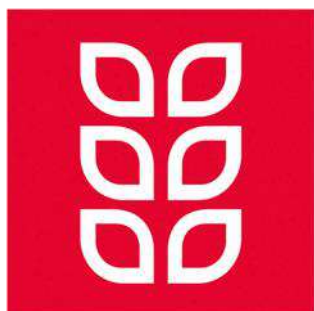


CLIMATE RESILIENT AGRICULTURE ASSESSMENT



**HEKS
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**Swiss Agency for Development
and Cooperation SDC**

This assessment was conducted in four specific Cambodian provinces, which are Battambang, Banteay Meanchey, Oddar Meanchey, and Preah Vihear, as part of The Nurturing Climate Resilience (Nuture) project, being implemented by HEKS/EPER and Caritas Switzerland with contribution funding provided by the Swiss Agency for Development and Cooperation (SDC).

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Acronyms

AC	Agriculture Cooperative
ACIAR	Australian Centre for International Agricultural Research
AEAC	Agricultural Extension Advisory Committee
AFD	Agence Française de Développement
AI	Artificial Intelligence
AIMS	Accelerating Inclusive Markets for Smallholders
ASPIRE	Agricultural Services Programme for Innovation, Resilience and Extension
AVSF	Agronomes et Vétérinaires Sans Frontières
AWD	Alternate Wet and Drying
BB2C	Brooklyn Bridge to Cambodia
CARDI	Cambodian Australia Agricultural Research and Development Institute
CASC	Conservation Agriculture Service Centre
CAST	Commercialization of Aquaculture for Sustainable Trade
CAVAC	Cambodia Agricultural Value Chain Program
CCAP	Climate Change Action Plan
CCCSP	Cambodia Climate Change Strategic Plan
CE SAIN	Centre of Excellence on Sustainable Agriculture Intensification and Nutrition
CEW	Commune Extension Worker
CHAIN	Cambodia Horticulture Advancing Income and Nutrition
CIAS	Cambodia Inter-Censal Agriculture Survey
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CISIS	Cambodian Information System on Irrigation Schemes
CMD	Cassava Mosaic Disease
CPSA	Cambodia Partnership for Sustainable Agriculture
CSD	Crop Seed Department
CSO	Civil Society Organization
D&D	Decentralisation and Deconcentration
DAE	Department of Agriculture Extension
DAEng	Department of Agriculture Engineering
DALRM	Department of Agriculture Land Resources Management
DAO	District Agriculture Office
DS	Dry Season
EU	European Union
EWS	Early Warning System
FC	Forestry Community
FGD	Focus Group Discussion
FI	Finance Institution
FWUC	Farmer Water User Group
GAP	Good Agricultural Practices
GDA	General Department of Agriculture
GDP	Gross Domestic Product
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMO	Genetically Modified Organisms
GPS	Global Positioning System
IDE	International Development Enterprises

IPM	Integrated Pest Management
IFAD	International Fund for Agricultural Development
IoT	Internet of Things
KAS	Khmer Agriculture Suite
KII	Key Informant Interviews
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economy and Finance
MISTI	Ministry of Industry, Science, Technology and Innovation
MFI	Micro-Finance Institution
MoC	Ministry of Commerce
MOU	Memorandum Of Understanding
MOWRAM	Ministry Of Water Resources and Meteorology
NCDDS	National Committee for Sub-National Democratic Development Secretariat
NCDM	National Committee for Disaster Management
NCS	National Council for Sustainable Development
NGO	Non-Governmental Organization
NSDP	National Strategic Development Plan
ODC	Open Development Cambodia
OPV	Open-Pollinated Varieties
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PGS	Participatory Guarantee Systems
PIN	People In Need
PMUAC	Preah Vihear Meanchey Union of Agricultural Cooperatives
PPE	Personal Protection Equipment
R&D	Research and Development
RGC	Royal Government of Cambodia
RUA	Royal University of Agriculture
SAAMBAT	Sustainable Assets for Agricultural Markets, Business and Trade
SAW	Strategic for Agriculture and Water
SDC	Swiss Agency for Development and Cooperation
SLCMV	Sri Lanka Cassava Mosaic Virus
SRP	Sustainable Rice Platform
UNDP	United Nation Development Programme
USAID	United States Agency for International Development
VC	Value Chain
VAHW	Village Animal Health Workers
WAT4CAM	Water Resources Management and Agro-ecological Transition for Cambodia
WS	Wet Season

Executive summary

Introduction

Cambodia is considered as one of the most vulnerable countries to climate change impacts. To mitigate the related challenges, HEKS/EPER will implement the Nurture project, which aims at increasing the resilience of smallholder farmers. Thus, the objective of this Climate Resilient Agriculture Assessment is to characterize potential climate resilient value chains, existing farming practices, products, and services, and look at resources and digital tools that support this effort, to develop recommendations and prioritise interventions for the Nurture project.

The Nurture project and the study focus on four specific provinces, which are Battambang, Banteay Meanchey, Oddar Meanchey, and Preah Vihear. The data collection approach combined desk review, semi-structure interviews at national and provincial level, and focus group discussions with smallholder farmers. The districts selection has been conducted in close collaboration with HEKS/EPER team, based on several criteria: the climate vulnerability, poverty rates, NGOs active in the districts, existing irrigation infrastructures, agriculture cooperatives (AC) and farmer water user groups (FWUC).

Characterisation of the production and market systems

To characterise each potential value chain, key information on the production of key crops and market systems were collected during the assessment by looking at the stakeholders involved in the different value chains, their key activities and functions, the level of interactions and respective constraints, etc. The table below provides an overview of the organisation of each potential value chain considered.

Table 1. Overview of the production and market systems

RICE	- Main agricultural product, traditionally cultivated for subsistence purpose. High potential in the 4 provinces. - High interest from the government: mechanization, access to inputs, diversification, irrigation, etc. - Main actors: input suppliers, producers, collectors, millers, traders. - Organizing farmers into cooperatives allows to facilitate access to market and inputs. - Creation of FWUC to efficiently manage the water resources.
CASSAVA	- Second largest crop produced and vital cash crop, high resilience to drought. - Grown by smallholder farmers, high potential in the 4 provinces, especially in upland areas. - Marketing is done by traders; farmers do not have influence on selling price (high dependence on the border markets of Thailand and Vietnam). - Cassava requires considerable post-harvest effort. - Opportunity to move up the value chain, with export of high value finished products.
MAIZE	- High potential especially in Battambang, but also in Banteay Meanchey. - Most of the maize produced is for the feed industry (90%). - Maize is sold directly to collectors, then circulating to Vietnam (80%) or to local factories (20%). - Price fluctuation depends on the neighboring countries. - The country only process half of its capacity.
MANGO	- High potential especially in Battambang, but also in Oddar Meanchey. - Contractors are involved in the management of the production, as well as collection and trading. - Low margin product, high price fluctuations due to overproduction during the harvest season. - Informal markets, an increasing part is exported formally to China (FTA) - Few companies processing and exporting (e.g.: Misota Food Cambodia, in Battambang)
VEGETABLE	- High potential in the 4 provinces, but especially in Battambang and Banteay Meanchey. - Sector dominated by smallholder farmers and women. - High margin products. - Production limited, irregular supply: a large quantity of fresh vegetable is still imported from Vietnam. - Producers often organized in clusters, which facilitates the collection for the middlemen. - Lack of access to information and market, limited technical knowledge to increase productivity.

SOYBEAN	- High potential in Battambang and Preah Vihear. - Minor crop, although the area planted has risen steadily. - Sold to collectors and small traders, who sell to large traders, who then forward the product to Vietnamese or Thai traders. - Low price compared to other crops, which is a disincentive for farmers. - Growth opportunity due to increasing demand from other countries.
SESAME	- Drought tolerant crop, low fertilizer requirement. - Export in Vietnam, Japan, Thailand, and China. - Profit changes drastically from year to year, depending upon the weather.
CASHEW	- High potential in Preah Vihear and Oddar Meanchey. - Mainly cultivated in small plantation (2-5 ha). - Around 95% of the production is exported informally, mostly to Vietnam. - Sector poorly organized. - Growing demand in export markets, opportunity to increase production and structure the VC.
LONGAN	- High potential in Banteay Meanchey and Battambang. - Thailand is the main market; trade is done through informal channels. - Contractors/Collectors are involved in the management of the production, as well as collection, grading, and trading. - An agreement is under discussion with MAFF to enable formal export to China.
POULTRY	- High potential in the 4 targeted provinces. - Mostly traditional and backyard systems, the production oriented toward local consumption. - Relative price stability, with seasonal spikes during celebrations. - Potential with development of the semi-intensive production system.

Main constraints

The situation analysis enabled the identification of key market barriers that limit adoption of climate resilient practices among smallholder farmers.

- **Availability of technical knowledge** is limited: most of the smallholder farmers are aware and noticed changes in weather patterns. However, there is still very little knowledge about possible mitigation strategies, which could be improved through implementation of adapted extension services.
- **Extension services** are still perceived as **inadequate**: there are currently little or no government agricultural extension services provided at the village level and farmers often rely on each other, and other actors in the value chain network, for information to support their decision-making.
- Even if irrigation infrastructures exist in the selected areas, most of the farmers are producing under rainfed systems and mentioned that **access to water remains a key issue** for their farming activities, especially during the dry season. Only 15% of existing irrigation schemes are considered in good functioning conditions.
- **Access to finance** remains a key challenge for agriculture: high interest rate, hard collateral, and weak financial education are key constraints that limit the ability of farmers to access to credit. However, access to finance is crucial as adopting climate-smart technologies or practices represents a long-term investment, with potential yield reductions to be expected initially, and benefits only realised after a few years.
- **Access to market is limited**, the value chains are poorly organized with a wide network of informal market stakeholders, and very low negotiation power from the farmers and the absence of mechanisms to face potential market failures.
- Remarkable progress has been made in climate change policy but the country still faces difficulties due to **limited understanding of the impacts** of climate change at various institutional levels, **limited information and resource availability**, a **lack of coordination** between public and private entities, and **insufficient financial support** to ensure concrete implementation.

Production systems to consider

The potential production systems to be considered by NURTURE were identified using a **scorecard tool**, which enabled to rank and prioritise the potential value chains. The evaluation criteria used include production characteristics criteria (e.g.: production volumes, yield, etc.), climate vulnerability criteria (e.g.: environmental impacts, resilience to climate change, etc.), and market system characteristics criteria (e.g.: price stability, growth opportunity, etc.). The scoring methodology was applied and resulted in a final ranking of climate-resilient systems to consider: 1) vegetable, 2) rice, 3) cassava, 4) maize, 5) poultry, 6) cashew, 7) soybean, 8) mango, 9) longan and 10) sesame.

Existing agricultural practices

For each selected crop, a review of the current practices was carried out. Several characteristics were considered such as the number of cycles per year, varieties, potential diversification, use of machinery, irrigation systems, crop calendar, climate-resilient practices in use, etc. The table below provides an overview of the cropping systems for each crop considered.

Table 2. Overview of the crops and cropping systems

RICE	- Smallholder farmers are mainly growing wet season rice as a monoculture. - Dependence on rainfed agriculture and poor water control. - Use of traditional varieties (farm saved seeds), but improved varieties represent the largest part of traded rice production. - Use of short and medium varieties, as a response to shorter rainy season. - Production predominantly manual, with little to no machinery used (mostly hand tractor, diesel water pumps, combine harvesters by service providers).
CASSAVA	- Cassava causes severe soil erosion; it is mainly cultivated as a monoculture. - Good resilience to droughts. Cassava can survive in extreme conditions, requires low production costs. - Climate resilient practices observed: mostly cover crop, crop rotation and zero/minimum tillage.
MAIZE	- Cultivated in monoculture. - Maize production in upland areas is mainly done in rainfed system, not under irrigation. - Intensive use of pesticides, herbicides, and fertilizer leading to water pollution, soil contamination. - Potential for 2 harvests per year if irrigation is available and short duration hybrids are used (95 days) - In some areas maize is grown in rotation or intercropped with beans or other upland crops.
MANGO	- 2 harvests per year with the variety Keo Romeat. - Usually not irrigated. - Excessive use of chemical products. - Quite resistant to drought, but additional irrigation prevents crop damage and increases yields.
VEGETABLE	- Vegetables can be harvested all year. - High sensitivity to pests and diseases. - Dependence on water; water saving solutions already used in some areas (e.g.: drip irrigation). - High potential for diversification and adoption of agro-ecological practices.
SOYBEAN	- Rainfed crop. 1 harvest per year, possibility of 2 with irrigation. - Good for crop rotation thanks to nitrogen fixation.
SESAME	- Cultivated from March to June, high capacity to resist droughts. - Farmers practice crop rotation, rotating cassava with sesame or maize. - Sesame is grown without irrigation and requires a low amount of fertilizer.
CASHEW	- Cashew trees come to full production capacity in 5-7 years. - Use of high yielding varieties. - Crop usually associated with cassava during the first 3 years of cultivation. - Usually not irrigated.
LONGAN	- Sensitive to environmental conditions, irregular yields from year to year. - Irrigation systems are needed. - According to the Pailin Longan Association (PLA), the harvest typically occurs from August to end-December, peaking in November.

- | | |
|--|--|
| | <ul style="list-style-type: none"> - Seeding trees take up to 6 years to bear fruit. - Use of Potassium chlorate to induce the flowering, for off-season production. |
|--|--|

Impacts of climate change on productivity

The effect of increasing periods of drought and flood have already been observed for several years on annual crops. A complicating factor is the effect of La Nina and its counterpart El Nino, creating temporal climate effects. The effects of climate change and impacts vary across the different agricultural value chains, resulting in important **loss of yields**. For example, upland crops like maize and soybean could be seriously impacted by prolonged drought period, flooding, or higher temperatures. In addition, higher temperatures and increasing rainfall could also change not only the **spectrum of pests and diseases** but also the **intensity**. Higher temperatures may also **affect flowering** (for instance maize has an upper limit of 30 degree Celsius) and **pollination** in both self-pollinated and cross-pollinated crops.

