economic growth and enhance social welfare in the evolving normalcy. Furthermore, the government is dedicated to constructing a digital economy that serves as a new growth catalyst and an ecosystem, fostering elevated economic productivity and efficiency, thus advancing the well-being of Cambodia's digital society (TSC 2022).

Cambodia has developed a long-term, three-phase digital technology strategy for the country:

- **2021–2025 Phase 1** – Digital Foundation, e.g., building digital infrastructure and digital trustworthiness
- **2026–2030 Phase 2** – Digital Adoption, e.g., digital citizen, digital government, and digital business
- **2031–2040 Phase 3** – Digital Transformation, e.g., a sizable digital economy to be one of the growth drivers

MAFF has already executed the government digital technology strategy phase one as part of the technology implementation. Although MAFF has no specific strategy for DAT, the ASDP (2019–2023), ADP (2021–2030 in draft), and ASMP (2021–2030 in draft) have integrated DAT into the strategic action plan and implementation.

Chapters 3 and 4 set out the DAT technologies supported by the industries. Many technologies are already in place, being adopted and benefiting both producers and market agents.

Except for Laos, the country's human capital and educational indices are among the lowest in the ASEAN region and the world, with illiteracy rates higher than those of its neighbors (Humphries 2015). The contemporary Cambodian IT sector is experiencing a skills gap, with companies finding it difficult to recruit qualified personnel. Respondents say there are many entry-level candidates, but their skills are relatively low, and most companies must train their employees. There is a severe shortage of senior-level employees with higher skills and expertise. The lack of senior managers and senior-level executives is causing salary packages to fall behind the rest of the industry, casting doubt on Cambodia's future as a global IT outsourcing destination. As the workforce expands due to ongoing economic growth, there is a growing need for experienced ICT professionals to lead teams, handle client expectations, and guide during periods of change and expansion.

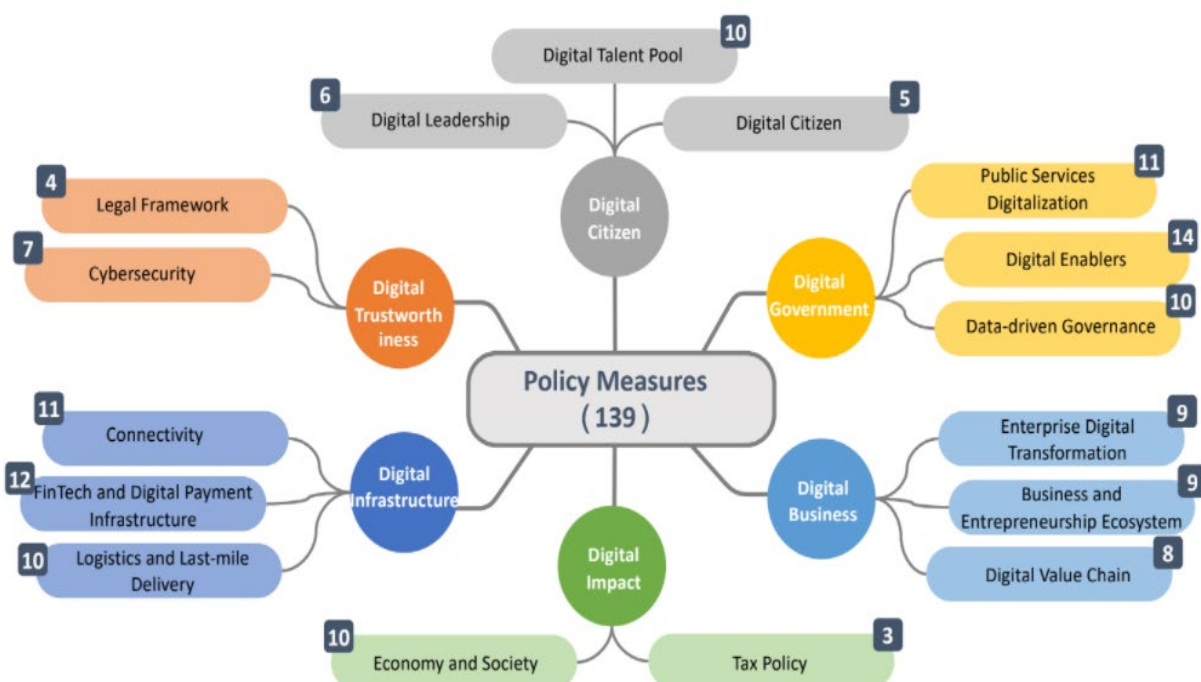


Figure 2.5. Policies, technologies, and human capital readiness⁹

Most Cambodian IT businesses are mostly run by foreign or international businesses. They may stay financially competitive and flourish by providing low-cost, high-skilled solutions to their business partners and clients. The government must address the lack of a competent workforce and the rising expenses of retaining skilled workers to enable Cambodia to provide comparable market prices.

The HR readiness of the graduate skill set is a concern. Some enterprises, local universities, and other IT training providers work closely to build HR capacity. However, there is a lack of coordination and harmonization of attempts to provide more holistic learning opportunities for employees.

There is a growing demand for specialist personnel to adapt to innovations as IT solutions become more complicated and AI more prevalent. In the adoption process, both technical and soft skills are necessary. In the next years, significant computer skills will be required to stay up with more complex algorithms and product development with integrated AI. The ICT sector will require more graduates who can evaluate large amounts of data and work with sophisticated algorithms to adapt and replicate new technologies as programming becomes easier and more tools become accessible to streamline this process further.

Though digital literacy is growing, it remains low among ASEAN countries. Cambodia experienced a year-on-year average digital literacy growth rate of 1.63 percent from 2017 to

⁹ Information gathered from a webinar workshop hosted by UNIDO, ADB, MEF, 2021. The Status of the 4IR in Cambodia (Policies, Technologies, and Human Capital Readiness) and Potential Avenues for Supporting Cambodia Transition to this New Industrial Model by 2030

2019 (figure 2.6) (World Bank 2019). Cambodia has the lowest figure for ICT literacy among ASEAN countries.

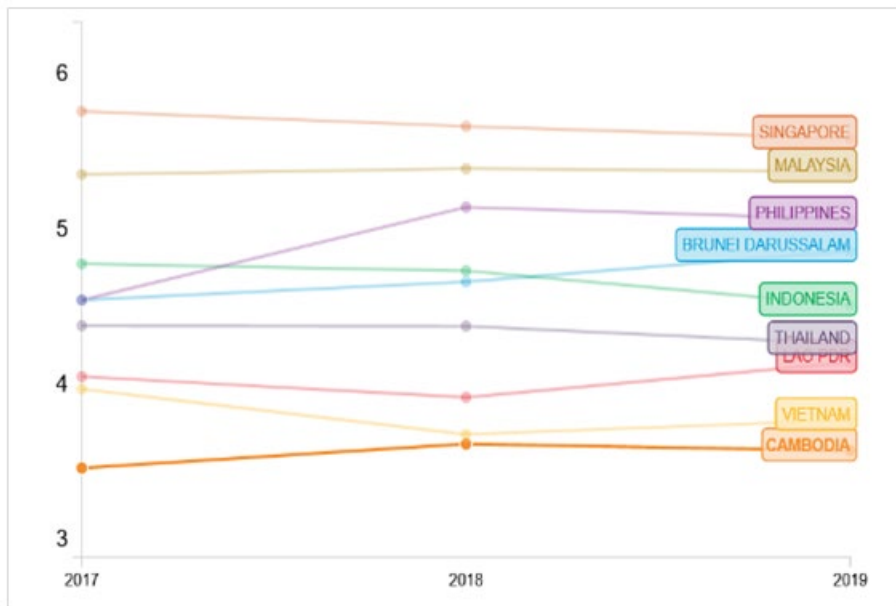


Figure 2.6. Digital literacy among ASEAN member states, 2017–2019

Recognizing the emerging roles of digital technologies in sustaining economic growth, Cambodia is facing a pressing need to address digital literacy among Cambodian citizens. The overall results from the ICT tests indicate a low to below-average digital literacy level for all three youth groups, with an average between 47 and 51 percentage points. Digital literacy level is also gender related. Female youths were found to have consistently lower literacy levels than their male counterparts, particularly in the hardware, software, and safety competence areas (UNDP 2020b).

Cambodia has comparatively limited ICT growth and low readiness for digital adoption. Overall, for ICT development in 2017, Cambodia was ranked 128th out of 176 countries, with limited ICT growth compared to other countries, especially some in the region. At the same time, Cambodia’s readiness for digital adoption is also low. Cambodia is in a low level of readiness with a score of 9.27 out of 25 and is below the average of other countries in the Accelerate Stage, which is 11.82. In this regard, Cambodia was ranked 102nd out of 141 countries, with six out of seven indicators considered low. Cambodia ranked 7th out of 9 ASEAN countries in the Digital Readiness Index by CISCO; note that the study did not include Brunei. Similarly, based on the average of the three sub-indices—business, people, and government—the World Bank’s Digital Adoption Index (DAI) shows that Cambodia was also ranked low compared to other countries in the region, with a DAI score of 0.4 on a scale of 1.00 in 2016 (SNEC 2021).

Basic computer and IT skills are lacking, with less than 1 percent having advanced ICT skills. The 2017 National Employment Agency’s employer survey revealed that 19.7 percent and 19.0 percent of employers experienced skill gaps in basic computer literacy and advanced IT/software use, respectively (National Employment Agency, 2018). One or both of these skills were listed among the top five shortages in six out of ten industries, specifically education,

finance, insurance, garments and footwear, ICT, logistics, transportation, and plastics. In the ICT sector, 33.7 percent of employers noted a lack of necessary skills. Less than 30 percent of the population possesses basic digital skills, such as using simple spreadsheet arithmetic formulas. This low figure is a notable contrast to Indonesia's nearly 50 percent proficiency. Intermediate digital skills, needed for device connectivity and installation, are found in less than 3 percent of Cambodians. Less than 1 percent have advanced software discovery and configuration skills. Computer and Internet usage among individuals with tertiary education stands at only 32.4 percent in Cambodia, a stark contrast to figures such as 68.1 percent in Bangladesh, 87.8 percent in Indonesia, 52.6 percent in Pakistan, and 89.7 percent in Thailand.

While agricultural employment has decreased, service and clerical roles have increased. There has been minimal change in professional, technical, and managerial positions (ODI & CDRI 2020).

In response, the Cambodian government's TSC is a new public initiative fostering digital technology growth. It invites students, young people, and researchers to start modern tech businesses. TSC aims to identify and expand quick-growing enterprises, adhering to the government's digital economy strategy. In 2020, the MEF discussed the expectations of its anticipated digital platform under the SAAMBAT project with the TSC and related stakeholders. The project's development goal is to sustainably raise the productivity of rural youth, businesses, and the rural economy, reducing poverty and increasing food security. The effort intends to enhance value chain infrastructure, skills, technology, business, and a digital platform for the agriculture value chain.

2.2 Ecosystem Analysis

Understanding how to digitally gather, store, analyze, and distribute electronic data and information along the agricultural value chain is the focus of ecosystem analysis in DAT. Precision farming, IoT, and other innovative ICT technologies are included in this category to improve agricultural efficiency.

The demand in agriculture can be grouped into four sections: inputs, production, distribution and marketing, and consumption. Each represents the diverse needs of DAT, bringing unique resources, demands, and potential challenges that DAT could address.

The input group, encompassing entities providing agricultural necessities like seeds, fertilizers, chemical pesticides, machinery, and finance, can be split into two primary categories: urban-based input providers and local or community-based providers such as agricultural cooperatives. Urban areas indicate higher ICT literacy, improved access to mobile and smart devices, and moderate connectivity to SMS, broadband, 3G/4G networks, and weather/market forecasting. Conversely, rural and community providers display reduced ICT literacy, connectivity, broadband, 3G/4G mobile networks, and weather and market forecasts. Providers in rural and community locations have low ICT literacy, connectivity, market access, and restricted access to weather forecasting and basic services. Input suppliers have the least access to information on output potential, demand, crop pricing, and supply chain logistics as compared to other stakeholders.