Public and private sector involvement

The involvement of stakeholders from the private and public sectors to provide services that contribute to the adoption of climate resilient practices has been assessed.

In the **private sector**: there are very few product or service providers offering climate-smart solutions. Their **scale of operations is limited** and the main focus is on rice. Equipment and services **costs are higher** than conventional practices and the **level of awareness** is relatively low, which requires time to demonstrate the effectiveness and generate interest among farmers. In the **public sector**: existing systems to support the uptake of climate resilient practices are mainly provided through the extension service system in place, which remains inadequate. Ongoing initiatives dedicated to support the transition toward sustainable agriculture are often **project-based** and supported by **development partners**, this includes the establishment of CASIC, a national mechanism under MAFF, promoting conservation agriculture practices through knowledge management, coordination, promotion, and research. The MetKasekor model is an innovative extension service system currently piloted, which focuses on sustainable agriculture with involvement of public institutions, private sector, agricultural cooperatives, and farmers.

Existing digital tools

Digital solutions and tools that could be used to support climate resilient adoption among farmers were assessed, by characterising the service providers, profiles of farmers targeted, operation and processes, services' accessibility, etc. Among the range of digital tools, information services, data-driven agriculture services, and financial services were considered. The remaining constraints inhibiting the wider digitalisation in the sector and limiting adoption of these tools were identified, as follows.

- **Limited knowledge and capacity** were mentioned as being key factors limiting the use of digital tool: from the service providers, who face challenges to update online platforms with quality information, to promote apps or digital tools among farmers, or who have to cover expensive operational costs to run the digital services; and from farmers, who are often not aware of the potential benefits of digital services, who do not have the digital capacity to use their smartphone, or the necessary knowledge to interpret or use the information or service.
- Various initiatives have been implemented in recent years, but these efforts were mostly **small-scale, project-based**, and were **not connected to each other**. There is no unified platform developed for digital agriculture technologies that can be used jointly by the government, farmers, private sector actors and development partners.
- Besides, another key challenge highlighted was the **underdeveloped internet infrastructure** in rural areas. Even if phone and internet coverage has reached a wide segment of the rural

population, internet is mainly used for entertainment. The slow internet speed is a challenge discouraging farmers from using e-commerce and digital payment services.

- Finally, the **lack of meteorology infrastructure, accurate and accessible data** across the entire country was also identified as a key constraint, especially to predict outcomes and to develop legitimate commercial index-based crop insurance schemes.

Recommendations and opportunities for the project

To enhance the capacity of the Cambodian agroecosystems to cope with climate change, there are a lot of existing **adaptation and mitigation measures** in the agricultural practices that could be implemented within the Nurture project. These adaptations can be, for example, linked to the choice of the seed variety, irrigation technologies, the use of cover crops, crop rotations, the promotion of diversification or by shifting the planting dates.

Dissemination of climate resilient practices is slow, and the **transition process** requires changes at different levels. Thus, the project should support different aspects:

- **Supporting access to finance**, for example testing digital loan mechanisms by collaborating with Microfinance Institution (MFI) and a digital service provider; or piloting index-based insurance scheme.
- **Facilitating access to markets**, by identifying niche market opportunities (organic cashew for instance) and by supporting the establishment of linkages between existing buyers and producers, through ACs or other aggregators to better respond to market opportunities and obtain a more equitable price.
- **Supporting and reinforcing extension services**, for example through business development activities, to strengthen AC to develop their markets through activities such as contract farming, drying, certification, etc.; or by developing and implementing digital literacy trainings among ACs, service term providers or individual farmers.

Farming activities are being affected by **increased frequency and severity of climate events**, manifested in yield loss or crop failure, that are becoming more and more common, especially for smallholder farmers. Facilitating their adaptation to climate change will require a **combination of technical, research, market, and policy solutions** to address the main barriers. This will include the **creation of incentives, credits, and other financing mechanisms** to support adaptation efforts, the **development of research** to identify the most effective adaptation options, the **strengthening of extension services** to provide technical support to farmers on how to enhance their resilience to climate change, and the **support of private sector actors** to facilitate the availability of adapted products and services.

A Introduction

A.1 Context

Over the past two decades, Cambodia has enjoyed a rapid economic growth, and the agricultural sector has contributed to this trend, accounting for 22% of the GDP in 2020. From the social-economic point of view, agriculture also remains an important sector which employs more than 3 million people in the country and has significantly contributed to the Kingdom's good performances in poverty alleviation.

Nonetheless, there are risks and fragilities in the current trends of Cambodian agricultural sector that need urgently to be taken into consideration. Cambodia is considered as one of the most vulnerable countries to climate change impacts¹. There is already emerging evidence that agriculture and overall food security are being affected by increased frequency and severity of climate events, manifested in yield loss or crop failure that are becoming more and more common. As such, attention will be needed not only on the productivity and economic growth of the sector, but also on its resilience to climate change and the mitigation of its contribution to climate change, to ensure sustainability of the Cambodian agricultural systems.

As a response to these challenges, the Nurturing Climate Resilience (Nurture) project funded by the Swiss Agency for Development and Cooperation (SDC), implemented by HEKS/EPER and Caritas Switzerland, aims to improve the resilience of smallholder farmers and vulnerable groups, who mainly depend on climate-sensitive value chains, to the impacts of extreme flood, drought, and increased temperature events on their activities. As such, the project's specific objectives are to, on the one hand, increase yields and incomes of smallholder farmers through improved water management practices and better access for irrigation and on the other hand, to disseminate more sustainable and efficient agro-ecological practices, minimising the impacts of floods, droughts and higher temperatures and leading to an increase of the farmers' climate resilience.

A.2 Objectives of the assessment

To ensure the sustainable and inclusive growth of the agriculture sector in Cambodia, the Nurture project seeks to improve access to knowledge, the availability of services and of technologies, and services' governance that will contribute to the enhancement of climate change resilience of smallholder farmers. The lack or inadequate access to climate resilient technologies and to knowledge, especially around suitable and adapted practices, has been broadly identified as a factor limiting the sustainability of the agricultural systems.

The main objective of this study is to characterise potential climate-resilient value chains, with an additional focus on the identification of existing digital tools and resources supporting this effort. This assessment will serve the Nurture Project team to prioritise the interventions and to finalise the full project proposal, benefiting from a sufficiently documented baseline to start its implementation.

The specific objectives of the study are to:

- Characterise the most potential climate-resilient value chains in the targeted provinces (Battambang, Banteay Meanchey, Oddar Meanchey, Preah Vihear); the related market systems; the main constraints and opportunities; the social economic and environmental situations, including gender differences.

¹ Cambodia is ranked 140th out of 181 countries in the 2020 ND-GAIN Index (World Bank group, 2021))

- Characterise the farming practices for the selected value chains; the farmers' profiles; the main impacts from climate events; the farmers' knowledge and perception of climate-smart practices; their willingness to change, etc.
- Map and assess the main stakeholders involved in the value chains, including within the private and public sector; their willingness or level of engagement to commit in climate-resilient agricultural systems; existing climate-resilient initiatives, etc.
- Identify products and services, in particular digital tools that exists to disseminate climate-resilient knowledge and information; their effectiveness and efficiency; the remaining gender gaps in terms of usage.
- Facilitate the development of practical recommendations to guide the Nurture Project Team in designing the approach to support improvement of smallholder farmers' climate resilience.

A.3 Methodology

The data collection approach for this assessment combined both qualitative and quantitative methods, to best be able to achieve these objectives. For all the analyses needed, the consultant used a combination of desk review and field data collection.

Relevant stakeholders were identified at national and local level. The list of stakeholders met at national level is provided in Annex 1. *List of key sector stakeholders interviewed*. The research tools and set of interview guides were finalised and included semi-structured interviews with the key informants identified, but also surveys of farmers, their organisations, and specific women farmers groups for the value chains considered (cf. Annex 16. *Interview guides*).

The field visit and data collection phase were conducted in a single week (instead of the planned two, due to ongoing local elections, related travel limitations and availability of local authorities), with four teams of data collectors. It was a combination of:

- Semi-structured interviews with the key stakeholders identified above, at national and provincial level (national and local authorities, development partners, other stakeholders involved in the value chains...)
- Focus group discussions (FGD) and observations with the selected target groups (smallholder farmers - men and women - and their organisations). The target groups were identified based on their production systems.

A total of 20 focus groups were conducted, involving 8 participants for each session in average (FGD sessions with farmer representatives involved in the main production systems identified and per province; and FGD sessions specifically with smallholder women farmers). As such, 5 FGD sessions were conducted per targeted province, as well as additional semi-structure interviews with key informants located at provincial level (interviews with official representatives, private sector stakeholder, etc.). The list of stakeholders met during the field survey is also provided, in Annex 2.

B Identification of potential climate-resilient value chains

B.1 Mapping of vulnerable areas in the 4 targeted provinces

To map the vulnerable areas in the targeted provinces and selected districts, the following criteria were considered:

- Climate vulnerability, by identifying the occurrence of floods and droughts, and their level of impacts on the different production systems in the previous years.

- Poverty and dependence on farming, by looking at the poverty rate and number of poor households registered in the targeted areas.
- NGOs that are active in the districts, to highlight underserved areas and districts where development partners could be a potential catalyst to reinforce or support the activities.
- Existing irrigation infrastructures, to highlight potential water access constraints.
- Existing and active agricultural cooperatives or water user groups in the targeted districts, identifying the main services that are provided to farmers, and appraising the level of support currently received by the households.

The key information for each province is summarised in the following table, and further description is provided in the next sub-sections.

Table 3: Key information summarised for the 4 targeted provinces.

	BATTAMBANG	PREAH VIHEAR	BANTEAY MEANCHEY	ODDAR MEANCHEY
DISTRICTS SELECTED	Koas Krala and Rukh kiri	Rovieng and Choam Ksant districts	Preah Netr Preah and Monkol Borey	Banteay Ampil and Anlong Veng
CLIMATE VULNERABILITY	Highly vulnerable communes: 22% to flood, 18% to drought.	Highly vulnerable communes: 35% to flood, 63% to drought. Ranked top 1 most vulnerable province to drought.	Highly vulnerable communes: 52% to flood, 25% to drought. Ranked top 5 most vulnerable province to flood and drought.	Highly vulnerable communes: 75% to flood, 50% to drought. Ranked top 3 most vulnerable province to flood, and top 4 to drought.
POVERTY RATE	Average poverty rate 24% (43% in Koas Krala and 25% in Rukh kiri)	Average poverty rate is 19% (17% in Rovieng and 19% in Choam Ksant)	Average poverty rate is 12% (14% in Preah Netr Preah, 12% in Monkol Borey)	Average poverty rate is 13% (12% in Banteay Ampil, 14% in Anlong Veng)
ACTIVE NGOS, DEVELOPMENT PARTNERS	Active projects: ASPIRE, AIMS, WAT4CAM, MetKasekor, Harvest II, CAST, C-SAIN	Active projects: ASPIRE, CHAIN, WAT4CAM	Active projects: ASPIRE, C-Smart	Active projects: ASPIRE, C-Smart, CHAIN, C-SAIN
IRRIGATION INFRASTRUCTURES	5 irrigation systems in each district selected	42 systems in Rovieng and 39 in Choam Ksant	5 systems in Preah Netr Preah, and 3 in Monkol Borey.	40 systems in total, still inadequate.
AC AND FWUC	In total 7 FWUCs, 9 ACs in the 2 districts, plus ASPIRE clusters	In total 6 FWUCs, 15 ACs, plus ASPIRE clusters	In total 6 FWUCs, 7 ACs active and functional, plus ASPIRE clusters	In total 1 FWUC, 15 ACs, plus ASPIRE clusters

B.1.1 Battambang

Known as the rice granary of Cambodia, the province has an economy strongly focused on agriculture and more particularly on rice cultivation. Battambang province represents more than

120,000 ha of agriculture holding land, with an average size of land of 3.1 ha, and 57% of the farmers having a semi-large agricultural exploitation from 1 to 4ha (National Institute of Statistics, 2019). The average poverty rate in the province is 23.8%². Main crops cultivated are rice, with 133,000 ha planted and 302,000 tons produced, maize, which represent 61% of the total maize cultivated area in Cambodia with 60,000 ha planted and 185,000 tons produced, and cassava with 55,000 ha planted and 665 000 tons harvested which represented 1/3 of national production in 2019 (National Institute of Statistics, 2019).

The districts targeted are: **Koas Krala** and **Rukh kiri** (cf. Figure 1 below). Common difficulties mentioned by the farmers met in those districts are the road and water access, without any water saving solution in use. These districts were chosen because of their vulnerability to climate disasters. Indeed, regular droughts were reported in Kroas Krala and Rukh Kiri districts, together with floods. Poverty rates are relatively high, with 43% in Kroas Krala and 25% in Rukh Kiri (PDAFF, 2022). In addition, several development programs are being implemented in these areas, such as ASPIRE, AIMS, CAST, WAT4CAM, MetKasekor C-SAIN, but also HARVEST II projects, which confirms that these are strategic locations. The existing irrigation infrastructures, Farmers Water User Groups (FWUC), Agricultural Cooperatives (AC) and producer's groups confirm the potential of these areas to drive initiatives that will increase resilience to climate change.

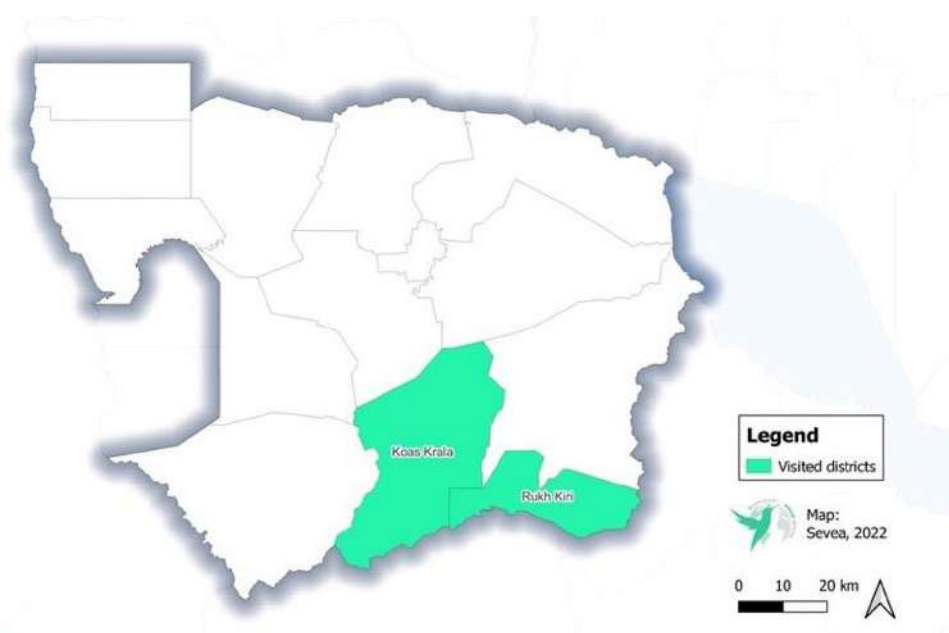


Figure 1: Districts targeted in Battambang province

Battambang province is significantly affected by climate disasters: 1,400 persons were affected by flash floods in 2019 (National Institute of Statistics, 2019), with 21,6% of the communes characterised as being “highly vulnerable communes”, and 33,3% being “quite vulnerable communes” to floods (NCSD, 2019). Droughts are also causing a lot of damages in this province: around 104,700 ha of rice were affected by droughts in 2019 (National Institute of Statistics, 2019),

² The national poverty line in Cambodia is now riel 10,951 or is equivalent to US\$2.7 (market exchange rate) per person per day (World Bank, 2022).

which represent 27% of the total rice production in the province. As such, 17.6% of the communes are defined as being “highly vulnerable communes”, and 30.4% being “quite vulnerable communes” to droughts (NCSD, 2019).

B.1.2 Preah Vihear

Preah Vihear is a plateau and mountainous region, with 29,190 ha of agriculture holding land, and an average size of land of 2.7 ha. There are 68% of the farms in the region that are defined as semi-large (from 1 to 4ha), and 22% of the agricultural production is for home consumption (National Institute of Statistics, 2019). Agriculture is important in this province as 85% of its economy is based on farming. The main crops cultivated are rice (35,000 ha and 53,000 tonnes produced), cassava (17,000 ha and 119,000 tonnes), soybean (3,100 ha and 2,600 tonnes), cashew (22,000 ha and 4,100 tonnes), and vegetables. The average of poverty rate in the province is 19,4%.

The selected districts are **Rovieng** and **Choam Ksant** districts, as being considerably vulnerable to climate disasters (cf. Figure 2). The poverty rates are reaching 22% in Rovieng, and 19% in Choam Ksant. Besides, there have been several supporting projects implemented, such as ASPIRE and CHAIN programs, but also efforts to support the farming communities through the rehabilitation of irrigation infrastructures (WAT4CAM project), establishment of FWUCs or ACs. In addition, 2 Forestry Communities (FC) were formed in Rovieng district. However, FGD revealed that key production challenges remain, especially access to water, high production costs, poor seeds quality, high post-harvest losses, soil erosion and fertility depletion.

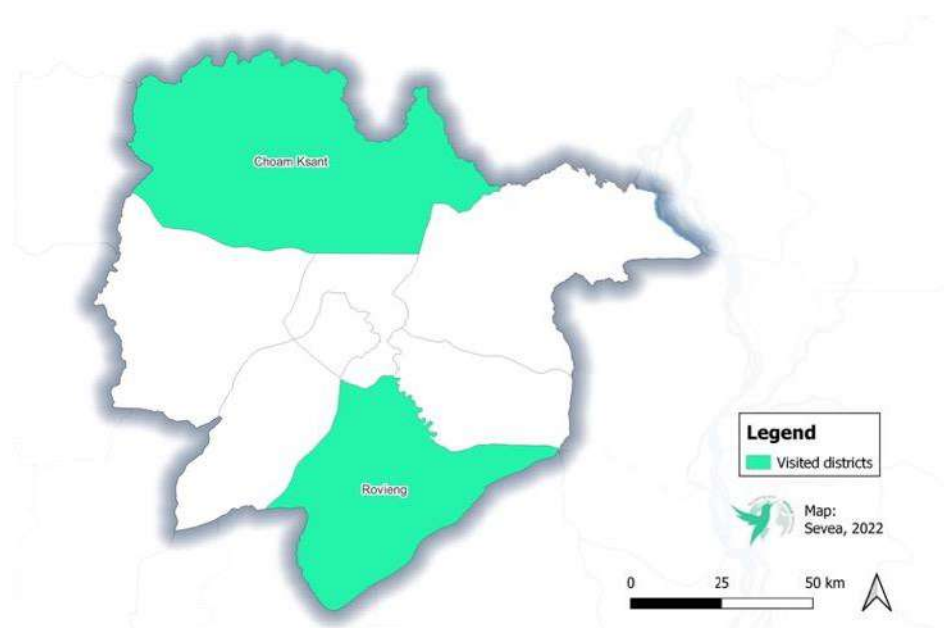


Figure 2: Districts targeted in Preah Vihear province

Preah Vihear province is also impacted by extreme climate events. Indeed, around 5,500 households were affected by flash floods in 2019 (National Institute of Statistics, 2019), with 35.3% of the communes characterised as being highly vulnerable, and 41.2% as quite vulnerable (NCSD, 2019). However, drought is the most important challenge in Preah Vihear: the province was ranked top 1 most vulnerable to drought in 2019, with 62.7% of the communes being highly vulnerable, and 19,6% quite vulnerable (NCSD, 2019).

B.1.3 Banteay Meanchey

Banteay Meanchey is a province located in the north-west of the country, next to the border of Thailand. It is a key crossing point between Thailand and Cambodia via Poipet. The province is mostly covered by extensive lowlands, with 75,500 ha of agriculture holding land, an average land size of 3 ha, and 59% of the farms being semi-large exploitations from 1 to 4ha (National Institute of Statistics, 2019). The poverty rate is estimated at 11.6%, and 49,3% of agricultural holdings reported that destination of agricultural production is for home consumption (National Institute of Statistics, 2019). The main crops cultivated in Banteay Meanchey are rice (132,700 ha and 238,600 tonnes), cassava (42,800 ha and 778,000 tonnes), corn (6,600 ha and 39,000 tonnes), and vegetables (ranked top 5 province in Cambodia) (National Institute of Statistics, 2019).

The selected districts are **Preah Netr Preah** and **Monkol Borey** (cf. Figure 3). The poverty rate in Preah Netr Preah is estimated at 14%, and there are 3 active ACs identified in this district. In Monkol Borey, there are 4 ACs, and the poverty rate reaches 12%.

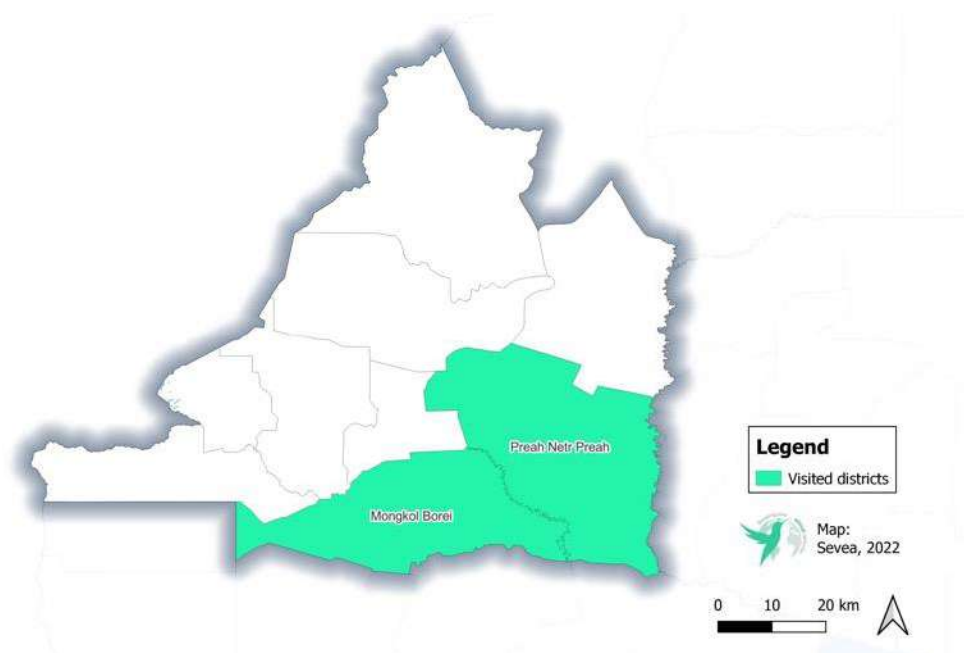


Figure 3: Districts targeted in Banteay Meanchey province

Concerning the climate vulnerability, Banteay Meanchey is the 2nd most vulnerable province in Cambodia to storms, with 7.7% of its communes defined as “highly vulnerable”, and 43.1% as “quite vulnerable” (NCSD, 2019). On top of that, around 67,680 ha of rice were affected by droughts in 2019 (National Institute of Statistics, 2019), the province was ranked top 5 of the most vulnerable province to droughts in 2019, with 24.6% of the communes defined as “highly vulnerable”, and 32.3% as “quite vulnerable”. Similarly, the province is the 5th most vulnerable to floods, with more than 2,000 households affected by flash floods in 2019 (National Institute of Statistics, 2019), 52.3% of its communes being “highly vulnerable”, and 23.1% being “quite vulnerable”. All the farmers met during the survey were concerned, and expressed serious need of support, especially with water technology solutions.

B.1.4 Oddar Meanchey

Oddar Meanchey is located in the North-West of Cambodia and has an active international trade due to its location close to Thailand. The province represents 30,100 ha of agriculture holding land, with an average land size of 5 ha. Semi-large exploitations from 1 to 4 ha represents 59% of the farms, and 30.6% of agricultural holdings reported that destination of agricultural production is for home consumption (National Institute of Statistics, 2019). The poverty rate in the province is estimated at 13.3%. The main crops cultivated are rice (54,200 ha and 45,800 tonnes produced), cassava (40,600 ha and 532,300 tonnes), and vegetables.

The selected districts are **Banteay Ampil** and **Anlong Veng** (see Figure 4). There are existing irrigation infrastructures in both districts, 28 in Banteay Ampil and 12 in Anlong Veng, which seems insufficient as most of the farmers met during the field survey mentioned that access to water is one of their main constraints. Only one FWUC is officially registered in Banteay Ampil district, as well as 8 active ACs in Anlong Veng, and 7 in Banteay Ampil. Concerning the poverty rate, it is estimated at 12.3% in Banteay Ampil and at 14.1% in Anlong Veng.

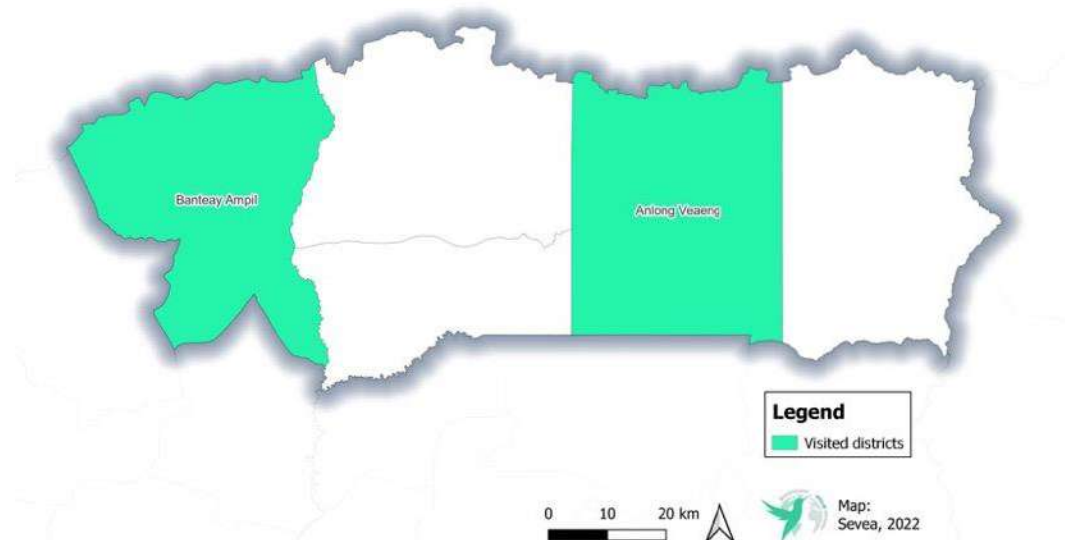


Figure 4: Districts targeted in Oddar Meanchey province

Oddar Meanchey is also highly vulnerable to climate disasters. There are 29.2% of the communes recognised as being “quite vulnerable” to storms. Oddar Meanchey is the 4th most vulnerable province to droughts, with 50% of communes defined as “highly vulnerable”, and 25% as “quite vulnerable”. Moreover, Oddar Meanchey is the 3rd most vulnerable province to floods, with 75% of communes registered as “highly vulnerable”, and 16.7% as “quite vulnerable” (NCSD, 2019).