The production group comprises individual farmers, farmer groups and cooperatives, and private company farms in Cambodia. Farmers are divided into small, medium, and large-scale farms, with the last category largely composed of business investment farms. In 2022, rural areas contained 1.7 million farm households or around 40 percent of the 6.8 million farming population (IFAD 2022). The National Institute of Statistics (NIS) classifies about 75 percent of these farmers as smallholders, with typical holding sizes of one to two hectares. In rural areas, 15 percent of households rely exclusively on wage labor, while another 23 percent are landless and have less than 0.5 hectares of land. Some 4 percent of agricultural households rent their land. About 40 percent of agricultural households primarily produce for the market (IFAD 2022). Large-scale producers, albeit fewer, tend to use digital tools like weather stations, soil sensors, and decision-support software more prominently.

In the agricultural value chain, **distribution and marketing groups** include farmers, marketing agents (e.g., traders, brokers), consumers, transporters, and processors. Traditional markets and processors, among others. Traditional markets, wholesalers, and supermarkets are the main distributors in Cambodia. Although these subgroups have similar connectivity rates (i.e., SMS, 3G/4G fixed Internet, and mobile networks), traditional distributors have substantially less smartphone access to these technologies. The absence of information sharing and communication with other value chain stakeholders and actors is a constraint for traditional wholesalers and supermarket distributors. Supermarkets are relatively new in Cambodia, but their presence has grown significantly due to increased household incomes, urbanization, and consumer preference for high-quality items. According to the MEF, in 2021, Cambodia has 26 different types of supermarkets, including 23 in Phnom Penh, and three more are in the works. There is no record of the supermarket's sales or consumption of agricultural products.

The consumer group consists of consumers of both raw and processed agricultural products. Consumers are categorized by income level. High-income individuals tend to have more smartphone access, enabling them to make informed decisions and leverage traceability technologies when buying agricultural products. Consumers in larger cities visit supermarkets more often than those in rural parts of Cambodia, where traditional markets dominate for buying agricultural products. Consumption patterns suggest increased demand for rice, fish, and animal products. Fruit and vegetable consumption remains consistent. Consumption of fruits and vegetables has been consistent.

Ecosystem analysis

Despite increased support for DAT innovation, Cambodia still faces several macro-environmental barriers to growth. This is true for the six assessment dimension areas, resulting in an average score of 3.05 out of 5 (figure 2.7)¹⁰. The entrepreneur and finance factor receives the best ranking, owing to the country's strong presence of technological hubs working to upskill DATs with enough resources. In contrast, the country placed worst regarding human capital, scoring 2.89. Despite these results, Cambodia has the potential to make significant advancements in the DAT sector in the next years.

¹⁰ The ecosystem analysis approach was adopted from the 2020 World Bank report, "Scaling Up Disruptive Agricultural Technologies in Africa".

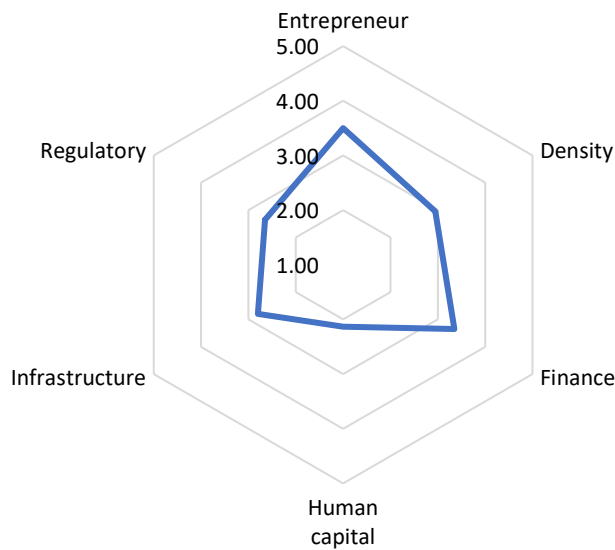


Figure 2.7. Overall ecosystem analysis score

2.2.1 Entrepreneurial culture: Average score of 3.5

Attitudes towards entrepreneurial risks are good, collaboration with academic institutions, and DAT-embracing companies scored well. The average score for entrepreneurial culture, comprising attitudes towards entrepreneurial risk (4.5 out of 5), entrepreneurial capacity (2.5), cooperation with universities, private firms, and DPs (3.5), and economic freedom (3), signifies how important a risk-taking culture and collaboration are to an innovation ecosystem. It also propels businesses to utilize DAT, fostering further risk tolerance and collaboration. It also fosters relationships with development partners, NGOs, and university-business collaborations, which is encouraged as this heightens the demand for entrepreneurial education. Cambodians display a remarkable entrepreneurial spirit, noted in their average score of 3.5 (figure 2.8). Growth-oriented business performance is influenced by factors like entrepreneurship and six pillars of a robust entrepreneurship ecosystem: skilled human capital, effective markets, supportive policy environment, availability of funding, an entrepreneurial-friendly culture, funding availability, an entrepreneurship-friendly culture, and supportive entrepreneurship groups and networks are the six pillars of a well-functioning entrepreneurship ecosystem.

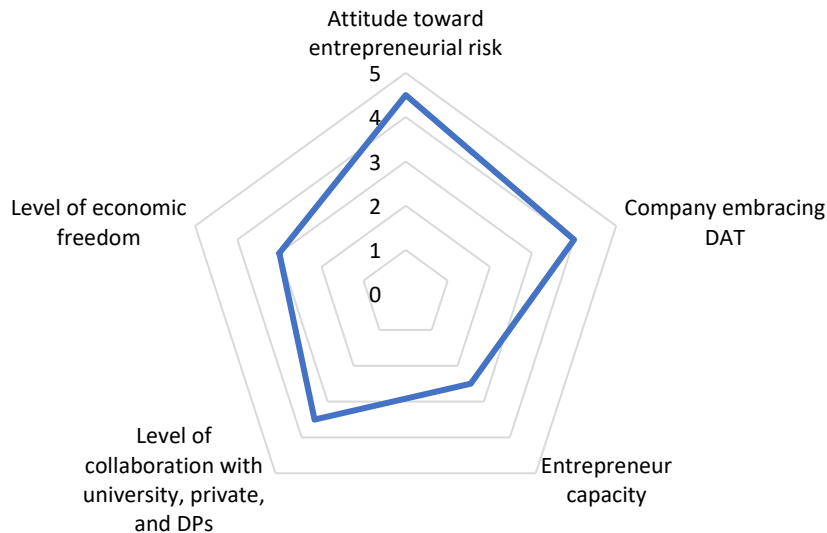


Figure 2.8. Entrepreneur culture scores

2.2.2 Density: Average score of 2.9

Cambodia scored decently for DAT and technological density. Innovation often depends on the interaction frequency and intensity among highly skilled inventors. Concentrating creative human capital in hubs boosts the chances of successful ideation (figure 2.9). Factors such as cluster development (3.0 out of 5), multi-stakeholder cooperation (score 3.5), and technological hubs presence (score 3.0) average together a density score of 2.95.

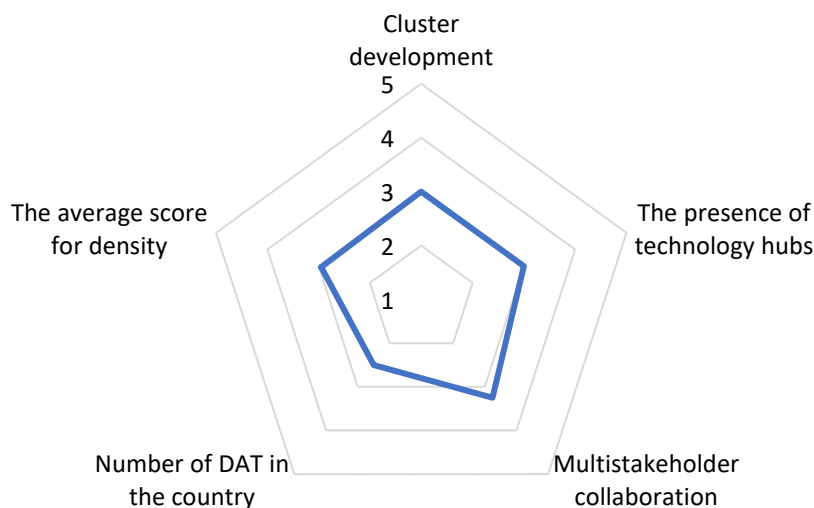


Figure 2.9. Density scores

2.2.3 Finance: Average score of 3.5

Domestic credit to the private sector is good, but more agricultural R&D financing is required. Start-ups and small businesses rely on low-interest financing options, such as microloans, venture capital, and public capital markets. Additionally, experienced investors'

guidance can be vital. The finance and investment average score is 3.35 out of 5 (figure 2.10), encompassing equity financing (score 4), domestic private sector loans (score 4), number of equity technology startup deals in 2021 (score 2), and agricultural R&D financing (score 2.25).

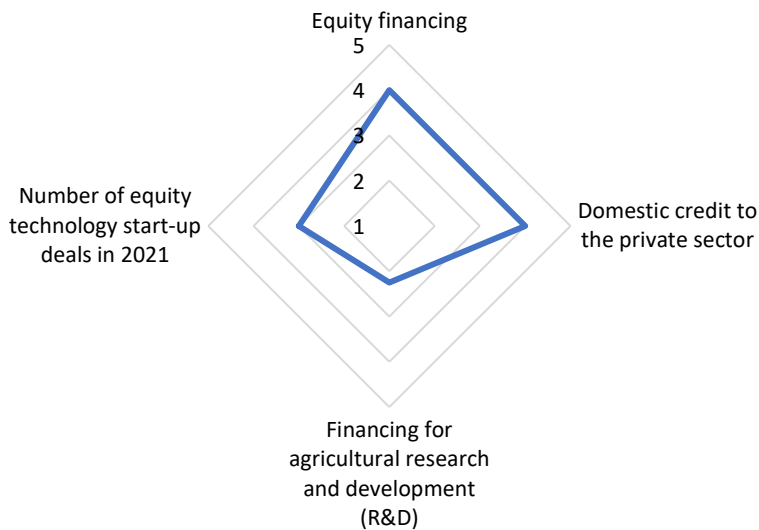


Figure 2.10. Finance scores

2.2.4 Human capital: Average score of 2.13

A business's growth relies on the recruitment of skilled professionals, which is lacking in Cambodia. A strong innovation ecosystem facilitates the investment in human capital to start new businesses and retain individuals suited for an entrepreneurial atmosphere. It also helps firms in their future progression and fosters innovation. Cambodia can propel investment in human capital by building adaptable labor markets, advocating for workplace diversity, and attracting various skilled workers (figure 2.11). The average score for human capital and workforce in digital technology stands at 2.13 out of 5, accounting for the population's digital skills (2), the DATs labor market (2), the future workforce (2.5), and graduate capabilities (2).

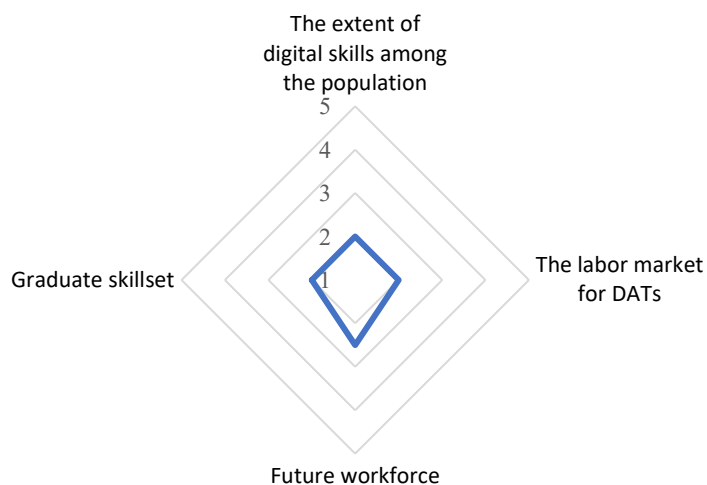


Figure 2.11. Human capital and workforce scores

2.2.5 Infrastructure: Average score of 2.8

Telecommunications, transportation, logistics, roads and bridges, storage, broadband connectivity, and last-mile infrastructure are just a few areas that require assistance. Infrastructure has an average score of 2.8 out of 5 (figure 2.12), which includes infrastructure (average score of 2.8), transportation availability (score 3), energy supply reliability (score 3), Internet access, and mobile phone availability (score 3), and water supply reliability (score 2). Cambodia's communications infrastructure, such as mobile and broadband, as indicated in section 2.1.1, is well-developed, with long-term evolution infrastructure and high penetration of fiber broadband services.