B.2 Characterisation of the production and market systems

The section below provides an overview of the organisation of each potential value chain, together with key information on the market organisation and related systems. A table summarising the production level per province is available in *Annex 3. Summary of production estimates in the 4 targeted provinces*, together with a table summarizing the production and market information collected at district level in *Annex 4. Summary of information collected at district level through FGDs*

Rice

- **Relevance:** rice is the main agricultural product of the country, traditionally cultivated for subsistence purpose, the margin generated by paddy production is generally quite low. The government is committed to promote the production and export of paddy, as it is shown by the multiple agreements with peer countries. Government policies and actions focus on mechanization, access to agricultural inputs, diversification of crops, irrigation sector improvement and horizontal linkage between farmers.
- **Market organisation:** main actors are input suppliers, producers, collectors, millers, and traders (cf. *Annex 5. Rice production and market systems*).
- **Constraints / Opportunities:** the value chain suffers from a weak linkage between its different actors, but efforts are gradually being made to build strong and value-creating relationships. The organization of farmers into associations or cooperatives allows to facilitate the access to market and inputs; and the creation of FWUC to efficiently manage the water resources. The production under contract farming can also offer great opportunities to farmers, to overcome their lack of influence on the selling prices.

Cassava

- **Relevance:** cassava is the second largest crop produced in Cambodia and is a vital cash crop securing jobs and livelihoods for thousands of Cambodian households.
- **Market organisation:** the Cambodian cassava industry is completely dependent on the border markets of Thailand and Vietnam which act as cassava trade-brokers between Cambodian and international and Chinese markets. The international markets, therefore, influence cassava demand, and locally the marketing is done almost exclusively through traders. An overview of the stakeholders and the market organisation is provided in *Annex 6. Cassava production and market systems*.
- **Constraints / Opportunities:** farmers have no influence on the selling prices. An additional challenge for the farmers is that cassava requires considerable post-harvest effort because the roots are highly perishables and must be processed into a storable form soon after harvest. Contract farming can provide a good market opportunity for smallholder farmers, but such schemes are inexistent in the targeted provinces.

Maize

- **Relevance:** maize is also a major crop produced in Cambodia, especially in Battambang where maize cultivated area represents more than 60% of the total maize cultivated area.
- **Market organisation:** three categories of maize are grown in Cambodia, these are white maize and sweet corn for human consumption (10%), and red maize mainly for animals or livestock (90%). Estimates show that maize was cultivated on 178,100 ha in 2020/2021 with a total production of over 1.2M tons. Exports of maize used for livestock feed have declined sharply over the last few years, while production and domestic demand for animal feed have risen. Export remains mainly informal, with maize products being sold directly to collectors and then transported to Vietnam for about 80%, and about 20% going to local factories (the maize production and market system is available in *Annex 7. Maize production and market systems*).
- **Constraints / Opportunities:** the price fluctuation depends largely on the neighbouring countries that set the price and buy most of the production. A large amount of animal feeds must be imported to meet the domestic demand. In 2020, the country imported 208,000 tons of feeds (mainly from Vietnam and Thailand). Out of the 21 animal feed manufacturing factories existing, 17 mills are operational. The country only processes half of its capacity, 1.13M tons of feed per year instead of 2.17M tons. Thus, actual feed production is only 52.2% of total capacity.

Sugarcane:

- **Relevance:** sugarcane normally requires irrigation, so the growing area is limited to areas where irrigation systems are available or can be developed. Sugarcane is grown in Oddar Meanchey and Preah Vihear provinces, and is mostly grown in plantations, rather than in small-scale farms (ODC, 2021).
- **Market organisation:** from 2005 to 2013, Cambodia experienced the largest expansion in sugarcane area harvested worldwide, with a 376% increase, due to the potential of sugarcane to be used as bioethanol (Mckay et al., 2015). In 2013, large-scale sugar production in Cambodia resulted in the potential for bioethanol production as well as increased foreign investment in bioethanol plants. According to the Ministry of Industry and Handicraft, approximately 100,000 ha of sugarcane plantations with a planned capacity of 1.8 million tonnes of refined sugar have been remarked in 2017 (ODC, 2021). Thus, it is mostly the private sector controlling the sugarcane production in the country and reaping the benefits.
- **Constraints / Opportunities:** sugarcane has resulted in major human rights issues, the production is often associated with forced evictions of smallholder farmers by (foreign) companies. A major dislocation of rural livelihoods seems to be already underway in Cambodia because of sugarcane concessions (Mckay et al., 2015). Another concern is around the high water requirement of sugarcane, which might ultimately make the crop poorly performant in terms of addressing climate change concerns.

Vegetable

- **Relevance:** the vegetable sector is crucial for food security, nutrition, diversification of the agricultural activities and economic development (CPSA, 2020). Vegetable production³ represents a small percentage of the cultivated area, but home gardening is widespread among rural households for subsistence purpose, and women are the primary producers and marketers of vegetables.
- **Market organisation:** the sector is dominated by smallholder farmers, vegetable farms are mostly of small size, producers are often organized in clusters (with farmers in a same area producing similar vegetables), and vegetables are mainly sold to collectors. An illustration of the value chain is provided in *Annex 8. Vegetable production and market systems*. Despite environmental conditions suitable for the production and the high value of the vegetables, the production in Cambodia is rather limited and a large quantity of fresh vegetables are still imported from Vietnam.
- **Constraints / Opportunities:** vegetable production tends to be labour intensive, costly to operate and vulnerable to diseases and climate events. The small size of the production and the irregularity of the supply (both in terms of quality and quantity) are major constraints to establish sustainable contracts for selling and explain the dependence on import. The main opportunities for the sector development are to expand the production seasons, to focus on perishable and high value crops and to adopt GAP and other certified practices. Smallholder farmers face other general challenges such as a lack of market

³ A wide variety of vegetables is cultivated across the country, including leafy, stem and fruit-bearing vegetables, root, bulb and tuberous vegetables, leguminous green vegetables, etc. (CIAS, 2019). Fruit bearing vegetables covered by the CIAS includes chili, cucumber, eggplant, ivy gourd, pumpkin, small bell, snake gourd, and squash/winter squash. Cucumber was grown on approximately 21,000 households in Cambodia with area planted estimated at 2,289 hectares. The total production for cucumbers was 23,348 tons. Pumpkin was grown by 22,000 households with area planted estimated at 4,544 hectares.

information (demand, price) and access to market, limited technical knowledge to increase productivity, limited access to affordable and quality inputs, among others.

Soybean

- **Relevance:** soybean is still a minor crop although the area planted in Cambodia has risen steadily over the past decade. One of the main production areas is the province of Preah Vihear, and soybean production also increased in Battambang. In the past, farmers grew soybean mainly for subsistence, on a small scale, and as supplementary crop for livelihood. However, soybean has now become one of the main cash crops. Average yields of 1.5 MT/ha are still low compared to a potential yield of 3.4 MT/ha as demonstrated by trials done by ACIAR.
- **Market organization:** soybean is either sold to animal feed factories, used in human consumption, or used as protein source for fish feed production (USDA CAST programme). Farmers mostly sell soybeans to collectors and small traders, who in turn sell to large traders (normally known as silo operators), who then forward the produce to Thai or Vietnamese traders. (GrowAsia, 2015). An illustration of the value chain is provided in *Annex 9. Soybean production and market systems*.
- **Constraints / Opportunities:** soybean price is relatively low during the harvesting time because the price in rural areas is determined by traders, and because the local production is considered to be of poor quality. The price of soybean is lower compared to other crops, which is a disincentive for farmers to increase soybean production, even more because their access to markets is limited, but it might change due to large demand from other countries that could influence it.

Sesame:

- **Relevance:** sesame is convenient in the Cambodian context, where problems of access to irrigation are widespread. Sesame is a drought-tolerant crop that requires less water than more traditional crops. Besides, it has low fertilizer requirement, which represents an advantage in terms of farmers' incomes (Myint et al., 2020). Currently, it is predominantly grown in Battambang and Kampong Cham provinces.
- **Market organisation:** The value chain is not very developed, and extremely limited information is available on the different value chain actors and their interactions. However, the global sesame market demand is rising and there is high competition in the market among producing countries for an international trade (Myint et al., 2020).
- **Constraints / Opportunities:** even if domestic market is growing in terms of demand, and markets such as Vietnam, Japan, Thailand and China seem promising for exports, profit from sesame farming changes drastically from year to year depending upon the weather. It has been reported how some farmers might earn a lot, others close to nothing. Planting sesame is risky, and Cambodian farmers have highlighted how the crop is highly susceptible to diseases, insects, and wet weather, and is very laborious to harvest. To date, even if sesame could be used to develop different products, possibly generate additional incomes through export, and even more importantly would help increase climate resilience (e.g.: highly resistant to drought), remaining constraints hamper the cultivation of the crop (Touch et al., 2016; Myint et al., 2020).

Pepper:

- **Relevance:** the national planted area for black pepper was estimated at 9,219 ha in 2019, and the quantity produced at 22,926 tonnes (National Institute of Statistics, 2019). The production reported in the 4 targeted provinces is marginal, with a low number of

households choosing to plant pepper. In addition, the government is focusing on programs working on producing high value pepper varieties (e.g.: Harvest 2).

- **Market organisation:** Vietnam and Thailand together absorb about 95% of pepper from Cambodia, with only a small amount of direct export from Cambodia to consumer countries.
- **Constraints / Opportunities:** insect pests and diseases are the major production constraints. The initial investment is high, USD 30,000/ha.

Mango

- **Relevance:** mangoes are traditional Cambodian fruit crops grown countrywide, well adapted to the country's climate and soil. The total national production is around 1,750,000 tons (2020) and average yield is 15,5 tons per hectare (Vireak, 2021).
- **Market organization:** the domestic consumption is estimated at 15%. The role of the contractors is important in the value chain, as they are involved in the management of different production steps, as well as in the collection and trading. Most of the production is marketed by informal channels, the majority being transported to Vietnam. However, an increasing part of the production is now exported formally to China, as a MoU was signed to import a maximum of 500,000 tons of mangoes per year from Cambodia. An overview of the value chain is provided in *Annex 10. Mango production and market systems*. There are few companies processing and exporting mango, such as Misota Food Cambodia, which is one of the few fruit processing companies based in Battambang.
- **Constraints / Opportunities:** the margin generated by mango production is generally low, except for commercial farmers with high technical skills, and the sector faces high price fluctuations due to overproduction during the harvest season.

Cashew

- **Relevance:** the area planted was estimated at 289,800 ha in 2019. Cashews are mainly produced in small plantations of 2-5 ha.
- **Market organisation:** there are very few processing factories in Cambodia, almost all the productions are exported as a raw product to be processed in Vietnam factories. Most of the value added is therefore captured in other countries. The only cashew processor is Santana Agro in Preah Vihear. Santana produces cashew on 4,000 ha and buys additional cashew from local farmers. The main stakeholders of this value chain and their interactions are presented in *Annex 11. Cashew production and market systems*.
- **Constraints / Opportunities:** the sector is poorly organized, with a long and inefficient value chain with a lot of different collectors.

Longan

- **Relevance:** the total production in Cambodia is around 25,000 tons/year, with recent increase expected up to 50,000 tons/year.
- **Market organisation:** Thailand is the main market for Cambodian longan, which is done through informal channels. The share of export and domestic consumption is not known. For the export market, the collectors employ labour to harvest and grade the longan at the farms. Longans are then transported directly to processing factories in Thailand. The supply chain for the local market is much simpler: longans are harvested, collected by collectors, and then sold at wholesale markets within 24 hours. There is no large processing factory for longan in Cambodia, but the processing is being developed locally, for example with Navita Food in Battambang, testing syrup longan and dried longan, or Malai AC in Banteay Meanchey, producing syrup longan and wine longan. An agreement

is currently under discussion with MAFF, to enable official export of longan from Cambodia to China, which represents an interesting growth opportunity.

- **Constraints / Opportunities:** Transport must be done within 24h, as longan can spoil very easily, and there is no cleaning and packaging done in Cambodia. In general, there is market price fluctuation in the domestic market (1,500-6,000 KHR/kg), but not for export since the price is fixed in the buyer contract (3,000 – 4,000 KHR/kg). Farmers thus prefer to send to collectors for export when possible.

Rubber

- **Relevance:** in 2020, more than 400,000 ha were officially planted with rubber, 40% of which are smallholdings⁴. Most of them were planted from 2001 to 2015 (157,000 ha) due to the combined support of AFD and World Bank projects but also to the increase of rubber prices from 2008 to 2013. Most of the rubber smallholdings are found in 6 provinces, which are not the project target provinces. As part of the FGD conducted, only one farmer confirmed that he tried rubber, but has since given up.
- **Market information:** the farm gate price of rubber is closely related to world prices. Most forecasts (including World Bank forecast) suggest a world price increase by about 13% from now to 2030, as demand for natural rubber is expected to exceed the supply in the foreseeable future.
- **Constraints / Opportunities:** Oddar Meanchey, Banteay Meanchey, Preah Vihear and Battambang are characterized by a long dry season and an annual rainfall of 1200 mm or less, which is not optimal to rubber cultivation. In addition, expected changes in climate patterns in these areas could result in a drastic reduction in latex yield potential as well as a delayed growth, and therefore should not be promoted for rubber planting.