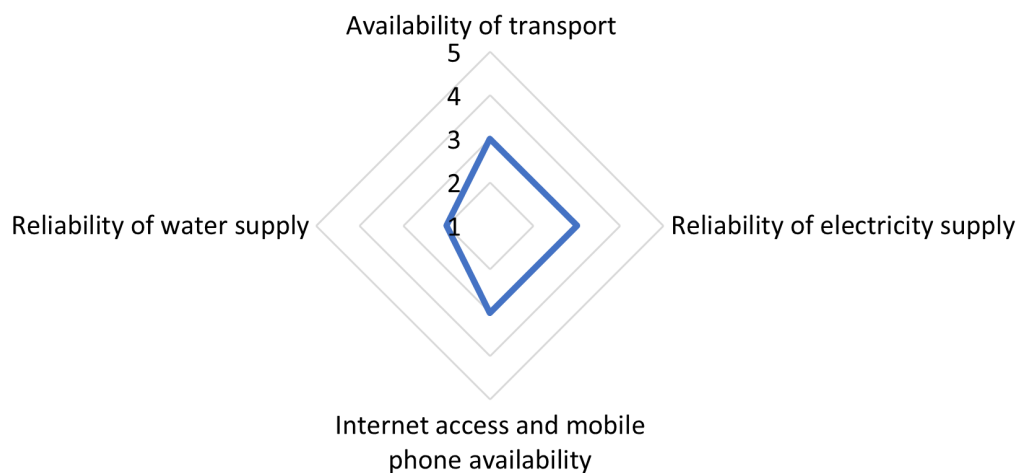


Figure 2.12. Infrastructure scores

2.2.6 Regulatory environment: Average score of 2.65.

The regulatory environment in Cambodia does not strongly support entrepreneurs and investors, which are vital for DAT development. With a score of 2.65 out of 5, governments play a critical role in creating a stable, predictable, and beneficial regulatory environment for entrepreneurs and investors, which includes ease of starting and running a business (score 3), a protection policy (score 2), agricultural regulatory framework (score 3), patent protection (score 2), tax-paying environment (score 3), strong investor protection (score 2.5), and suitable market conditions (score 3) (figure 2.13). Supportive policies include making starting and closing a business easier, tax policy, patent protection, formalizing alternative funding mechanisms, and investing in R&D. Key relevant laws related to e-commerce and digital payment have been implemented in Cambodia, such as the 2015 law on telecommunications, the 2019 e-commerce law, the 2019 consumer protection law, and the draft cybercrime law. To advance the digital economy agenda, the government of Cambodia has formulated a working group to draft a digital economy policy led by the Supreme National Economic Council (SNEC) under the directions of the MEF.

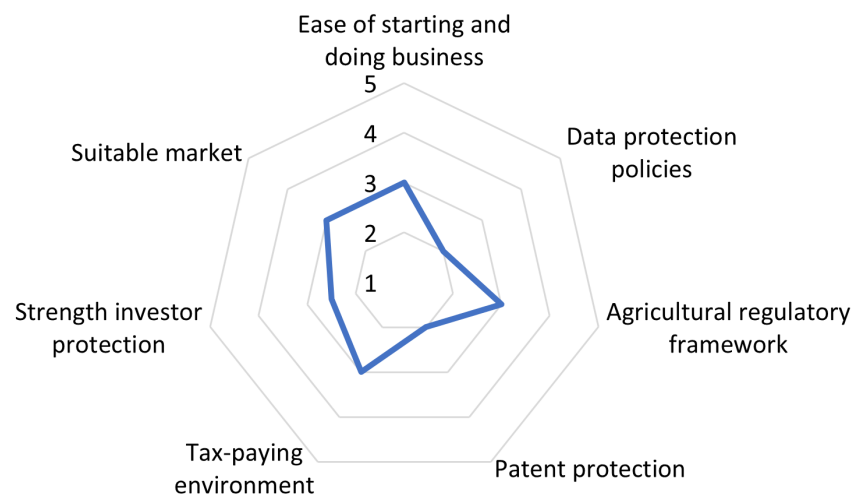


Figure 2.13. Regulatory environment

Chapter 3: Digital Products and Services in Cambodia

Digital products and services have recently grown in popularity among Cambodians. Figure 3.1 presents the digital agriculture use and sub-use cases. The following are some discussions and examples of digital products and services focusing on agriculture and other related activities.

Access to Services		Access to Markets		Access to Assets
Digital advisory	Agri-digital financial services	Digital procurement	Agri e-commerce	Smart farming
Agri VAS	Credit and loans	Digital records	Inputs	Smart shared assets
Smart advisory	Input financing	Digital records with payments	Outputs	Equipment monitoring
Weather information	Credit scoring	Digital records with traceability	Inputs and outputs	Livestock and fishery management
Pest and disease management	Crowdfunding	Digital records with payments and traceability		
Product verification	Insurance			
Record keeping	Digital agri-wallet			
	Savings			
	Accountability tool			

Figure 3.1. Digital agriculture use and sub-use cases

3.1 Access to Services

According to Digital Agriculture Maps (GSMA 2020), access to services is separated into digital advisory¹¹ and digital agri-financial services.¹² Table 3.1 summarizes and compares digital platforms in Cambodia in terms of digital farmer advisory and financial services.

¹¹ Digital advisory services first appeared in the late 1990s in response to the need to overcome the knowledge gaps limiting farmers' productivity. Technologies such as sensors, satellites and drones, as well as big data analytics and AI, underpin many of these services.

¹² Agri Digital Financial Services refers to a range of financial services accessed and delivered through digital channels, including payments, credit, savings, remittances and insurance

Table 3.1. Access to digital agriculture services

Farmer Digital Advisory Services	Digital Platforms in Cambodia	Digital Financial Services	Digital Platforms in Cambodia
Agri VAS ¹³	Chamkar and Tonlesap App provide daily advice on irrigation and fertilizers, technical knowledge on vegetable cropping, and market information	Credit and loan ¹⁴	The ACLEDA Toanchet smartphone app enables customers to do banking transactions from anywhere, anytime. The AMK mobile app provides a safe, user-friendly mobile banking application with a wide range of functionality to fulfill daily needs.
Smart Advisory ¹⁵	The Angkor Salad app provides customized advisory services to vegetable producers in several provinces on seed choice for specific soil conditions and optimal, precise use of agricultural inputs	Credit scoring ¹⁶	The Credit Bureau app reduces lender risk and lowers the number of non-performing loans within the Cambodian economy
Weather information ¹⁷	The Angkor Salad app has a geo-data-based weather information service that helps Cambodian vegetable farmers increase production, reduce input use, and improve livelihoods	Crowdfunding ¹⁸	RAI Capital Platform serves as a marketplace platform, enabling users to acquire loans digitally and to onboard suitable investors around the region

¹³ Agricultural Value-added Services (Agri VAS) is focused on delivering best-practice information directly to farmers based on general crop types via basic channels or through intermediaries

¹⁴ Credit and loans: Lending products that target smallholders and address specific agricultural needs. Most of these products enable the provision of short-term financing for agricultural inputs.

¹⁵ Smart advisory services: These help farmers optimize agricultural production by providing advice on the types of crops to grow in a specific field and the most appropriate digital agriculture inputs and the precise amounts of inputs.

¹⁶ Credit scoring: Digital solutions that assess the creditworthiness of smallholder farmers using aggregated data from multiple sources including bio data, procurement records and mobile money transactions.

¹⁷ Weather information: Specialist services that provide regional and localized weather forecasts. This sub-category may include weather-adaptive and climate-smart advice.

¹⁸ Online platforms that enable investment in smallholders by sourcing funds from individuals.

Pest and disease management ¹⁹	Angkor Salad App provides advice on diseases and pest management for vegetables Tonlesap App also provides information and documents to manage crop pests and diseases	Crop insurance ²⁰	Agribee crop insurance protects against loss of or damage to crops or livestock Forte's in-depth corporate insurance coverage offers solutions tailored to farmers
Farm record keeping ²¹	The Angkor Salad app allows users to record their agricultural products, cultivated areas, dates, and locations. Tonlesap App allows users to save, borrow, and pay with AMK bank for income-generating activities to increase food security	Input financing ²²	AgriBee is a technology platform that connects key players to boost value chain efficiency Agribuddy helps farmers utilize their farmland and produce high yields cost-effectively by providing finance, knowledge, goods, and services to their doorsteps
Market linkage platform	CAMAgri Market and Tonlesap App allow producers to promote and sell their products and services to end-consumers, trader retailers, and wholesalers	Online agri-marketplace platform	Delishop has over 60 partners and over 10,000 products, making it an excellent option for end-consumers looking to acquire their groceries in one place, with free delivery

¹⁹ Pest and disease management use digital tools that help farmers diagnose plant disease and develop strategies.

to treat diseased plants as well as mitigate future outbreaks. Most of the services are accessible via mobile applications and require a farmer to upload a picture of the infected plant for diagnosis.

²⁰ Agricultural insurance services that help smallholder farmers mitigate the risks associated with external shocks such as weather events and pest and disease outbreaks.

²¹ Record keeping: Digital tools that enable farmers to keep detailed records of livestock, including health and feeding data, to help mitigate diseases and avoid missed conceptions.

²² Digital tools that enable financing for the purchase of agricultural inputs.

Product verification ²³	CamGap barcode provides detailed information on production sources and good agricultural practices (GAP) assurance.	Saving ²⁴	AMK MFI is a microfinance institution in Cambodia that provides the rural population with tailored microfinance services
	AgriBee App provides a service of agricultural insurance to protect against loss of or damage to crops or livestock	Digital Agri wallet ²⁵	WING provides every Cambodian with convenient access to financial services WING provides convenient access to financial services
		Accountability Tools ²⁶	True Money Wallet is a new exclusive payment method in Cambodia បញ្ជីលុយខ្ញុំ (BanhJiLuy) or My Money Tracker is a simple, fast, and secure money tracking app designed to help Cambodians take control of their finances

Source: GSMA 2020.

²³ Product verification: Digital tools designed to enable farmers to validate the authenticity of agriculture inputs such as seeds, fertilizers, agro-chemicals and other agro-inputs and prevent the proliferation of counterfeit products. Most services require farmers to send a scratch-off code from the product to a specified number via SMS.

²⁴ Digital savings products for farmers designed to match their spending and savings habits, enabling them to put money aside for agricultural activities.

²⁵ Digital wallets enable farmers to transact with various actors within the agriculture ecosystem.

²⁶ Digital tools designed to help farmers view farming as a business by allowing them to track farming expenses and revenues and prove their creditworthiness.

There are several advantages to using digital advising services. The first advantage is that once the information and interface are in place, adding each additional farmer costs the business very little and is significantly less expensive than in-person advice. Advice can also be tailored to the farmer's particular plot, crop type, and crop cycle stage. Aside from that, if confidence is built, the business may spread virally, with one farmer referring another to the advisory application (Voutier 2020).

Tonlesap App, initiated by AMK and developed in collaboration with MAFF, offers a range of services as part of a comprehensive agricultural advisory package. These services span agricultural techniques, production verification, market insights, information on local agriculture, business policies, laws and regulations, and weather forecasts. The app was designed in response to the government's mandate for digital solutions in the agricultural sector. It primarily targets Cambodian farmers, disseminating crucial farming knowledge to the public. The app connects suppliers, farmers, and buyers in an agriculture supply chain, aiming to raise the farmers' income by providing technical expertise, budget planning, and access to finance via AMK Microfinance Institution. Amid the government's direction and the digital age, it helps disseminate agricultural knowledge, particularly to Cambodian farmers, giving them resources to enhance yield quality and farming productivity.

In addition to digital advisory services, agricultural digital financial services (DFS) significantly benefit farmers and traders. DFS includes payments, credit, savings, remittances, and insurance accessed through digital channels and incorporates mobile financial services (GSMA 2020). Cambodian providers are innovating new DFS, but customizing them for smallholder households remains challenging. Digital payments have surged thanks to the development of mobile financial services covering most of the country. Payment providers now offer over-the-counter, mobile-enabled money transfers, bill payments, and airtime top-ups. Many MFIs and banks are launching agent networks and mobile banking platforms. For example, in 2013, Amret initiated its first mobile financial services project with a grant from the World Bank Group's AgriFin facility to broaden product options for smallholders.

Another service provider is AgriBee,²⁷ a value chain management platform that facilitates all stakeholders in the agriculture sector. AgriBee's platform boosts the Cambodian agricultural value chain by offering all key players funding, technical assistance, market access, and support services. These include farmers, Agri-input suppliers, crop traders, rice millers, exporters, and financial institutions. All these stakeholders can also become AgriBee investors.

Similarly, the Angkor Salad project uses geodata to deliver services. Its services help at least 100,000 vegetable farmers in Cambodia to increase their production, income, and food security and reduce water, fertilizer, and pesticide use.

The app provides five information services:

²⁷ For further information, see <https://agribee.co>.

- a) **Irrigation advice:** Provides advice on volume, schedule, and irrigation duration based on geospatial data and volume of water required by the vegetables on their crop cycle.
- b) **Fertilizer advice:** Provides recommendations on the type and amount of fertilizer based on soil analysis and vegetable types.
- c) **Crop planning and calendar Advice:** Based on the Asian Vegetable R&D Center variety experiments and the wet or dry season, advice on the vegetable kind and variety, as well as when to plant, was given. Adapted to local soil, agro-ecological, and market requirements.
- d) **Market information:** Market data includes the daily purchase price, buyer information, and associated logistical costs.
- e) **Khmer GAP compliance:** Farm advice tailored to the crop, agricultural system, and area, as well as how to produce safe, high-quality vegetables (safe growing guidelines and practices). A self-audit checklist for GAP compliance is included.

Stakeholders

Digitalization differs greatly across sectors. Manufacturing has witnessed minimal digital advancement, while agriculture has experienced more. However, the services sector teems with digital applications. It is suggested that with enough digital connectivity, low-income countries could increasingly export services across borders digitally. For Cambodia, it is crucial to question if these efforts are sufficient to counteract job losses, assess the inclusivity of such a transformation, and understand how these digital applications relate to agricultural or manufacturing sectors, potentially causing a permanent productivity shift rather than a single income shift. Table 3.2 presents some examples of services implemented in Cambodia.

Table 3.2. Digital agriculture services

Type of Services	Progress	Opportunities and Challenges
Food Delivery: ²⁸ e.g., Foodpanda, Nham 24	Many apps are already used for food delivery	Saves time and travel costs and reduces COVID-19 transmission risk; however, while it is available in surrounding cities or provincial centers, ICT literacy is required
Transport services: PassApp, Grab, Wego or TADA	In Cambodia, transportation services are used for transporting crops, including vegetables, fruits, especially during lockdown	Excludes less technologically advanced drivers
Financial services: Pi Pay	Significant coverage accounting for some US\$150 million, compared with Wing, which processed US\$2 billion	Targeted initially at urban consumers; how can the poorest also benefit?
Business services: MangoTango	Founded in 2014, providing offshore (exports of) services, e.g., for Google	Much scope for digital labor opportunities
Government	Weak implementation of e-government initiatives	Opportunity for progress, but the government is the weakest link

²⁸ For further information on food delivery apps in Cambodia, see <https://www.b2b-cambodia.com/articles/food-delivery-apps-in-cambodia/>

		between the system and external gateway
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Source: ODI and CDRI 2020.

Supporting ICT infrastructure

In response to a significant surge in demand, both digital and supporting infrastructures, particularly electricity, have rapidly advanced in recent years. These developments play a crucial role in national socio-economic progress, encompassing technological advancement and the facilitation of digital transformation. The expansion of digital infrastructure aligns with the increasing need for Internet connectivity, particularly mobile broadband.

Cambodia has a moderate telecommunications score, lower than neighboring countries. In 2020, the UN's Telecommunication Infrastructure Index evaluated Cambodia's score at 0.54 out of 1.00, indicating a moderate level on a global scale. However, this progress remains comparatively restrained compared to neighboring countries. According to CISCO's assessment, Cambodia's technology infrastructure received a score of only 0.47 out of 4.00, only ranking ahead of Laos and Myanmar in the region (UN, 2020).

The advancement of financial sector infrastructure, technology, and digital payment systems is still nascent. Despite this, the banking industry sees a rise in electronic payments, demonstrated by an increase in deposit accounts (8.9 million), e-wallet accounts (6.91 million), and payment cards (6.8 million). This is bolstered by the ongoing modernization of key payment infrastructures like the Bakong system²⁹ and online banking (WEF 2021). The lack of a unified payment platform linking banks and billing providers hinders the expansion of public and private e-services. In the non-banking sector, FinTech adoption is minimal. The growth of digital payment infrastructure is lagging as some institutions have not fully committed to digital transformation due to resource constraints and situational factors (SNEC 2021).

Cambodia's physical infrastructure, like roads, railways, and ICT, does not yet fully support the logistics sector. Also, traditional and fragmented last-mile delivery increases transportation costs, especially for small businesses. Furthermore, the absence of a precise address system database hinders the sector's modernization. The fragmented transportation sector ecosystem also limits local postal services' operations. The logistics and last-mile delivery struggle to meet current and future demand, as they lack full integration with digital technologies, particularly in domestic transportation (SNEC 2021).

With this critical context, the digital sector emerges as a potent growth engine for Cambodia's economy, aligning it with regional and global trends. Digital technology can boost productivity, foster economic diversification, and create jobs, thereby reducing poverty and social inequality. Digital technology is reshaping international business, enhancing media, facilitating innovative financial services, and enriching entertainment. Amid the COVID-19 pandemic, the fervor for digital technologies is escalating as businesses and users navigate constraints and grasp new opportunities.

²⁹ For further information, see Bakong Digital Currency: <https://bakong.nbc.org.kh/en/>

DFS

Access to financial services is a key enabler for digital adoption in the banking sector, but it also plays a significant role in boosting digital payment adoption in Cambodia. While digital infrastructure has improved and industry support is in place, only a small portion of surveyed AIS employ digital payments. Access to smartphones and mobile Internet is double that of broadband Internet penetration due to cheaper setup costs, easy access, and quality. A 2021 FAO study on the National Agriculture Innovation System revealed that 85 percent of female respondents' own smartphones, compared to 94 percent of male respondents. This finding shed light on gender disparities in smartphone and Internet access (FAO 2021). Only 36 percent of female respondents know how to search for agricultural inputs information online compared to 47 percent of men. About 64 percent of the surveyed AIS have had a bank account for less than five years. Acleda Bank is the most popular among the surveyed AIS, followed by ABA Bank and Canadia Bank.

Despite an inconsistent QR code payment system, QR codes are crucial for digital finance and payments in Cambodia. One retailer, for example, may show many QR codes for customers to use to pay. The National Bank of Cambodia (NBC) issued a regulation in June 2020 to implement the KHQR Code Specification in Cambodia. The EMV Merchant-Presented QR Code Specification for Payment System (EMV QRCPs) is used to create the suggested standard QR code, which ensures interoperability. At the end of 2020, all financial institutions had applied the KHQR code. Within the region, there has been a rise in the use of QR codes as standard (table 3.3.). Cambodia and other nations use the KHQR Code Specification (MSC 2021).

Table 3.3. Comparison of QR code applications in Cambodia, Thailand, and Indonesia

Country	QR Code Function
Cambodia	- Consumers do not need to scan many QR codes to make payments from different mobile wallet apps; merchants only need to show one QR code in their shop. - Consumers can use the same QR code to make payments outside of Cambodia according to internationally or regionally standardized QR codes
Indonesia	The Central Bank of Indonesia has launched a national standard for QR called Quick Response Code Indonesia Standard for all digital payments using QR codes
Thailand	The Central Bank cooperated with global card schemes and payment service providers to create the Thai QR Payment Standard, which complies with international standards and increases payment channels for SMEs to access digital payment and allow cross-border payment. Benefits of the standardized QR code

3.2 Access to Markets

The private sector contributes significantly to the country's economic growth. Input providers (e.g., seeds, fertilizers, pesticides), machinery and equipment providers, financial services, and markets are all private partners in the agricultural value chain. The government

values the private sector's role in the country's progress, especially its innovative contributions to the agricultural value chain. However, certain barriers may hinder this sector's potential to innovate. These agricultural innovation obstacles are outlined below:

- Lack of communication and information exchange between farmers/producers, input suppliers, and markets
- Limited investment capital for promoting new products and activities; bank loans have a high interest rate
- Unstable market price and highly driven by external markets in the neighboring countries
- High competition from imported products
- Technical knowledge of agriculture is limited
- Limited knowledge of business plan development
- Lack of strategy to promote the products
- Lack of local agricultural market to collect production from farmers/producers within or close by to the production areas
- Lack of government support to reduce production and transportation costs
- Costs for the importation of agricultural inputs are high
- Poor storage systems for storing and/or preserving agricultural products

Five scenarios collectively compose the assessment of the agricultural market. These are agri-e-commerce and digital procurement (access to markets), smart farming (access to assets), digital advice and agri-digital financial services (access to services), and agri-e-commerce (access to markets). Access to markets is categorized into two types: digital procurement and agri-e-commerce (GSMA 2020). Both are crucial in expanding market knowledge, prices, accessibility, and connectivity within value chains. Digital procurement tools are integral to global food chains, optimizing agribusinesses, cooperatives, and smallholder farmers' collaboration with crop purchasers and AIS. Agri e-commerce bridges consumers and smallholder farmers. Table 3.4 illustrates this access to markets.

Digitizing farmer and farm records forms the basis of all digital procurement tools. Despite the increased popularity of payment-capable solutions, they remain predominant where mobile money is accessible. Digital records allow agribusinesses to foster accountability with smallholder farmers, enhancing loyalty, trust, and operational efficiency over time. Farmers benefit farmers by saving both time and money associated with cash collection and increasing security by reducing theft and fraud risks. The CAMAgri Market app, a creation of MAFF, exemplifies this. It serves as a platform for farmers to promote their products to a nationwide network of potential producers and buyers. This platform not only aids farmers in marketing their products but also simplifies the consumer search process.

Table 3.4. DAT platforms

Digital Procurement	Digital Platforms in Cambodia	Agri E-commerce	Digital Platforms in Cambodia
Digital records ³⁰	Angkor Saland App allows users to make digital records regarding their products, services, prices, or locations	Inputs ³¹	Tonlesap App allows users to sell agricultural inputs, such as chicken breeds, fertilizers, and pesticides, to farmers
Digital records with payments ³²	Tonlesap App allows producers to sell their products and services to consumers and private sector retailers and wholesalers	Outputs ³³	CAMAgri Market and Tonlesap App allow producers to sell their products and services to retailers, wholesalers, and consumers
Digital records with traceability ³⁴	CamGap barcode provides information concerning product sources, such as product types, producer names, locations, etc. This helps producers record their products, avoid fakes, and assists buyers in exploring or checking products.	Inputs and outputs ³⁵	
Digital records with payments and traceability ³⁶	Tonlesap App allows users to make records of their products, services, prices, and locations, then payment		

In the Electronic Marketing Communication System, mobile operators have provided a unique application to customers. The system is an SMS service developed for maize, soya bean, and cassava trading in Cambodia. Its purpose is to enhance communication between remote farmers and traders. The system provides useful information to farmers and traders on market price, pricing trends, potential buyers, product quantity, and product quality (FAO 2017). Currently, the utilization of the SMS-based daily price system (MAFF 2015) has facilitated the collection and distribution of wholesale selling price data for vegetables, fruits,

³⁰ Digital records replace paper-based systems and digitize transactions between farmers and agribusinesses.

³¹ Inputs are agri-input platforms enabling the sale of inputs such as seeds, fertilizers, pesticides/herbicides from input suppliers to farmers.