Banana

- **Relevance:** although banana is a ubiquitous crop in all four provinces, most bananas are grown at the homesteads and used for personal consumption. Local bananas are pretty climate change resilient and seem less affected by black Sigatoka disease than the more likely plantation Cavendish banana.
- **Market organisation:** bananas are produced for local consumption, but also for export. Indeed, Cambodia exported a total of 157,800 tons of yellow bananas in 2019 and 147,760 tons in the first six months of 2020. There is a high demand from China to export banana (GIZ, 2020). Concerning the domestic consumption, banana is sold in markets, or supermarkets in cities (CPSA, 2020). Stakeholders involved in the value chain are farmers, workers, and input suppliers for the production process. Collectors, transporters, traders, retailers, etc. are involved for the collection and the trade.
- **Constraints / Opportunities:** the main challenges are at the production level, with a lack of labour with specific skills on banana production, due to the lower daily wage of workers compared to other sectors; and at the postharvest level, with a quality and quantity not sufficient to meet the demand from retailers, a lack of labour, market information and working capital, and loans from financial institutions (FI) with high interest rate. At the collection level, there is a lack of storage facilities, an inconsistent demand from retailers, and standard issues such as packaging, good manufacturing practices, etc. (CPSA, 2020);

Poultry

⁴ Smallholding includes private owned plantations up to 100 ha

- **Relevance:** poultry raising is an integral part of the rural life, and more than the half of Cambodian households are involved in livestock and poultry production (Sun, 2018)^T. Many factors are driving the demand for meat in Cambodia, including the economic growth, the development of urban population and the change in people's eating behaviour. Most poultry in the rural areas are free ranging and there is a very high mortality rate. By moving to a semi-intensive system using low-cost housing and by acquiring fully vaccinated chicks productivity will increase and mortality rates will decline.
- **Market organisation:** as the local production is unable to cope with the domestic demand, live chickens are imported from surrounding countries. The poultry production being oriented toward local consumption, there is almost no export, and its organization is rather simple (the organisation of the poultry value chain is provided in *Annex 12. Poultry production and market systems*). Local breed chick producers sell their chicks all year long, with peaks of production around specific holidays. Native chickens, as opposed to high performing imported chicken varieties, are most likely more resilient to climate change effects. Traditionally backyard chickens are free roaming in Cambodian villages which accounts to high mortality rates and low productivity.
- **Constraints / Opportunities:** there are opportunities to increase the national poultry production to meet the growing demand, especially for local smallholder producers eager to increase their productivity and improve their livelihood. Further development of the semi-intensive production system is a good alternative and empirical evidence shows that the production of 200 broiler chickens in 3-month cycles can be highly profitable for smallholder farmers, and especially women (IFAD, 2021)⁵.

Pig

- **Relevance:** pig production is declining, and the share of smallholder farming production is even more declining, from 79,8% in 2016 to 45,2% in 2020. There is a clear trend towards an intensification of the production and the development of industrial farms.
- **Constraints / Opportunities:** pig farming is perceived as a high-risk business since the last African Swine Fever epidemic, and there are significant constraints limiting the sector's growth such as the low feed availability and costs, leading to inadequate feeding practices in term of quantity and quality, the diseases and low level of knowledge about potential control procedure, the breeds quality, lack of market information, among others.

Aquaculture

- **Relevance:** aquaculture is still at an early stage of development compared to Vietnam and Thailand, but production is on the rise. According to the MAFF, in 2019, aquaculture provided approximately 39% of Cambodia's total fish production. Fish provides around 66% of daily animal protein and 19% of total protein consumption for Cambodians and is thus a critical factor to food security.
- **Market organisation:** 9,190 MT of fresh fish and 4,910 MT of processed fish products were exported from Cambodia in 2019 (FIA, 2019). Aquaculture freshwater fish is mostly produced in ponds (compared to cages) at an estimated 60% of production volume. Smallholders' systems essentially rely on 1 or 2 ponds and follow cycles of 8 to 9 months.

⁵ The IFAD funded AIMS project introduced a system of semi-intensive poultry production in farmer clusters. On the one hand producers were trained to raise 21 days old and fully vaccinated chicks, using solar powered incubators; and on the other hand, farmers that purchase the chicks and produce broilers for sale in 3 months cycles. Farmers are also trained in producing local feed which constitutes 70% of the feed while commercial feed and pre-mix is reduced to 30% of the ration.

The main stakeholders involved in the value chain are producers, hatcheries, nurseries, input suppliers, transporters, wholesalers, retailers, processors, and exporters. The supply chain is poorly organized with a wide network of informal market stakeholders operating across the country and relying for a large part on imports from neighbouring countries. Retailers, processors, and traders currently reap the largest benefits (84%) in terms of profits, with only about 7% of the direct added value going to fish farmers.

- **Constraints / Opportunities:** farmers depend on rainfall to fill their ponds, which represents a significant limitation. In addition, fish farming brings in very limited profits, which is partly due to limited knowledge, low input, and unfavourable selling prices due to competition with cheap imported fish. The promotion of the aquaculture sector is a key government priority with a goal of yearly increase in production of 20%. In addition, there is a focus on promoting value addition and quality of products, including GAP (FIA, 2015).

B.3 Main constraints and opportunities to build climate resilience

This section focuses on the market barriers and opportunities, in light of fostering the uptake of climate resilient practices and building climate resilience.

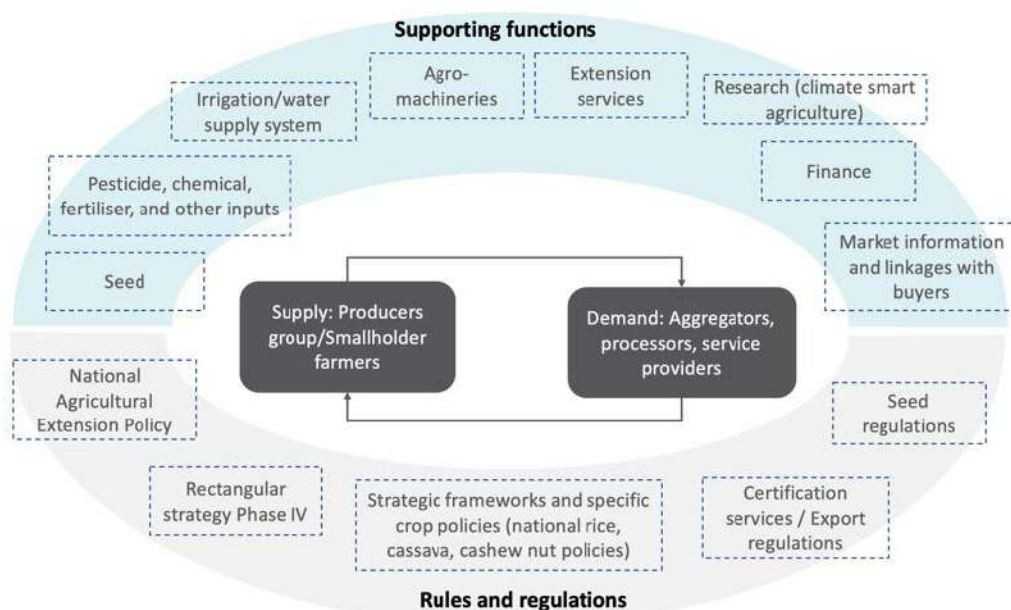


Figure 5: Market systems supporting functions

The specific market systems, as illustrated in the Figure 5 above, that should be leveraged to enable the transition towards regenerative farming practices were considered.

B.3.1 Availability of technical knowledge

Numerous studies show that farmers are generally highly aware of climate changes and associated risks. They are, however, usually less informed around possible strategies and practices that can help them deal with such changes (Sohail et al., 2022), which was confirmed through FGD with farmers.

Awareness

Most of the farmers interviewed are aware that the climate is changing with both more frequent floods and droughts being cited as symptoms, and studies also showed how farmers were aware in changes in rainfall patterns, or of the increased frequency of droughts (Touch et al., 2016). Cambodian farmers could respond effectively to these challenges by introducing appropriate and relevant technologies (e.g.: drip or micro sprinkler irrigation systems, adoption of drought tolerant varieties, etc.). However, there is very little knowledge about possible mitigation strategies, which could be improved through implementation of adapted extension services.

This was illustrated in all the provinces, including in Battambang, where most of the farmers said they notice changes in weather patterns, especially more common heavy rainfall, drought, and insect damage. As most of them depend on rainfed systems, these issues are of first importance. However, they do not have a deep understanding of the causes and thus have divergent opinions. They usually attribute those changes to modifications that occurred in their close environment: cutting down of trees, construction of a neighboring dam or overuse of pesticides. Those farmers mentioned that violent climate events resulted in up to 30% of losses in their farms. Despite few farmers already practicing basic conservation agriculture techniques (e.g.: planting cover crops or rotating crops), most of them remain unfamiliar with such solutions. There is a need for demonstrations. All of them unanimously showed their willingness to adopt climate resilience techniques, as long as it is proved that such solutions will help them to deal with climate crisis.

Generation of scientific knowledge

There are few institutions responsible for the generation of scientific knowledge, specifically to support the transition to sustainable farming, such as the **Bos Knor Research Station**, conducting field experimentation, providing capacity building, but also long-term demonstration; but also the **Center of Excellence on Sustainable Agricultural Intensification and Nutrition** (CE SAIN) through the establishment of Agri-Technology Park⁶ which promote conservation agriculture and sustainable intensification in different agroecosystems, through demonstrations of technologies and production techniques. Additional Centers of Excellence should be established as part of ASPIRE-AT (IFAD-funded program, currently under design), to contribute to the dissemination of improved agriculture techniques through demonstration of production and post-harvest technologies. The roles of public, private sector actors, but also development partners active in this field are further described in the section C.3.

Despite the availability of scientific knowledge, there is still a disconnection between research centers, academic institutions, and farmers, to ensure proper knowledge transfer towards sustainable agriculture. Such division is mainly due to difficulties related to the farm level realities (e.g.: farmers' financial capacity), the difficulty to transformed scientific knowledge into practical measures, but also limited resources from researchers to disseminate the knowledge.

Extension services

Role of the public sector

The Department of Agricultural Extension (DAE) is responsible for managing extension and advisory services to farmers. MAFF develops extension policies and strategies, the Agricultural Extension Advisory Committee (AEAC)⁷ also coordinates activities related to research, extension,

⁶ RUA in Phnom Penh, Bos Knor station in Kampong Cham, Reasmey Sophornna High School in Kampong Thom province, Toek Vil Agricultural Research Station in Siem Reap province, and the Research and Training Farm at the University of Battambang (UBB).

⁷ The AEAC is a permanent Board chaired by a Secretary of State of MAFF, with members from the related Departments under MAFF, to maintain and support Agriculture Extension.

and training, which are then implemented by the DAE. Along with DAE, the PDAFF is responsible to organize trainings at the district agriculture office (DAO) level, involving diverse stakeholders (including private sector, NGOs, farmer organizations and development partners). Further, DAO facilitates trainings and knowledge transfer with agricultural extension services providers at local level. The public extension service system is relatively vertical, its overall organization is illustrated in the Figure 6 below. The digital transmission of knowledge to farmers is also supervised at the DAE level, through the call center, e-library, website, Facebook, telegram groups, and Youtube.

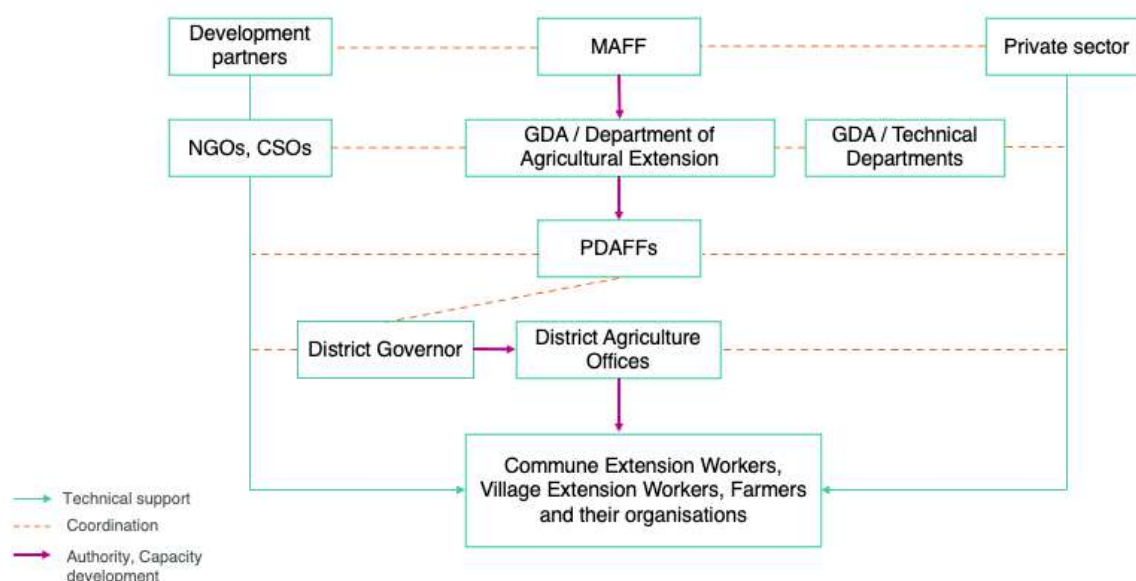


Figure 6: Cambodian extension services system

Learnings from literature and from the field survey is that extension services are still perceived as inadequate. Adaption of climate-resilient practices requires adapting knowledge, technologies, and practices to local conditions. Extension services should help in transferring climate mitigation knowledge to farmers, to equip them with the right tools to adopt more climate-smart agricultural practices. But this starts with the right level of extension which is currently poorly implemented (Sotha, 2022). Additionally, the FGD with farmers revealed that access to services and training is unequal depending on the area. Most of the farmers situated in very remote areas never received a single training, and do not have access to support services. Farmers located in more accessible areas usually take advantage of training organized by the government and NGOs. The training courses mostly deal with farming techniques (e.g.: plant disease), but are not tailored to farmers' individual needs, and never covered specifically climate resilient practices. On top of that, none of the farmers met benefited from regular follow-up.