³² Digital records with payments are solutions that replace paper-based systems, digitize transactions between farmers and agribusinesses and enable the integration of digital payments for the procurement of crops.

³³ Outputs are platforms that enable farmers to sell to consumers (B2C model) and to enterprise customers (B2B model) such as companies in the catering industry and market retailers, or a hybrid of the two.

³⁴ Digital records with traceability are solutions that replace paper-based systems, digitize transactions between farmers and agribusinesses and support the traceability of produce from "farm to fork".

³⁵ Inputs and outputs are platforms that enable the sale of agricultural inputs to farmers from input suppliers, as well as the sale of agricultural produce from farmers to consumers and businesses.

³⁶ Digital records with payments and traceability are digital solutions that replace paper-based systems, digitize transactions between farmers and agribusinesses, enable the integration of digital payments for the procurement of crops and support the traceability of produce from "farm to fork".

meat, and cereals traded by wholesalers in 27 markets across Cambodia under MAFF. Market information systems foster transparency, competition, and fair benefit distribution among market participants. This aids in curbing information asymmetry, fostering competitiveness, and enhancing efficiency. For small farmers, it elevates their bargaining power and knowledge of marketing opportunities. For traders, they can identify partners, broaden their business, and negotiate efficiently. Such systems are also crucial for governments to make informed agricultural growth and food security policy decisions.

Agricultural e-commerce

Agricultural produce is becoming increasingly popular on e-commerce platforms, allowing customers and small-scale farmers to expand their market reach. In Cambodia, these platforms enhance the supply of farm produce to city dwellers via digital payments. Services like Agribuddy deliver essential resources, information, and assistance directly to farmers in seven provinces, empowering them to maximize land use and cultivate high-yield crops.

Agribuddy employs its e-buddy wallet to enhance agricultural value chains, particularly for crops such as corn, cassava, and rice, through a digital payment initiative in e-commerce. This program employs an app connecting farmers to credit sources and agricultural suppliers, processors, crop buyers, and input manufacturers. Agribuddy coordinates credit contracts at the communal level with farmers and reputable sources via buddy enterprises. All transactions are managed through the e-buddy wallet app.

Another example of agri e-commerce is Delishop, one of the first agricultural online marketplaces in Phnom Penh. Delishop is a growing company that is adapting to a rapidly changing sector. Delishop has over 60 partners and over 10,000 products, making it a great option for consumers looking to acquire all their groceries in one place.

Oxfam launched BlockChain for the Livelihoods for Organic Cambodian Rice (BlocRice) project, which introduced cashless payments to Cambodian farmers.

Agri QR codes (GDA and NAV)

Cambodia's MAFF introduced the CamGAP logo with an integrated QR code system for verifying agricultural practices. This product label assures buyers of the quality and safety of fruit and vegetable items. Furthermore, CamGAP has boosted local food safety and promoted exports to global markets. Together with GAP regulation, the QR codes will help us build consumer trust in the supply chain and producers. By 2021, about 250 farms, orchards, and plantations have been provided for CamGAP standards (Pisei 2021). It is worth noting that CamGAP has been evaluated by the ASEAN Expert Working Group to fully comply with the ASEAN GAP rules.

QR codes have also been widely applied in other sectors, including health, finance, tourism, transport, and trade. The "Stop COVID" QR code is a location and contact-tracing app designed to prevent the coronavirus spreading developed by the MPTC. Businesses and the general public nationwide have adopted the Stop COVID code. This QR code system has now evolved into the so-called Stop QR Code Vaccine to scan vaccination cards for multiple purposes, for now, and in the future. Interestingly, the Stop Covid QR won the Global South COVID-19 Digital Innovation Challenge award from the International Telecommunication Union (ITU), a UN-specialized agency for ICT.

QR codes are increasingly used in the financial sector and saw particular growth in Cambodia during the COVID-19 pandemic. Many banks and microfinance institutions employ QR codes for payment and transfer systems, reducing transaction costs, saving time, and enhancing security. Alongside QR codes, the NBC launched Bakong, a form of digital money.

Cambodia has introduced QR-coded certificates for the tourism sector, compared to other sectors. These certificates, delivered upon completion of training by the Ministry of Tourism, can be scanned by customers to fetch information about the company and the certificate itself. An online system for validating e-certificates has been launched to combat the surge of counterfeit certifications.

Since 2017, the Ministry of Public Works and Transport has implemented QR codes and barcodes on vehicle license plates. Doing so helps enhance data management, prevent fraud, and assist police investigations. Country-specific codes, like Cambodia's 884, are included to distinguish the manufacturing nation.

3.3 Access to Assets

Digital technology, often termed smart farming or digital tools, has been used in Cambodia's agriculture sector for the past decade. Various digital tools have been discussed (table 3.5).

Table 3.5. Access to assets

Smart Farming	Digital Platforms in Cambodia
Smart shared assets ³⁷	Smart farm assistance helps farmers monitor their soil and humidity conditions and remotely control their water systems via mobile phones
Equipment monitoring ³⁸	Geographic Information Systems (GIS), GPS, and satellite images are used for many purposes, e.g., GIS can analyze soil data and historical farming practices to determine the best crops to plant
Livestock and fishery management ³⁹	Drones are used for spraying crops and pesticides

³⁷ Smart shared assets: The smart monitoring of equipment such as irrigation systems that enable farmers to remotely control, track and look after their equipment and farming operations, leading to a reduction in water consumption and wastage.

³⁸ Equipment monitoring: Digital tools that allow farmers to monitor herds remotely to determine their exact location at anytime, track the health and habits of livestock including when they are in oestrus or about to calve.

³⁹ Livestock and fishery management: Digital tools that enable the sharing economy for assets such as tractors, drones and other mechanized farming equipment.

Smart farming is the latest application of digital agriculture popular in emerging markets. Smart farming employs digital solutions that allow farmers to create and transmit data about specific crops, animals, or practices using various technologies. In Cambodia, remote sensing, GIS, and satellites monitor areas cultivating rice, maize, sugar cane, and cassava. GIS technology is useful for mapping agricultural and irrigation systems. In 2021, MAFF utilized geo-informatics and drones to forecast cassava and cashew cropping areas. However, this advanced tool has not been adopted by small-scale farmers, who generally have elementary to vocational level education.

The arrival of drone technology applications signals a new dawn for the primary industry sector in Cambodia. With automated flight capabilities within set boundaries, this 15-kilogram drone⁴⁰ can carry up to 20 liters of liquid. Integrated with GPS and five diverse electrostatic sprayers for various crops, it uses 20 to 50 percent less pesticide than manual application methods. These drones can capture plantation imagery and offer time-saving, cost-effective fertilizer spraying and data collection benefits. Unfortunately, agricultural drones cost between US\$6,000 and US\$20,000 depending on size; as a result, they are not widely used by farmers due to their expense and need for ICT knowledge.

The agricultural Internet of Things (IoT) and mobile apps in agriculture have been developed and implemented in Cambodian agriculture. The “Smart Farm Assistance” IoT and mobile app have been launched to allow farmers to monitor soil and humidity conditions and control their irrigation system remotely. This tool facilitates irrigation control via an app and SMS.

In addition, the Cambodian Agricultural Value Chain Program (CAVAC) is collaborating with a local firm, Agri-Smart, to create a cost-effective mechanical rice seed planter. This device can be fastened to two-wheel tractors, commonly owned by farmers, and efficiently plants seeds in the moist soil that dominates Cambodia. Moreover, this method protects seeds from pests and makes weeding easier due to the neat rows. Notably, this innovative approach requires fewer seeds than traditional manual broadcasting.

Digital assets, such as remote sensing technologies like GIS, GPS, drones, and satellite imaging, were used in 2021 to classify and map cashew nut plantations in Cambodia. MAFF’s General Directorate estimated cultivated areas and cashew nut production in 15 provinces.

⁴⁰ For further information on drone laws in Cambodia, see <https://drone-laws.com/drone-laws-in-cambodia/> and <https://uavcoach.com/drone-laws-in-cambodia/>

Chapter 4: Selected DAT Applications and Solutions in Cambodia

4.1 Agri-Tech Solutions and Models

After analyzing different models in the ASEAN region, Cambodia employs five main agri-tech business models (figure 4.1).

	Model	Customer	Value
	Farmer advisory	Multiple data consumers	Access to pre-qualified farmer customers
	Peer-to-peer lending	Farmers and lenders	Attractive loan terms
	Traceability	Food brands	Consumer trust
	Digital marketplaces	Traders	Reduced transaction costs
	Mechanization platforms	Farmers	Increased yields

Figure 4.1. Principal agri-tech business models

Source: Grow Asia 2020.

Digital advisory services offer tailored advice to farmers via mobile apps. Initially, general farming guidance is shared on social media, then customized solutions are provided on the app. The solutions address issues like pest identification, climate, and planting timing. Examples include Angkor Salad, Chamkar, and Tonlesap App.

- a) **Peer-to-peer lending platforms** enable individuals to loan money to farmers digitally. They cater to the financing needs of micro-entrepreneurs, smallholder farms, and SMEs. These platforms foster financial inclusion in the Kingdom, providing easier access to credit and investment for local businesses. A notable example is the Rai Capital App.⁴¹
- b) **Traceability solutions** use ledgers to record the origin of goods for companies selling fast-moving consumer goods, aiding supply chain understanding and customer commitments. They are often tied to product certifications. These solutions are applied extensively to food, beverage, and medicine production. Some institutions,

⁴¹ For further information, see <https://www.rai.capital/>

including the Ministry of Post and Telecommunications, MAFF,⁴² GS1 Cambodia Association,⁴³ etc., have launched and provided traceability, barcodes, and QR codes.

- c) **Digital marketplaces** facilitate online connections between buyers and sellers. Widely used among producers and service providers, they consolidate key information about products, prices, quality, and more, benefiting all users in the value chain. Examples of digital marketplaces are available at CAMAgri Market app,⁴⁴ Tonlesap App,⁴⁵ or Angkor Salad.⁴⁶
- d) **Mechanization platforms enable owners of agricultural equipment like tractors and drones** to lend their machinery to farmers digitally. Increased urban migration has bolstered machinery use in farming as a replacement for human labor. This can be seen via the Agriculture Ministry, which produces a wide range of agriculture maps⁴⁷ assisting farmers in identifying and selecting cultivated areas, crop locations, or weather conditions. Likewise, drones, though prohibitively expensive for many, are gaining popularity with Cambodian farmers able to afford them.

4.2 Three Agri-Tech DAT Solutions with Scale-Up Potential

4.2.1 Climate-smart solutions

Smart Farm Assistance: Founded in 2019 by tech-savvy young entrepreneurs, Smart Farm Assistance revolutionizes farming practices. It operates through remote control devices on field-mounted poles, with sensors disseminating weather data, soil quality evaluations, and irrigation management (figure 4.2). Farmers interact via a smartphone app, receiving crucial data through SMS. Their offerings encompass (a) Smart Valve, utilizing the IoT for remote irrigation; (b) Smart Pump, employing IoT for motor pumps and intelligent farm irrigation. Farmers can use their phones to check soil conditions and humidity data to regulate their irrigation system remotely.

⁴² For further information on using QR codes to combat COVID-19, see <https://www.khmertimeskh.com/50816215/cambodia-introduces-qr-code-scanning-for-venues-to-combat-covid-19/>, <https://www.phnompenhpost.com/national/cambodias-stop-covid-qr-code-wins-international-award>

⁴³ For further information on the GS1 Cambodia Association barcode, see <https://gs1cambodia.org/en/gs1-system>

⁴⁴ For further information, see <https://www.amis.org.kh/>

⁴⁵ For further information, see <https://www.amkcambodia.com/en/tonlesap-the-first-mobile-application-provides-agriculture-knowledge-in-cambodia-2/>

⁴⁶ For further information, see <https://www.angkorsalad.com/>

⁴⁷ For further information on agricultural land use maps in Cambodia (MAFF), see https://web.facebook.com/vengsakhon/posts/3109053009149578?_rdc=1&_rdr

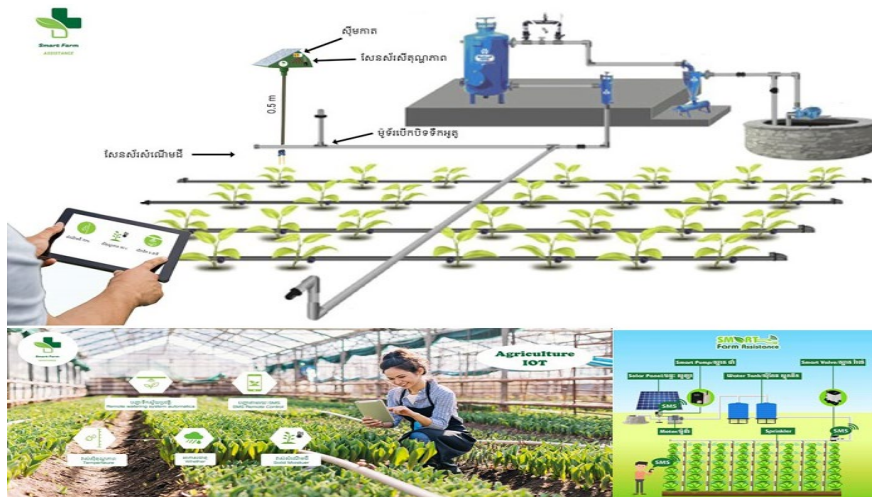


Figure 4.2. Irrigation scheme for climate-smart assistant

Angkor Salad: This app uses geodata to provide services that help at least 100,000 Cambodian vegetable growers increase productivity, income, and food security while lowering water, fertilizer, and pesticide use. As previously discussed, the app offers advice on irrigation, fertilizer use, crop planning, markets, and Khmer GAP compliance (figure 4.2).

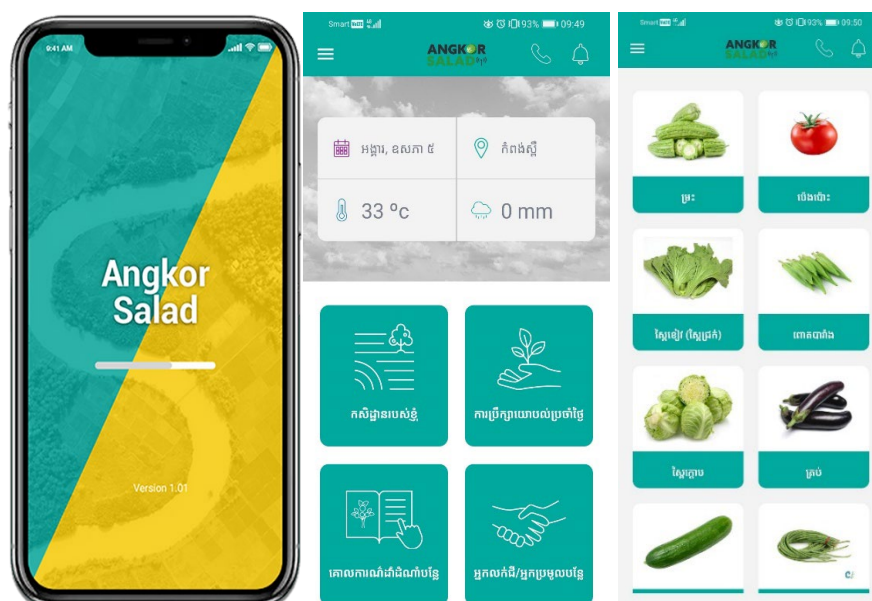


Figure 4.3. Angkor Salad app

4.2.2 Market linkages, online agri-marketplaces and agri-tech platforms

Market linkages

CAMAgri Market: MAFF launched CAMAgri Market in early 2020. The major goal is to provide information to assist farmers and traders in searching for and connecting to information. Farmers, traders, and other interested parties can now access the AMIS website or the CAMAgri Market app (figure 4.4) through MAFF's main portal to get up-to-date information on agricultural and commodity prices and other agricultural-related information. CAMAgri Market allows farmers to market their products to millions of potential buyers nationwide.

The goal is to create a platform that allows farmers to advertise their products while simultaneously making it easier for customers to find what they want. The South Korean Ministry of Agriculture helped develop the app. It was fully operating as of March 2021.



Figure 4.4. CAMAgri Market app

Online agri-marketplaces

Delishop: Established in 2019, Delishop secured a ‘One Belt One Road’ capital start-up investment the same year. It stands as a pioneering online marketplace for agricultural products in Phnom Penh. Adapting swiftly to the evolving sector, Delishop is a growing company. Serving as a one-stop shop for fresh groceries, it partners with over 60 suppliers, offering a diverse range of 10,000+ products. Delishop is the ultimate choice for seamless grocery shopping, emphasizing fresh products, swift service, and free delivery.



Figure 4.5. Delishop app

Agri-tech platforms

AgriOn: In 2020, the Cambodian Ministry of Commerce registered a CF and trading company called AgriOn (Cambodia), funded by two private investors and a Singapore-based firm, along with support from the USAID/HARVEST II initiative. The company also works with two major internationally funded projects: Accelerating Inclusive Markets for Smallholders (AIMS) and ASPIRE.

AgriBee (Cambodia) Plc., an agri-tech firm, oversees the agricultural value chain via its digital platform, uniting all stakeholders under “BeeApps”. This empowers them to enhance operations across the supply chain, ultimately delivering enhanced products to end customers. Established in late 2019, AgriBee’s digitalization platform, BeeApps, enables various participants to perform transactions and payments. Notably, AgriBee operates as a for-profit enterprise (figure 4.6).



Figure 4.6. The AgriON and AgriBee apps

4.2.3 E-extension services to improve farming productivity and management

Chamkar: Introduced in June 2021 under the ASPIRE project, facilitated by MAFF, and financed by IFAD, the Chamkar app is an e-commerce platform. Derived from the Khmer word for “farm,” Chamkar facilitates the online sale of safe and organic vegetables through various partners. The platform is designed to cater to busy and novice customers and streamlines the shopping experience, enabling swift selection of the freshest and healthiest vegetables. The app offers both self-pickup and delivery (figure 4.7.). Chamkar has several purposes:

- To improve access to ICT for smallholder farmers
- To help the farmer get updated information on farming technique
- To provide on-demand technical support to farmers via live messaging with agriculture experts
- To improve access to the market faster and better



Figure 4.7. Chamkar app

Agribuddy: The company has been in business since 2015 and has raised two rounds of funding: a start-up investment of US\$730,000 in 2017 (Kotoski 2017) and a Series A financing of US\$2.8 million in 2018 (Pitchbook 2018). Situated in the province of Siem Reap, Agribuddy serves farmers by providing capital, expertise, goods, and services. They facilitate the optimization of farming yields while minimizing expenses. In addition to their onsite assistance, Agribuddy operates an agricultural technology platform, enabling farmers to analyze farming data and improve crop output through collective intelligence. The platform connects farmers, agri-traders, and experts to communicate about farming issues, keep track of crop yield trends, and predict profitability. It helps rural farmers manage their farms, adopt new techniques, and receive asset management support based on long-term data.



Figure 4.8. Agribuddy app

Chapter 5: Conclusion and Recommendations

5.1 Conclusion

The DAT ecosystems analysis and mapping highlighted the potential for digital sector investment to foster business expansion and success. Emerging trends within Cambodia's DAT landscape include the following:

- Small ICT and DAT businesses are starting to aggregate their services to gain greater scale and financial viability.
- The DAT can run offline at the farm level and update when able to access the network in locations where service is available.
- Agribee, SmartFarm, CAMAgri Market, Rice Blockchain, and other apps assist in DAT development and adoption. For start-ups, these apps constitute a significant investment.
- Mobile payment systems are critical for enterprises to address financial solutions that bridge liquidity shortages for farmers and benefit the whole supply chain.
- The main challenge is not discovering solutions but sustaining them within their intended framework. MAFF plans to invest in DAT, focusing on knowledge, innovation, and incubation. All stakeholders, including MAFF, entrepreneurs, and other actors in Cambodia's agricultural value chain, agree on the need for a DAT strategy to enhance productivity, foster inclusive job growth, and reduce poverty.

Since COVID-19, digital adoption has been rising regionally and globally. More and more people are connected via online activities, and many businesses need to digitize their operations and practices.

Even before COVID-19, digital adoption in Cambodia, especially among the younger generation, was increasing noticeably. Like other countries in the region, Cambodia is embracing digital adaptation, particularly in response to COVID-19. This shift encompasses areas like e-banking, e-commerce, ride-sharing, and digital agriculture. Driven by the government's leadership—from upper-level officials like the Prime Minister and Deputy Prime Ministers to sub-national agencies—the push towards digitalization incorporates the private sector, development partners, and civil society.

Cambodia's digital future is promising, offering opportunities for the sector's development. Stakeholders are open to collaborations that enhance the digital economy and there is a growing momentum in this direction. Inviting international or regional contributions, creating an encouraging landscape for growth, and promoting local innovation are crucial for producing strong Cambodian start-ups that will contribute to the global digital economy.

5.2 Recommendations

For the government

Create an enabling regulatory environment. The government and regulators should provide enabling regulations to encourage DAT, AIS, and farmers to utilize financial technology and e-

commerce. A good method would be to simplify the e-commerce business registration and licensing process, establish systems or databases that provide access to digital identity and verification, and level the playing field so that all participants, official and informal, can compete fairly in the marketplaces.

Improve supporting digital infrastructure quality and access. The government should continue to invest in digital infrastructure, supporting the expansion of mobile broadband to rural areas and ensuring constant Internet service quality. The government should work with the private sector to create a robust e-commerce ecosystem. Creating an e-commerce ecosystem and fostering entrepreneurship in the agricultural industry would provide new opportunities and jobs.

Focus on enhancing digital literacy and building digital skills. A public digital literacy framework should be developed to cover Cambodia's entire spectrum of digital literacy development. Inclusive literacy approaches should be examined to ensure that everyone, irrespective of their social, cultural, or economic background, has equal and fair access to literacy opportunities. Promoting information literacy and skills to find, search, and navigate digital content and evaluate its quality is essential in an inclusive approach. Enhancing public familiarity with digital technology, especially in rural areas, is crucial for better digital literacy. A thorough assessment of digital skill gaps and readiness is necessary to aid the government in planning strategies and actions for boosting e-commerce and digital payments in business processes.

Develop an agriculture e-commerce framework. The government should create an agriculture e-commerce framework focusing on the agricultural value chain, including redesigning agricultural production, increasing trade exchange platforms, and improving online marketing and sales.

For the private sector and development partners

Invest in viable services that create impacts. With the availability of funding, the private sector should be encouraged to invest in the agriculture e-commerce businesses and some start-ups, including app developers, that can generate both social and economic impacts to work directly with AIS and farmers to transfer skills, technology, experiences, and resources.

Invest more in incubators and accelerator programs. To bolster the growth of tech innovation, particularly in DFS and e-commerce, the government, development partners, and donors must collaborate with the private sector. They should focus on investing in and promoting more incubators and accelerator programs. These initiatives will cater to current entrepreneurs and innovators, fostering the development of new tech start-ups. A noteworthy example is the Tonlesap App, created by the private microfinance institution AMK, with funding from donors like SNV and Harvest II projects. These kinds of initiatives are instrumental in supporting emerging start-ups.

For agriculture input suppliers (AIS), whether the private sector or agricultural cooperatives

Develop digital skills and improve digital literacy.

AIS should engage in digital skills development programs led by relevant ministries, local authorities, and private entities. Their involvement should align with their current digital skills and literacy. Tailored opportunities for inclusive participation and specific technical skills training should be provided according to actual requirements. Enhancing digital skills and literacy in this manner will also play a pivotal role in encouraging greater online transaction adoption among AIS.

Participate in public awareness and increase understanding of the benefits of digital payment and e-commerce. AIS must enhance their comprehension of the potential advantages of digital payment and e-commerce. This should align with the growth of their digital skills and literacy. Simply possessing the necessary skills may not suffice if AIS fail to recognize the benefits. Their active engagement in public awareness efforts is crucial to appreciate the advantages and understand existing regulations. Through this, their skepticism towards digital business can be gradually alleviated, fostering a greater sense of trust and willingness to embrace digital payment and participate in e-commerce.