There are currently little or no government agricultural extension services provided at the village level and farmers often rely on each other and other actors in the value chain network for information to support their decision-making. There is a lack of knowledge of the principles of resilient agricultural practices that urgently require agricultural extension services to build farmers' ability to better cope and adapt to climate change.

Role of development partners

However, improvements were noticed in agriculture extension services through the implementation of development projects that focus on knowledge transfer, skills development or quality of services provided. Concrete examples with AFD, iDE, SNV or AVSF programs are provided in the section C.3. Specific extension services models were tested and rolled out, such

as the Village Animal Health Workers (VAHW) model, within which AVSF trained veterinarian assistants to offer local veterinary services to smallholder farmers.

Another initiative, supported by multiple partners⁸ aims to test a new extension service model focused on sustainable intensification, called Metkasekor, based on a direct involvement of public agencies, private sectors, ACs, and farmers. This model, currently piloted in Battambang and Preah Vihear is illustrated in the following Figure 7.

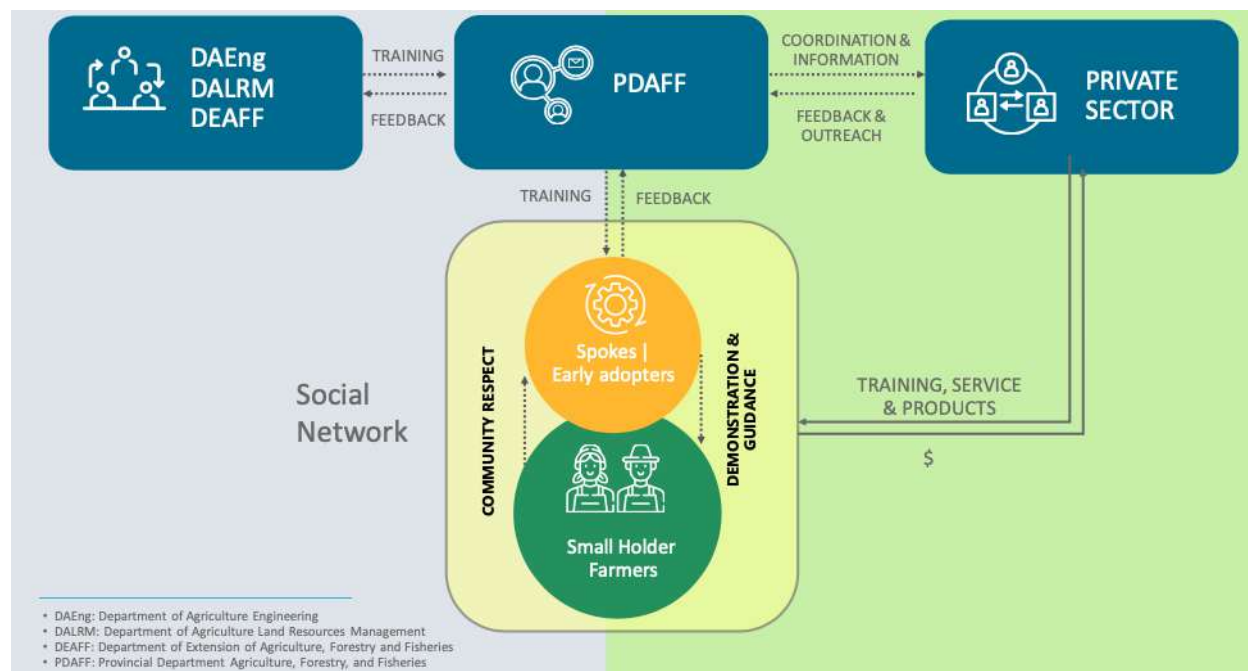


Figure 7: MetKasekor model (MetKasekor Pitch Deck, 2021)

This innovative extension model is currently at its embryonic phase, with ongoing mapping of farmers to identify early adopters, engagement of local service providers, to establish on-farm demonstrations. Thus, Nurture interventions could be coordinated with MetKasekor as well. Overall, development projects play a key role in capacity development, the main constraints remain in the scale and coverage of those activities, and the development of appropriated strategies to ensure their sustainability.

Role of the private sector

There are few stakeholders from the private sector that contribute and deliver extension services to farmers (they are further presented below in the section C.3.). Such services are usually provided along with input supply, and marketing activities. Other private companies providing extension services are often engaged in government or development projects initiatives, such as SmartAgro or Larano, which are companies involved in the pilot of the MetKasekor model. Considering the low profit margin from smallholder farmers' cropping systems, their capacity and

⁸ Swisscontact, Royal University of Agriculture (RUA), Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN), Kansas State University (KSU), CIRAD, Department of Agricultural Land Resources Management (DALRM, GDA), Department of Agricultural Engineering (DAEng, GDA), Department of Extension Agriculture, Forestry and Fisheries (DEAFF).

willingness to afford extension services is extremely limited, which also inhibit the ability of private companies to deliver such services. The testing of the MetKasekor model comes from the lack of opportunities for the private sector to invest and disseminate sustainable farming systems. The demand being low or non-existent, creating it represents a significant risk. This is why this hybrid extension model, relying on a collaboration with public extension service and development partners, would help to create awareness, by identifying farmers' early adopters, establishing demonstrations and piloting regenerative farming practices.

Overall, there are very few machinery providers offering climate-smart solutions, their scale of operations is limited, they mainly focus on rice cultivation, and they all face similar constraints: equipment or services costs are higher than the conventional ones, which limits its potential adoption, and the level of awareness is relatively low, which required time to demonstrate the effectiveness and generate farmers' interest.

The following Figure 8 is a visual mapping summarising the extension services in place that support adoption of climate resilient practices and technologies by smallholder farmers.



Figure 8: Mapping of extension service systems supporting climate change adaptation

Overall, the adoption of new techniques or technologies is limited, often project-based, limited in areas where the public sector, development partners or private sectors provide services, and farmers remain reluctant unless they see positive and lasting impacts on their activities.

Climate information

Access to climate information (from short-term weather forecasts, through seasonal forecasts to longer-term climate change information) is critical to build climate resilience among smallholders. Farmers would also need regular information regarding weather patterns, policy discussions and new best practice methods. They would need to have regular updates to help them prepare their cropping calendar appropriately. In spite of numerous, usually donor-led initiatives, major barriers regarding high initial investment costs, lack of knowledge on climate information tools and lack of government policies that support adoption hampers the access to climate information at scale

within the country (Antwi-Agyei, 2021). Existing information services and remaining constraints in terms of access or usefulness is further described in section *D. Existing digital tools and resources for climate-resilient agriculture*.

The diffusion of climate information is managed by the Ministry of Water Resources and Meteorology (MoWRAM), operating meteorology and hydrology infrastructures and software to disseminate 3 days and 7 days forecasts online. The system is working well and is available for each province on the Ministry's website. However, despite the usefulness of this service, most of the farmers are not yet able to translate such information into farming decisions. Other systems for diffusion exist, such as the national Early Warning System (EWS) 1294. The National Committee for Disaster Management (NCDM) provides overall supervision of this system at national level, and collaborates with MoWRAM and provincial ministries, also responsible for hazards' identification. At the local level, provincial and sub-provincial disaster management authorities have been responsible for the dissemination of warnings and maintenance of sensors, as well as addressing the concerns of local communities. Private companies are involved in software and hardware operation and improvements to the system.

B.3.2 Lack of access to water resources

Access to water remains a major constraint in the provinces and districts selected. Even if irrigation infrastructures exist in the selected areas, most of the farmers met during the field survey are producing under rainfed systems and mentioned that access to water remains a key issue for their farming activities, especially during the dry season. Indeed, the enhancement of water irrigation practices can help alleviate poverty, improve food security, and boost rice production and exports. The government has therefore invested significantly into the development and rehabilitation of large-scale infrastructures at the national level, as well as into the development of smaller scale water management approaches such as individual pumping or ground water usage.

Water supply for rice irrigation is generally distributed through a network of canals, constituting an irrigation scheme, but also includes water reservoirs, dams, or weirs that allow to catch and store water. Farmers feed water from the canals to their plots either by gravity or using individual pumps. Most of the canals are publicly owned. According to the Cambodian Information System on Irrigation Schemes (CISIS), developed by MoWRAM, there are currently 2,300 irrigation schemes throughout Cambodia, which could in theory cover nearly one million hectares of paddy in rainy season, and half a million hectares in dry season. However, most of the irrigation schemes dates back to the Khmer Rouge period, and because of a general lack of maintenance, inadequate designs, and poor governance, over half of these are either not fully functioning or show disappointingly low performances. As shown in Figure 9 below, the majority of irrigation schemes are located either in the south-eastern provinces of the Mekong floodplain, or in the north-western part of the country around the Tonle Sap Lake (including Battambang and Banteay Meanchey provinces).

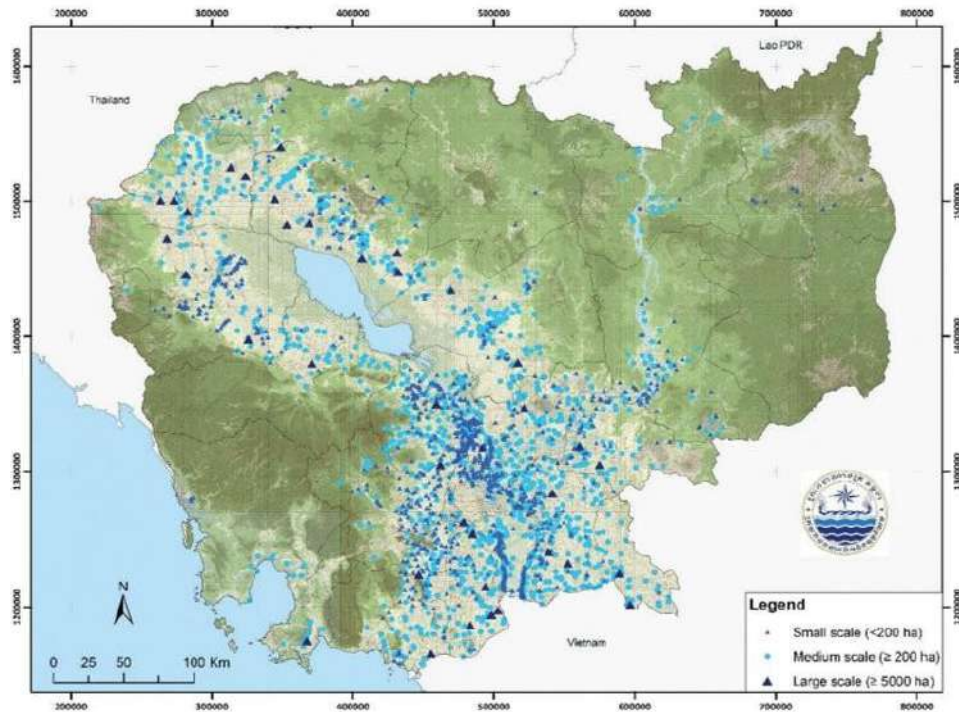


Figure 9: Geographic distribution of irrigated schemes in Cambodia (Brun, 2015)

As illustrated in the Figure 9, the distribution of irrigation schemes in Oddar Meanchey and Preah Vihear provinces is insufficient.

B.3.3 Access to Finance

Access to finance remains a key challenge for agriculture. High interest rate, hard collateral, and weak financial education are key constraints that limit the ability of farmers to access to credit. High risks related to climate hazards, flooding, irregular rainfall, lack of irrigation, and inappropriate fertiliser use make FIs reluctant to extend credit to agriculture, or compel them to charge higher interest rates to compensate for those risks. Lack of proper financial record, production plan, limited loan term, and weak financial capacity are other challenges. The issue of over indebtedness is another major concern across the country, which results from irresponsible lending and borrowing as well as low financial literacy.

Considering this unfavorable context, access to finance to facilitate adoption of climate resilient practices is even more sensitive. There are potential associated costs of mitigation practices, that makes the adoption of technologies or techniques hazardous. Indeed, adopting climate-smart practices or technologies represents a long-term investment, with potential yield decrease to anticipate at first, and potential benefits to be observed after few years. Also, farmers' interest is first driven by financial incentives, such as financial support, price or production profit offered by the market, which are often unavailable. Even if farmers know that yields are decreasing, that it is largely because of soil fertility issues and that usual practices are not sustainable (mono-cropping, use of chemical inputs), they are trapped in a system where they chose the best market option to optimize their profit, because they do not have the financial possibility to invest in other production system.

The role of MFIs is essential as they have the power to set up loans tailored to their client needs, they can easily play with interest rate, repayment periods and amounts allocated to make the loan

effective. However, MFIs remain unfamiliar with adaptation investments in agriculture and are often worried about market potential and performance. As an example, an online survey targeting Cambodian MFIs (Sevea, 2022) showed that only one respondent out of nine had developed a specific product to support climate-smart technologies investment for agri-MSMEs. Two main barriers to investing in this sector were raised: a high level of risk, and insufficient demand. MFIs would require more information about market potential, customers, and suppliers of sustainable solutions, as well as creating and scaling up de-risking mechanisms (i.e.: robust insurance products, guarantee mechanisms, risk-sharing mechanisms, cheaper funding, etc.).