Increase trust in adopting digital payment and e-commerce.

AIS can accomplish this by dedicating time to comprehending the laws and policies concerning digital payment and e-commerce. Additionally, when the government and relevant entities rigorously enforce e-commerce and consumer protection regulations while ensuring widespread accessibility for AIS, their comprehension of rights, privacy, secure online transactions, and dispute resolution procedures will grow. This systematic approach will lead to an incremental increase in trust.

Meanwhile, AIS should actively expand their understanding of business digitalization's potential for growth and broadening customer outreach. By recognizing the benefits, their confidence in this sector will naturally improve.

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Annex A. Approaches and Methodologies

The study method for DAT ecosystem assessment set to answer the following research questions:

- a) What are the key DAT solutions in Cambodia that are currently impacting the agriculture and food systems?
- b) What is the experience, and what lessons can be learned from the agricultural innovation ecosystem in these countries where DATs are growing and developing rapidly?
- c) What are some DATs that have strong potential to scale up their positive impact on the agriculture and food systems?
- d) What can the public sector do to improve the innovation ecosystem for DAT entrepreneurs in Cambodia? What role can the WB play in supporting innovation ecosystems and scaling selected DATs?
- e) What are DAT's potential roles in facilitating agricultural development support in Cambodia, and what factors should be reflected?

The study methodology includes a qualitative approach to gathering primary data, reviewing secondary data and documents provided by the WB Cambodia Office, and other documents obtained before and during fieldwork. Relevant project documents, various assessment reports, WB and government policies, and normative guidelines are included (figure A.1).

Primary and secondary sources of data are used in the study. Various actors/stakeholders directly involved in agriculture value chain production, assembly, marketing, existing information communication technologies, and distribution make up most of the primary sources. All actors involved in the agricultural value chain and ICT applications in the public and commercial sectors, including producer farmers, farmer groups, traders at various levels, input suppliers, and service providers, were included in the study. From the start of input supply to the end-users, the consultant team gathered all accessible information linked to ICT4Ag (figure A1).

Data Collection

The data gathered combined primary and secondary data (figure A1). The data collection study was conducted from input suppliers (supplying seeds, fertilizers, agricultural materials, and equipment), government representatives from MOC, GDA/MAFF, etc., and NGOs, DPs, and relevant private sector actors with potential in agricultural production, DAT, and marketing. The data-gathering process consisted of (a) desk review of secondary information and (b) consultations with key informants at the government ministries and private sector levels through individual meetings, group discussions, and semi-structured interviews.

The range of partners, stakeholders, and communities were met and discussed to gather appropriate information for DAT/ICT4Ag:

- a) We visited senior and experienced government officials from MAFF, GDA, and other relevant ministries and departments to discuss the current and future trends in DAT adoption and implementation and the expectations.

- b) Private sector representatives involved in the agricultural businesses convened to discuss current marketing, quantity, quality challenges, and the use of DAT.
- c) ADB, World Bank, Australian Aid, FAO, IFAD, and other key development partners were contacted to discuss their perspectives and support for the ICT4Ag sector now and in the future.
- d) NGOs and community-based organizations were brought together to discuss their involvement in the agricultural sector, how this sector contributes to the future of agricultural development, and their perspectives on ICT4Ag, such as extension, funding, and technologies.

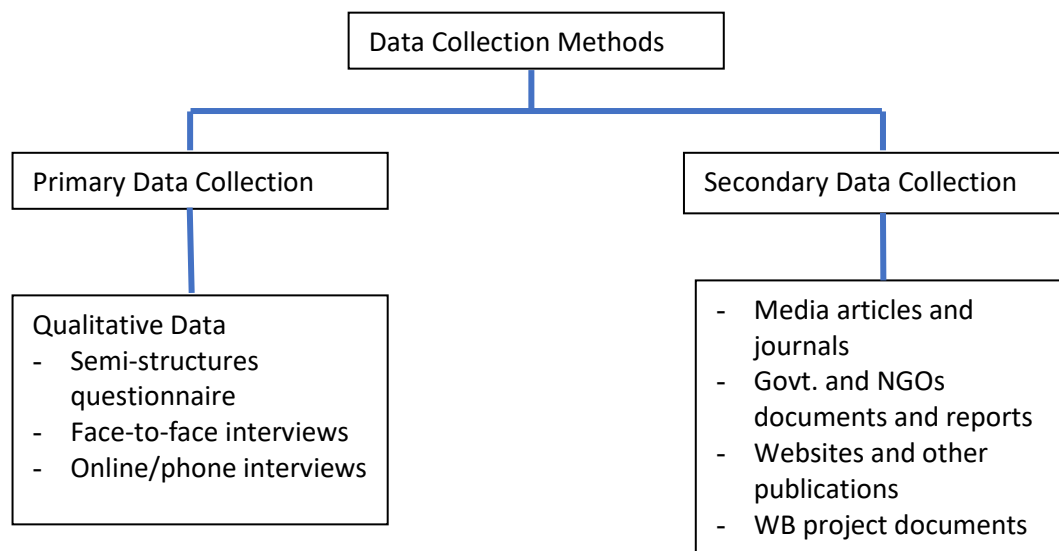


Figure A1. Data collection methods

The data collection questions focused on the tasks in the Terms of Reference. Target stakeholders were selected based on consultant team selection in consultation with the WB management team. The range of activities primarily focused on adoption and achievements and key aspects that have affected the overall results of DAT and performance of ICT4Ag in the past, current, and future. Interviews and discussions with key stakeholders and individuals based on **interview guides** agreed with WB management. These were intended only to assist in prompting questions and discussion and not as questionnaires.

Semi-structured interviews (SSIs) were conducted with key informants. In addition, senior and relevant staff of GDA/MAFF, private sector NGOs, etc., were consulted to secure additional information and insights. The **individual interviews** derived more detailed information and insights. The critical elements that influenced the results of ICT4Ag to date and in the future growth and development were identified alongside the management performance of relevant organizations.

The detailed interview guiding questions (in Annex 2 adopted from Kenya's Report) were used to explore the DAT ecosystem and the interview results used for drafting the report. The results of key elements listed below were a main part of the finding report.

- a) **Infrastructure:** The service operates in the digital technologies; service mobile access (low, intermediate, or high); Internet connectivity and available in the targeted area of service; the software/tools used in online/offline operations, data transfer, communication, tracking, payment, etc. (e.g., Excel, mobile payments, Internet payments?); the use any SMS-based tools, voice recordings, offline functioning platforms that can upload or receive data when the connection becomes available, etc.
- b) **Human capital:** User demographic profile (e.g., age, sex, income level, profession, from which regions in the country); supported means for users in adopting technology (e.g., through mentoring, etc.); the level of dependency of service or product on human capital; points of operation of human capital involvement; women for example in smallholder farming: the area of the point of the value chain that women contribute to operations; the organization put special effort in women inclusiveness, etc.; trends of users base between men/women, or urban/rural and types of user information frequently.
- c) **Density:** Actors or services engage with product or service offerings, e.g., NGOs, the government, technology firms, start-ups, small businesses, donors, MNOs, input suppliers, etc.
- d) **Finance:** Sources of finance and its available in-country; who provides finance to SMEs and start-ups, terms and conditions for SME loans, contract-farming loans, or input finance? For example, the government provides farmer cooperative group finance, etc.; the data collection and analysis needed for agricultural financing, credit scoring, etc.; digital diaries of farmers; is there a government-centralized database?
- e) **Regulatory environment:** The government funding mechanisms for R&D, Technology research funds, tax incentives for start-ups, type innovation plans for a tax incentive or tax-break incentives for value chain; consideration for social enterprises or social entrepreneurs that do smallholder farming projects for social good as well as for profit, recognition of legal entity of NGOs vs. private company models, etc.
- f) Company profile (finance and business model)
- g) Products, technologies, and services
- h) Agriculture value chain: Assessing DAT literacy and adoption; the application of the technology of smallholder farmers (senior vs. young generation); digital literacy and sustainable technology adoption; less know-how on using technology platforms to access information services, farming advice, weather information or use of digital diaries; credit scoring and loan applications; cash payments preferred over digital payments; value chain and transport and storage of goods; food control including shelf-life of products; the gap in QR coding/voucher programs; access to markets; use of e-commerce, buyer-seller platforms, collective inputs/purchase systems.
- i) Challenges and opportunities in DAT.

- j) Continuum Analysis.
- k) Priority tech solutions in the Ag Sector

Data Analysis

The data was checked, cleaned, and prepared for analysis by the consultant team (CT) in consultation with the World Bank Management. The CT systematically checked the accuracy, consistency, and validity of collected data and information and acknowledged any limitations/caveats in drawing conclusions using the data. Then, the distribution of each variable was examined for inconsistencies, missing values, and logical distribution. Inconsistency or discrepancy was verified with the original data collection sources.

The CT analyzed the cleaned data using Excel or SPSS software packages. Descriptive statistics, along with gender disaggregated results, will be the primary focus in presenting the study results. Where the team finds data to be weak during the evaluation, this was acknowledged in the final report, and areas for further data gathering may be identified.

The CT ensured a lack of biases by relying on a cross-section of information sources and triangulating the information received from each. The CT implemented a participatory approach and sought to maintain regular intensive communication with each other and WB staff through discussion and reflective sessions. This ensured the findings' quality, including validity, consistency, and data accuracy.

The research data from the DAT assessment was used for analysis of the following:

- Continuum analysis
- Ecosystem analysis
- Value-chain analysis
- Matrix analysis

The overall analysis for DAT was based on building blocks: input, production, distribution, and consumption (figure A.3). This block was not reviewed in detail in this study, but the connection between each block might still be relevant to be discussed and analyzed.

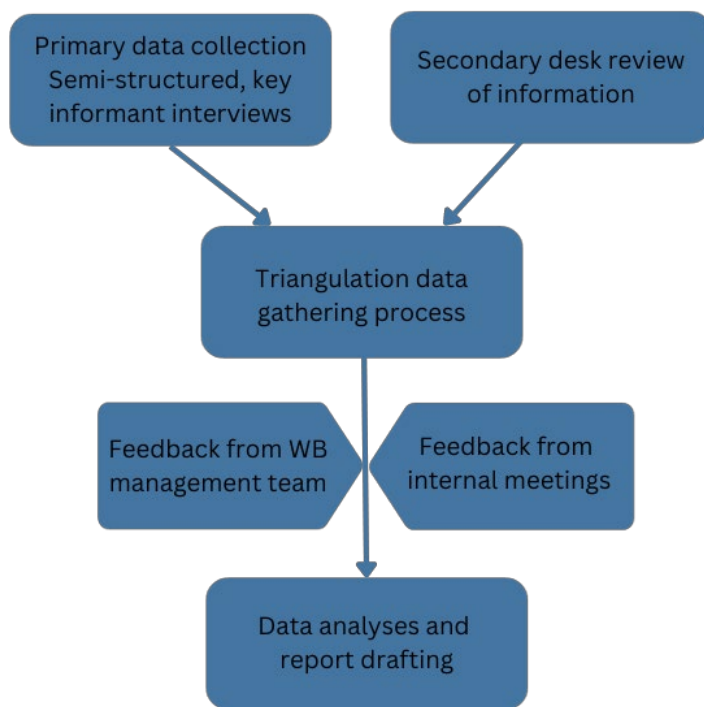


Figure A.2. Methodological framework for formulating the DAT ecosystem assessment

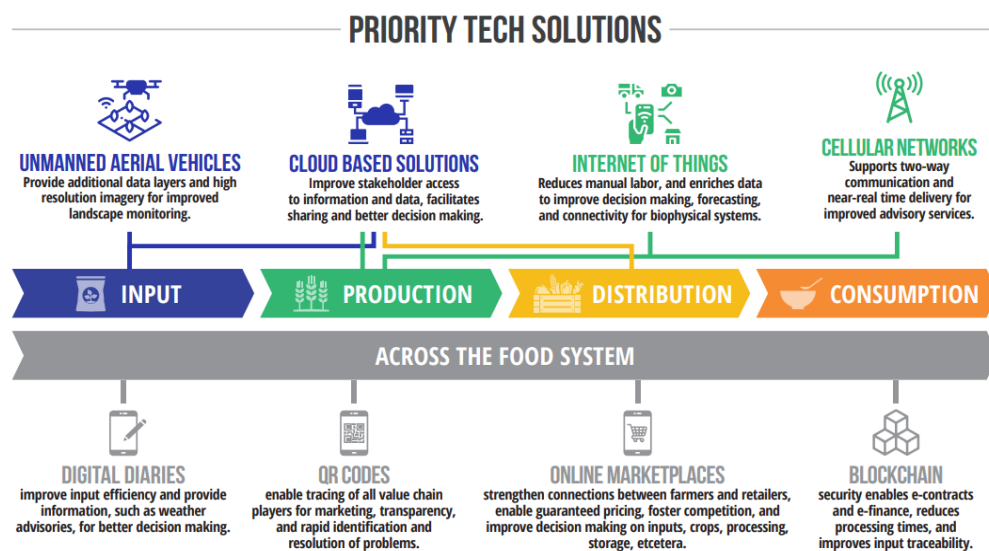


Figure A.3. Process of the analysis for DAT in Cambodia⁴⁸

The analyses of the DAT ecosystem assessment covered the following four interlinked activities:

- DAPs

⁴⁸ Digital Agriculture Profile: Vietnam

- b) Assessment of the DAT ecosystem
- c) Ecosystem assessment for DAT-related support to food system work in Cambodia
- d) Synthesis report with recommendations for the World Bank Group.