Meanwhile, de-risking mechanisms are very early stage in Cambodia, and efforts are being made in this direction. To avoid collateral, a guarantee fund (Credit Guarantee Corporation of Cambodia) was created in 2021, which could be used in the agricultural sector. Ongoing considerations around the creation of green funds could also help lowering the cost of funding for MFIs and climate-smart technology providers, through concessional finance, and potentially lowering interest rates for end-users. Ongoing pilots are conducted to test innovative mechanisms as pay-as-you-go facilities, risk-sharing mechanisms, or leasing, in order to i) reduce the upfront cost for the end-users, ii) share risks between FIs and climate-smart technology suppliers, iii) improve the viability and sustainability of climate-smart technology providers' business model.

These efforts would need to be complemented and scaled-up. Exploring opportunities in the carbon market could also be considered (the CIRAD's DEI MEAS Project is further described section C.3.), however, there are several barriers to consider:

- To be feasible many rural farmers must be gathered, otherwise not enough tons of CO₂ would be avoided. In fact, for carbon credits to be certified, there must be a relatively large potential for emission avoidance, requiring the aggregation of many individual farmers.
- There is uncertainty about the capacity of existing tools to quantify avoided carbon emissions, especially considering the diversity of agriculture practices to consider.
- It is difficult for farmers to foresee income gains several years after changing their way of producing. The economic argument must be tangible to be sure that they will commit to such changes.

B.3.4 Policy and institutional framework

It is important to look at the capacity of Cambodian institutions and stakeholders to integrate climate concerns into not only development plans, but also policies, that can help overcome the multiple barriers that farmers face. Cambodia has made remarkable progress in climate change policy, especially in mainstreaming climate change into national and sub-national planning. A detailed overview of existing and relevant policies can be found in *Annex 13. Policies for climate resilient agriculture*.

The government's strategy to tackle climate change is focused on adaptation, with a gradual increase in mitigation actions aligned with economic development goals. The National Council for Sustainable Development (NCSD) was established in 2015 and has representation of 26 Ministries and Agencies and 27 Provincial Governors.

There are two main ongoing policies implemented by the Royal Government of Cambodia (RGC) in response to climate change issues. The Cambodia Climate Change Strategic Plan (CCCSP) and Intended Nationally Determined Contribution (INDC), which represent the most prominent action plans and documents outlining key national efforts in climate change adaptation and mitigation. There are several other policies related to sustainable agriculture, including:

- Agricultural Sector Master Plan 2030, which aims at enhancing sustainable management of land, forestry, and fisheries resources.
- Master Plan for Crop Productions in Cambodia 2030: a plan to transition to modern agricultural system capable of generating high value through the development of agroindustry, agribusiness, and sustainable agriculture.
- Agricultural Sector Strategic Development Plan, 2019-2023: which includes the enhancement of agricultural productivity, diversification, and commercialisation.
- Roadmap of Conservation Agriculture and Sustainable Intensification Consortium (CASIC) 2022-2026, which provides direction for the transition to sustainable agriculture production and land management, to increase the resilience of production systems.
- Cambodia Climate Change Financing Framework (2014), which promotes a common approach to define climate finance and assess its current level as well as prospecting for future financing schemes.

Yet, the country still faces challenges in enhancing climate resilience due to limited understanding of climate change impacts at various institutions levels. For instance at the PDAFF or DAO levels, which hampers the development of strategies that will ensure the transfer of adapted climate mitigation knowledge to farmers. There is also limited availability of information and resources, with only two dedicated research centers, or insufficient number of extension agents deployed on the ground. Thus, such constraints are linked and intensified by the lack of coordination among public and private entities, and inadequate financial support to ensure concrete implementation on the ground.

Therefore, key barriers to be addressed are the limited staff (capacity and availability) at the sub-national levels in implementing adaptation and mitigation actions, as well as coordination with line ministries and other stakeholders, such as civil society, community-based organizations, NGOs, and the private sector, to ensure that efforts and resources are concerted, and synergies are leveraged.

B.4 Potential climate-resilient production systems to consider

The potential production systems to consider were identified using the scorecard, which enabled to rank and prioritise the relevant value chains. The scorecard was completed with information collected during the desk review, interviews with key informants and field survey. The scorecard is provided in a separate document under Excel format, enclosed with the report.

The analysis started with the scorecard containing 13 crop value chains and 3 animal value chains. The evaluation criteria used include i) production characteristics criteria (e.g.: production level in each province or involvement of women), ii) vulnerability criteria (e.g.: environmental impact or the resilience to climate change), iii) market system criteria (e.g.: number of people generating revenue, growth opportunity, etc.).

A score⁹ between 1 (poor) and 5 (excellent) was provided for most of the evaluation criteria. Other criteria were included for information only, and therefore don't influence the result of the scoring. For example, it was decided not to score the criteria "average revenue generated": lower revenue would represent an opportunity for the Nurture project to generate positive impacts on farmers' livelihood, but at the same time, higher revenue would bring advantageous conditions as farmers' investment capacity would be expected to be higher. Additionally, two non-negotiable criteria were

⁹ 1(Poor), 2(Fair), 3(Good), 4(Very good), 5(Excellent). Only the criteria "involvement of women" was scored between 1 and 3, as the variability in responses is lower.

identified to prioritise value chains that were most suited to the project: the number of people generating revenue from the value chain, and the growth opportunity.

After completion of the scorecard, it became clear that sugarcane, pepper, banana, rubber, pigs and aquaculture were not relevant to the target group. Of the three animal value chains initially selected for scoring only backyard chickens were retained. The number of people generating revenue from pig is low, with an expansion of commercial farms offsetting losses in backyard farmers, while the lack of water resources in the targeted districts make aquaculture a less likely option with limited growth opportunity. Backyard chickens, within a semi-intensive production system, however, is a cash generation option, especially for women.

Based on the scorecard, and final ranking (from most to least potential), the selected climate-resilient production systems to consider are: 1) vegetable, 2) rice, 3) cassava, 4) maize, 5) poultry, 6) cashew, 7) soybean, 8) mango, 9) longan, 10) sesame.

C Assessment of the agriculture practices & capacity to cope with climate change

C.1 Characterisation of the crops and cropping systems

C.1.1 Existing agricultural practices

This section will characterise the agroecosystems and current practices to produce the main crops selected, including existing climate change resilient practices, cropping calendar, patterns and dynamics, and incentives if relevant. In addition, the following table summarises the types of climate resilient practices employed per specific crop, which were observed during the field survey.

Table 4. Climate resilient practices observed during the field survey

VEGETABLE	- Use of homemade compost (Preah Vihear, Battambang). - Association of crops (all provinces). - Diversification (all provinces). - Use of drip irrigation system (Preah Vihear, Battambang). - Crop rotation (Battambang, Oddar Meanchey). - Plastic net (Preah Vihear, Battambang) - Production under greenhouse (Battambang).
CASHEW	- Association with cassava, during the first 3 years (Preah Vihear) - Organic production (Preah Vihear) - Mix cropping (Preah Vihear)
RICE	- Organic production (Preah Vihear) - Solar water pump (Battambang) - Crop rotation with vegetable or cashew (Oddar Mancheay) - Shift planting dates and adjust crop planting calendars (Banteay Meanchey) - Use of natural fertiliser (Banteay Meanchey)
LIVESTOCK	- Disease management (through vaccination and cleaning) (Preah Vihear)
CASSAVA	- Cover crops (Battambang) - Crop rotation, with sesame or maize (Battambang)
MAIZE	- Crop rotation (Battambang) - Cover crop (Battambang) - Use of compost (Battambang) - Mix cropping (Preah Vihear)

Rice

- **Production cycle & seasonality:** the number of cycles per year depends on irrigation opportunities, geographic location, pedo-climatic conditions, or farming systems. Smallholder farmers are mainly growing wet season rice as a monoculture. As dry season rice requires a high level of inputs (improved seeds, reliable irrigation), small-scale farmers are less able to afford and to take the risks associated to dry season rice farming. The rice cropping systems are described by their seasonality and the length of the growing cycles (cf. Figure 10). The main season (i.e.: 80% of the production) is during the wet season (WS). For the rice grown during the dry season (DS), from January to May (i.e.: 20% of the production), there are 2 categories: irrigated second crop rice (after wet season production) and irrigated flood recession rice (the areas are flooded 3-5 months before the recession takes place).

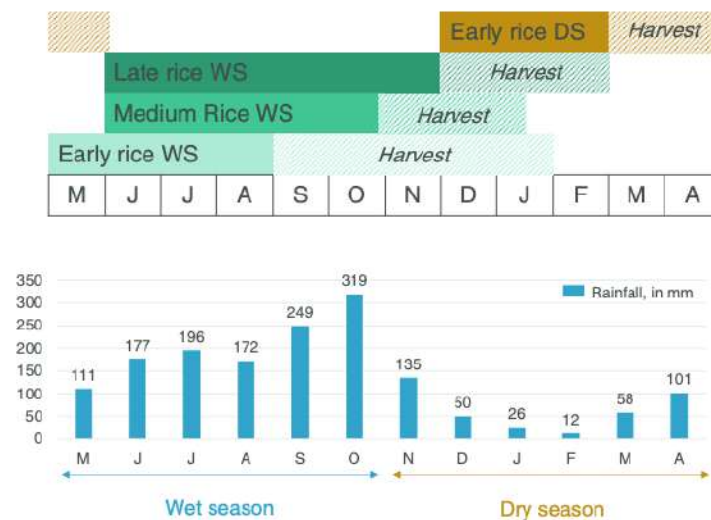


Figure 10: Rice production cycles & calendar

- **Seed varieties:** different varieties are used for WS rice (late, medium, and early varieties) with growing lengths from 90 to 140 days. Modern and recent varieties released by CARDI are tolerant to some biotic and abiotic stresses such as diseases, drought, heat, water submergence. Most farmers use traditional varieties, but improved varieties represent the largest part of rice production because of higher yield potential. The highest value varieties are the fragrant, Jasmine, varieties such as Phka Rumdoul and Phka Romeat. CARDI also recently released a purified line of Sen Kra Ob which is less fragrant than the Phka varieties but still commands a premium in the market. Sen Kra Ob is not photo-period sensitive and matures in 110 days so can be grown twice per year with irrigation. CARDI is also working on a non-photoperiod sensitive variety, Phka Mealdei, the first flood and drought tolerant variety released in Cambodia. In the past 5 years there has been an influx of Vietnamese varieties such as OM5451 which are preferred by Vietnamese traders. The OM varieties are usually of short duration, 95 to 100 days and can be cropped twice with irrigation.
- **Constraints:** smallholder farmers struggle to find quality inputs and lack farming knowledge, making it hard for most of them to produce dry season rice. Phka Rumdoul and Phka Romeat varieties are photo-period sensitive, have a long duration of over 140 days, and can only be planted once a year.
- **Current practices & technologies:** rice production is predominantly manual, with little machinery used. Although mechanization is increasing, smallholder farmers will at most own a hand tractor and a diesel water pump. Water pumps are often used for supplementary

irrigation of wet season rice: between 2 to 5 times per cycle depending on the weather conditions. Farmers use it to flood the field at the beginning of the cycle, then later during the cycle if needed to maintain the field flooded or to pump water out. Overall, rice is grown in bounded fields that are continuously flooded up to 7–10 days before harvest.

- **Climate resilient practices:** Farmers with adequate pedo-climatic conditions diversify their production with other crops such as maize or pulse (soybean, mung bean). However, crop diversification is not widespread in the traditional smallholder farms; and the fields during the dry season growing period are typically left as fallow. For irrigation, Alternate Wetting and Drying principles are sometimes applied, which allow to save water. Overall, there is little adoption of climate change resilient practices, the main one being a change from late maturing varieties (120-140 days) to short and medium maturing varieties (90 days) as a response to a shorter rainy season.

Cassava

- **Production cycle & seasonality:** cassava is planted in May at the beginning of the rainy season and harvested from November to February each year, knowing that roots can be harvested between six months and three years after planting. Once established, cassava can grow in areas that receive just 400 mm of average annual rainfall, but much higher yields can be obtained with higher levels of water supply.
- **Seed varieties:** a large amount of cassava seed is imported through informal channels through traders from Thailand and Vietnam. This informal trade has increased the pests and disease pressure. A particular worry is the rapid spread of the Sri Lanka Cassava Mosaic Virus (SLCMV), transmitted by infected stems imported from Vietnam and by whitefly. Yields can be reduced by 80% in severe cases. There are ongoing initiatives to establish clean seed production schemes, further details are available section C.5.
- **Constraints:** Cassava is often grown in fragile environments, such as on slopes and in the forest margins. It has the reputation of depleting soil nutrient reserves and causing severe erosion when planted on slopes. In Cambodia, cassava is grown on high fertility upland soils with no additional fertilizer application and mainly through monoculture farming.
- **Climate resilient practices:** existing practices in use were mostly observed through the WAT4CAM project, that pilots zero/minimum tillage and cover crops in cassava.