These four main activities produced a synthesis report based on the results of the DAPs, the ecosystem assessments, and identified policies and investment opportunities for developing the DAT ecosystem in Cambodia. It primarily provided recommendations for agricultural policies and the World Bank Group to enhance the innovation ecosystem in Cambodia. The report provided insights into and design principles of potential operational projects financed by the World Bank.

The quality of the report was ensured at multiple levels. The CT was responsible for conducting the study and producing a high-quality report based on factual and verifiable primary data. The CT critically reviewed the draft report to improve the drafts before submitting the final versions to World Bank Management.

Limitations, Risks, and Mitigation Strategies

The limitations and risks raised by the COVID-19 pandemic have been highlighted as a limiting factor for a face-to-face interview, and the consultants proposed mitigation measures for undertaking during the data collection. The consultants designed safety protocols for data surveys and face-to-face for SSIs and key informant interviews. The approach proposed was the “best-case scenario” at this planning stage, and some flexibility was required as the situation in Cambodia was closely monitored. Full or partial postponement of certain data collection elements may become necessary, especially if the situation deteriorates. In such a situation, the work (partial or complete) recommenced as soon as reasonably practical.

Other expected limitations include restricting available data from government and private institutions and engagement processes that contribute to the ICT4Ag. The strategy for mitigating the data collection, specifically from the government, needed WB management intervention.

Annex B. Guiding Questions

(Please find the addendum in a separate file)

Interview Questionnaires

A. Introduction

Thank you in advance for agreeing to be interviewed for the case studies on DAT innovation ecosystems in Cambodia, conducted by a technical adviser on behalf of the World Bank Group.

The objectives of the study are the following:

- Understand the status of the DAT innovation ecosystem in Cambodia
- Identify scale-up challenges and opportunities for engagement by the public sector, the private sector, and development partners to improve the ICT4Ag innovation ecosystem
- Draw key lessons based on the current Cambodia experience in supporting DAT innovation

Your opinions and experiences are extremely valuable toward achieving these objectives. We, therefore, appreciate your time and input.

Before we begin, there is a chance we may want to use some quotes from this interview to illustrate points in our report. Are you comfortable with us quoting you in our report? [If no] Would you be comfortable if we use your quote without naming you or your organization?

B. General information

Name of organization:

Name of respondents:

Gender:

Position:

Phone number:

Email or other contact info:

Date of interview:

Stakeholder interview questions

How long have you been in your current position? Can you please describe your role and responsibilities? How does your organization implement DAT, ICT4Ag, etc.?

A. Infrastructure/continuum analysis

1. What is your service, and how long has it been operational?
2. Please describe the main operations of your service.
3. In which part(s) of your service chain is the technology digital?
4. Do your service areas have low, intermediate, or high mobile access?
5. How much does your service area rely on Internet connectivity?
6. How much is the Internet connection available in your service area?

7. If the service does not rely on the Internet, how do you connect/reach your targets?
8. What software/tools do you use in your online/offline operations, data transfer, communication, tracking, payment, etc.? e.g., Excel, any other programs other than Excel? Mobile payments, Internet payments?
9. Do you use SMS-based tools, voice recordings, or offline functioning platforms to upload or receive data when the connection becomes available?

B. Human capital and culture

1. What is the user demographic profile of your users? (age, sex, income level, profession, from which regions in the country)
2. Do you help your users in adopting your technology? How? (e.g., Is it through mentoring?)
3. How much does your service or product depend on human capital?
4. At which points of operation is human capital involved, and where is it not involved?
5. Women in smallholder farming are key contributors to rural economies and livelihood systems. They hold important roles across agricultural value chains, from production and management of crops and livestock to harvesting and processing to selling and trading products in markets. At what point in the value chain do women contribute to your operations? Does your organization put special effort into women's inclusiveness? If so, how?
6. Are there noticeable gender trends in your user base or urban/rural areas? Do you examine this type of user information frequently?

C. Density

1. What other actors or services in your network do you engage with for your product or service offering? (NGOs, government, tech firms, start-ups, small businesses, donors, MNOs, input suppliers, etc.)

D. Finance

1. What sources of finance are available in-country?
2. Who is providing finance to SMEs and start-ups in-country? What are the terms and conditions for SME loans, contract-farming loans, or input finance?
3. Does the government provide farmer cooperative group finance?
4. What is happening behind the data collection and analysis needed for Ag finance? Is credit scoring happening?
5. Are digital diaries of farmers happening? Is there a government-centralized database?

E. Regulatory environment

1. Does the government have any funding mechanisms for R&D, tech research funds, or tax incentives for start-ups? Are there plans for this type of innovation or tax-break incentives for VCs?
2. Is there any consideration for social enterprises or entrepreneurs doing smallholder farming projects for social good and for profit? Is this a recognized legal entity? Or are only NGO vs. private company models allowed?
3. What are the data privacy regulations like? And data-sharing regulations like?
4. Are all companies forced or need to report data to government departments? Which ones? How often?

5. Is Big Data being used at the government level?
6. What types or examples of public-private projects have already happened at the Ag ministry? Any of them were ICT projects? If so, what happened, and what was the outcome?
7. What gaps in MAFF can tech-driven solutions or start-ups fill through pilot trials with the MAFF government department?

F. Company profile (finance and business models)

1. Source of funds (equity, grants, commercial pilots, etc.)
 - If you are funded, are you looking at other sources/building in revenue streams?
 - If you are seeking investment, is that primarily in the form of equity/debt?
2. Use of funds for technology/application use: How is the budget broken down?
3. Overall, how would you describe your business model?

G. Products, technology, and services

1. What facilitating conditions are working to assist farmers in adopting your technology? e.g., referrals by other farmers or trusted friends/relatives who encourage interested farmers to try the tech; groups/Facebook groups where farmers discuss certain topics/themes and where you could explain your tech to promote adoption.
2. Are users and farmers closely involved in co-designing your service or technology?
3. Do you use an agent in each area who handles the technology alone, and customers come to them for the service? e.g., a mobile wallet, for example, like Wave Money in Myanmar.
4. Do you use any social impact metrics to track your impact/success? If yes, what are some of these?
5. Do you have evidence of impact on smallholder livelihoods or production capacity, income, etc.? Can you share this with us? If not, have you seen this evidence in the field, i.e., by talking to users?
6. Do you believe your service impacts any specific value chain in Cambodia relative to others? e.g., maize, rice, pulses, etc.

H. Challenges and opportunities for Cambodia

1. What new trends do you see happening in Cambodia in agri-tech? What are the top three within the ecosystem, players, or service offerings?
2. Do you see opportunities for your business/organization emerging?
3. Are there challenges related to taking advantage of these opportunities? If so, what are they? i.e., need funding, regulatory issues, user adoption issues
4. Who are the most important ecosystem players currently, and from which sector?
5. What role could you see for NGOs/donors to play in supporting the development of sustainable, impactful services in the market system?
6. Is there anyone you can think of that we should also speak to on this subject?

Overall – Report recommendations to the WB team and the RGC

1. What is your overall report recommendation to the WB team and the RGC?
2. Why is this needed?
3. Any suggestions on how this could be implemented?

Questions for continuum analysis

A. For asking stakeholders about the technologies

1. What is your technology? How would you describe it? Is your technology of the following categories—agricultural productivity enhancement, market linkage improvement, data analytics, financial inclusion—or something else?
2. How much of your technology is digital? Does your technology require mobile devices to use? How advanced must the device be to use your technology, e.g., is a touchscreen smartphone needed, or can it be a simple keypad phone?
3. How much do you rely on the Internet to offer your service? Which services of your technology require the Internet and which do not?
4. Which areas of Cambodia is your technology present in? Do the users in these areas have good access to mobile devices and the Internet?
5. What are the challenges in scaling up your technology to other areas or scaling up more in the areas you are in?

B. For additional categorization

1. Which areas of Cambodia have low, intermediate, and high mobile penetration (low, intermediate, and high access to mobile devices)?
2. Which areas of Cambodia have low, intermediate, and high Internet connectivity (low, intermediate, and high access to the Internet)?
3. Are there any variations in mobile penetration/digital accessibility and Internet access depending on demographics (age, gender, and income)? If possible, please identify and compare the variations.
4. From the technologies that you have found out from the stakeholders:
 - What common digital technologies **applicable to agriculture** are currently deployed largely in low-connectivity environments and do not require high connectivity? Please list them, however basic they might be.
 - What common digital technologies **applicable to agriculture** are currently deployed largely in the intermediate-connectivity and less in the low-connectivity environment? Please list them.
 - What common digital technologies **applicable to agriculture** are currently deployed only in high-connectivity environments and cannot be deployed in low- or intermediate-connectivity environments? Please list them.
5. Next, please categorize each of the above lists depending on whether the technologies are deployed in low, intermediate, or high mobile access areas.

For questions 4 and 5, the table below can be used if it is helpful (insert more rows and columns as necessary):

What is technology?	Is it nascent (requires low Internet connectivity), transitional (requires intermediate Internet connectivity), or advanced	Is it largely deployed in low, intermediate, or high mobile penetration/access areas?
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	technology (requires high Internet connectivity)?	
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Questions for stakeholders:

What are the priority technology solutions in the Ag Sector of Cambodia?

1. How are you involved in the ag sector?
 - Input producer/supplier/distributor
 - Crop producer
 - Crop/product distributor
 - Consumer
 - Others
2. What are some digital technologies that are currently used in your services?
3. At what point of the value chain is the technology primarily used? (production, distribution, application/consumption). Which gaps are your technology and services addressing?
4. Do your services use any of the following technologies?
 - **Unmanned aerial vehicles** - Provide additional data layers and high-resolution imagery for improved landscape monitoring.
 - **Cloud-based solutions** - Improve stakeholder access to information and data; facilitate sharing and better decision-making.
 - **IoT** - Reduces manual labor and enriches data to improve decision-making, forecasting, and connectivity for biophysical systems.
 - **Cellular networks** - Support two-way communication and near-real-time delivery for improved advisory services.
 - **Digital diaries** - Improve input efficiency and provide information, such as weather advisories, for better decision-making.
 - **QR codes** - Enable tracing of all value chain players for marketing, transparency, and rapid identification and resolution of problems.
 - **Online marketplaces** - Strengthen connections between farmers and retailers, enable guaranteed pricing, foster competition, and improve decision-making on inputs, crops, processing, storage, etc.
 - **Blockchain** - Security enables e-contracts and e-finance, reduces processing times, and improves input traceability.
5. Are there challenges or other gaps that your technology cannot address currently? What are they?
6. Which part of the value chain is the gap in? (inputs, production, distribution, or consumption).