Maize

- **Production cycle & seasonality:** maize is a tropical grass well adapted to many climates, with wide-ranging maturities from 70 days to 210 days. In Cambodia, maize is widely adapted to soils in the higher rainfall upland area. Maize is not as drought tolerant as other upland crops and thus is mainly planted when rainfall is more reliable. The first harvesting season is from June to August and the second is from the end of October onwards.
- **Seed varieties:** There are both open-pollinated (OPV) and hybrid varieties available in Cambodia. OPVs have been developed by CARDI, and they released the first fully Cambodian maize hybrid (CMH01) in 2011 (a second hybrid is on the way). Hybrid seeds come mainly from Thailand (Pacific, Pioneer, CP) and Vietnam. Although hybrid seed is more expensive than OPV seed, yields are substantially higher. Vietnam authorized the use of three GMO varieties for animal feed use. The use of GMO maize is not authorized in Cambodia, but the Vietnamese GMO maize is widely available.
- **Constraints:** maize is mostly grown conventionally in monoculture, which degrades the soil quality and fertility. As a high-yielding grass species, maize also requires a substantial supply of nutrients (especially nitrogen) from external sources, including manufactured fertilizers and organic materials (e.g.: animal or green manures). This, along with the need to manage soils, weeds, insects, and diseases, makes maize production environmentally consequential.

According to ACIAR, the current yield gap, even with the use of hybrid seed is 6 MT per hectare (3.9 MT actual vs 10 MT potential yield).

- **Current practices & technologies:** maize production in upland areas of Cambodia is mainly done through rainfed system and not under irrigation. Because maize is not as drought tolerant as some of the other upland crops, such as mungbeans and sesame, good soil moisture at sowing time is required before the crop is planted, which explains why farmers tend to grow maize in the wet season.

Vegetables

- **Production cycle & seasonality:** rural households produce vegetables in the land surrounding their house for subsistence purpose. A large diversity of vegetables is cultivated, including eggplant, cucumber, tomato, lettuce or onion, the main crops being leafy vegetables. They produce vegetables all year long, with several cropping seasons per year according to the irrigation opportunities, the soil and climate context of the farm, and the type of vegetable. The early dry season is the main production season. Yields are significantly reduced during the “peaks” of the dry and rainy seasons.
- **Seed varieties:** The increasing use of hybrid seeds contributes to higher yields, better disease resistance and better post-harvest conditions. Hybrid vegetable seed is now widely available and sourced from Vietnam, Thailand, and China. Also, EWS is a specialized breeder of vegetables for the Tropics. Hybrid vegetable seeds are more expensive and seed viability is an issue, as seed packets are exposed to sunlight and high temperatures which affect seed quality and viability negatively.
- **Constraints:** despite the prevalence of traditional methods, increasing use of chemical inputs such as fertilizer and pesticides is hampering the environmental sustainability of vegetables, and posing concerns in terms of soil damage in the long term. In addition, irrigation is a major issue for the cultivation of vegetables. Often farmers cannot access a reliable water source all year long and end up getting water either by storing it in ponds or eventually buying water from private water sellers.
- **Current practices & technologies:** farmers are using a low level of inputs and traditional practices with a low level of mechanization (mostly hand-watering). Smallholder farmers production is still predominantly manual, and requires frequent labour and attention for the management of weed, pests, disease, soil fertility, etc. The introduction of new technologies has high potential to both increase yields and increase sustainability.
- **Climate resilient practices:** agroecology and conservation agriculture practices are increasingly promoted through development projects, granting socio-economic as well as environmental sustainability among many Cambodian livelihoods. However, there is very little adoption, and the notable exception is the adoption of drip irrigation and net or green houses, rapidly gaining ground with CSmart and CHAIN Projects.

Cashew

- **Production cycle & seasonality:** Cashew trees come to full production capacity in 5-7 years and continue to produce for up to 35 years. Cambodia trees are young, 33% are older than eight years and 54% were planted in 2017-2018. The seasonality is highlighted Figure 11.

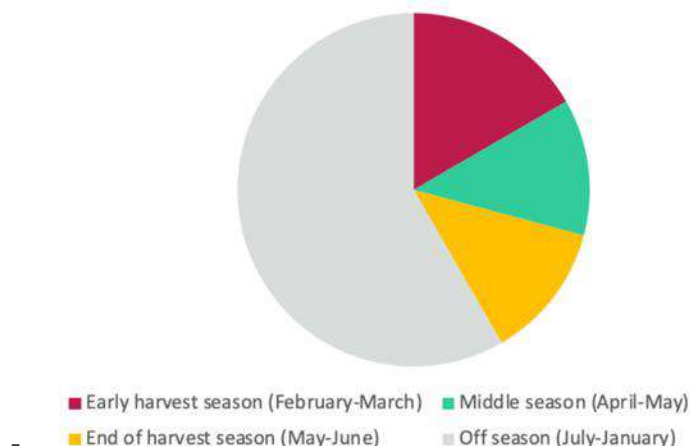


Figure 11: Seasonality of cashew nut production

- **Seed varieties:** Cambodian cashew production has been based on the use of high yielding varieties developed in the country (M23, M10, H09) or imported from Vietnam (N1). The use of high yielding varieties results in average yield in Cambodia that exceeds all producing countries, except Vietnam. According to farmers met during the field survey in Preah Vihear, they grow their own seeds and buy trees from nursery. The seeds used are hybrids.
- **Current practices & technologies:** In the first 3 years of cultivation, farmers associate cashews with cassava, and cut the trees after 10 years to allow them to grow back. They don't use any technique to improve pollination.

Mango

- **Production cycle & seasonality:** The main traditional harvest is from March to May. There is an off-season harvest with the Keo Romeat, the most popular mango variety cultivated in Cambodia for both domestic consumption and export. Two more seasons are added during the usual off-season period, a first harvest occurs between September and November while a second happens from December to February, as illustrated in the Figure 12 below.

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Harvest Keo Romeat	Main harvest season						First harvest off-season			Second harvest off-season		

Figure 12: Mango production cycles

- **Seed varieties:** there are several varieties of mangoes grown in Cambodia including Keo Romeat, Keo Chen, Kbal Damrey, Phomsen, Khtis and Thai mango. In 2011, GDA approved the cultivation of several mango varieties from China. R2E2 mango variety from Australia is the main exported mango to China and could be grown in Cambodia for future export to China.
- **Current practices & technologies:** The farmers, or the contractors, oversee the different production steps, including land preparation and tree establishment, pest, disease and weed management, irrigation, and harvesting. The main expenses sources are for ploughing, fertilizing, irrigating, and weeding. Although mango trees are quite resistant to drought, additional irrigation to rainwater prevents crop damage and increases yields.

Longan

- **Production cycle & seasonality:** Seeding trees take up to 6 years to bear fruit, whereas air layered trees can bear fruit 2-3 years after planting. According to the Pailin Longan Association, the harvest typically occurs from August to end-December, peaking in November.
- **Constraints:** longan is quite sensitive to environmental conditions with irregular yields from year to year. As longan trees are sensitive to drought, irrigation is essential. Farmers who grow this plant face challenges with water shortage.
- **Current practices & technologies:** Farmers use chlorate to induce the flowering of the longan trees, which can lead to an accumulation and leaching of residues, and a risk of ground water contamination in the long term.
- **Climate resilient practices:** At the early growth stage, intercropping is sometimes realized.

Soybean

- **Production cycle & seasonality:** farmers used to grow soybeans for subsistence, on a small scale, and as supplementary crop. Soybeans are normally grown in July or August and harvested in October or November.
- **Constraints:** the main production problems include availability of improved seeds, poor germination and seed viability, shattering of pod, drought stress, poor soil fertility, poor nodulation, among other factors. The government is currently promoting the use of modern inputs (e.g.: improved seed varieties, fertilizers, and pesticides) but uptake is marginal, and incentives are limited.
- **Current practices & technologies:** Some farmers still grow soybean by direct seeding, but now more and more farmers use seed drills.
- **Climate resilient practices:** Soybeans are typically grown in crop rotation with mungbean, sesame and maize. Planting and rotation with other crops ensure nitrogen fixation in the soils, which is a good practice to develop climate resilience. Rhizobium inoculation is being explored as a new practice but needs further research.

Sesame

- **Production cycle & seasonality:** sesame has a high capacity to resist droughts, so it is chosen to be cultivated from March to June (Loi Huu Nguyen, 2018). In some areas it is grown after rice, but in upland areas it is grown in the early wet season before soybean.
- **Constraints:** the major constraints for sesame farmers are a lack of technology, low access to credit, lack of knowledge about the quality of inputs and products.
- **Current practices & technologies:** sesame is typically grown on 2 to 3 ha plots, with an average yield of 0.7 tonnes/ha (GrowAsia, 2015). Sesame is sown through hand dibbling. The crop is usually grown under rainfed systems and require a low amount of fertilizer.
- **Climate resilient practices:** farmers met in Battambang said they practice crop rotation, rotating cassava with sesame or maize cultivation. The farmers usually switch according to the market trends and information received from collectors.

C.1.2 Gender differences

Finance and property

The field survey revealed that both men and women have land ownership. If they are married the land is in the name of both wife and husband as well as the house. The same applies for machinery, as well as money in the bank. Motorbikes are registered only in one name, it is sometimes in the name of the husband, sometimes of the wife.

Most of the farmers interviewed said that the salary perceived by women and men is equal. All the other revenues related to the farm are shared and spent within the household. Similarly, both males and females describe the workload as equal, with different tasks.

When available, women have equally access to finance services. No women noted reluctance from any financial institution because of their gender. They have also access to market information just as their husbands do, and to recent technologies especially smartphones that are now widespread in the communities.

Role and decision making

Women are responsible and are managing the household budget when it comes to daily life expenses. They are moreover in charge of taking care of the kids, the elderly and achieving other household tasks. As they must carry out these chores, females spend less time on the farm than their male counterparts.

Women participate in taking decision for the farm. However, there are limitations: women can independently take decision for small expenses, usually less than 25 dollars, but for biggest spendings, including input and important investment, women must consult their husband and the decision is taken with the agreement of both parties. However, men have often the last word when it comes to choose the specific technology or the type of fertilizer that is going to be used. Women don't take the initiative when it comes to adopt a new technology or a new process, men decide of the technique of farming and the way of production. According to CAVAC programme, because of transportation, social norms, or household responsibilities, only 10% of women have a proper access to extension services, which contributes to limiting their power in the decision making. The programme has collaborated with Angkor Green to empower women, supposing that their involvement will increase with adoption of modern techniques and mechanisation.

Indeed, men are usually doing the most physical demanding tasks on the farm, such as land preparation. They are also responsible for all the most technical tasks which require machinery, unlike women who are generally assigned to the other tasks. Women participate actively in the selling process. Most of the women interviewed (50% to 60%, depending on the area) indicated that they are in charge of negotiating the price of the harvest with the middleman. When there is no middleman, the women have the responsibility to sell the farm products on the local market. However, involvement of women in the technical tasks could increase with adoption of smart solutions (e.g.: usage of digital smart controllers and apps enabling remote control farming).

Climate change perceptions

Lastly, from the field survey, there is no clear trend showing a difference in perceptions between men and women. Farmers often state that they notice equally the changes induced by climate change. On the one hand, men declared they better perceive the changes as they spend much more time on the farm, on the other hand, men said that woman felt more concerned by climate change, asking for solutions, while it is not men's priority.

C.1.3 Typology of farmers

The Nurture project aims to target smallholder farmers, including the poorest and most vulnerable rural households. There are several definitions of smallholder farmers but commonly accepted is that it concerns farmers with less than 2 hectares of land (HLPE, 2013). This question becomes relevant as being asked in key Ministries (MEF, MAFF) and in donor projects (C-SMART, CHAIN, CAVAC), whether support to farmers with less than 2 hectares is value for money as this group is notoriously difficult to integrate in the value chain and related market systems.

As such, this question, whether the smallholder concept of less than 2 ha is still valid, was asked for each crop specific value chain.

- For arable crops, such as non-irrigated rice and cassava farms, less than 2 ha will probably never be profitable. Experience in successful irrigation schemes has shown that, where

farmers have reliable access to water, farmers are able to produce 2 to 2.5 crops per year with higher-than-average yields and can be profitable

- For vegetables, farmers with 1-2 ha are certainly not smallholders but semi-commercial. The same would be applied to pepper farmers where, depending on the price, net revenues per ha can reach between USD 18,000 and 32,000¹⁰.
- For maize, in Battambang, 4-5 ha would be considered as smallholding.
- Cashew farmers have on average 3-5 ha but with production levels of between 0.5 and 1.0 MT/ha, a selling price of between USD 0.70 and 1.20/kg, can still be considered as smallholders.
- However, 2 ha of longan in Battambang & Pailin earns a farmer sufficient income to call him semi-commercial.
- For semi-intensive raising of native chickens, the sale of 200 chickens every 3 months is semi-commercial and requires less than 1 ha.

C.2 Main impacts of climate change on crops' productivity

The climate change effects vary across the different agricultural value chains, as it is summarised in the Table 5 below. Apart from clear evidence in rice crop (increasing periods of intermittent drought and floods) and recognized by farmers as evidence of climate change, for many other crops no evidence is clearcut and anticipated effects are based on modelling.

Table 5: Climate change impacts on the different sectors

VC	HEAVY RAIN / FLOOD	DROUGHT	TEMPERATURE CHANGES
Rice	- Flood disasters can cause rice damage	- Decrease in yield or crop failure because of drought stress and water shortage.	- Changes in growth duration or growth patterns - Increase in evapotranspiration - increase in water demand. - yield could be 15% lower by 2040 ¹¹ .
Cassava	- Cassava is a root plant and needs five days submerged under water to be damaged. - Higher humidity can lead to disease.	- Cassava is considered as a drought resilient crop.	- Temperature shifts could lead to disease, - insect spectra could change, and intensity will increase
Maize & Soybean (rain fed, upland crops)	- change the spectrum of pests and diseases but also the intensity	- Decrease in yield.	- change the spectrum of pests and diseases but also the intensity - affect flowering (e.g.: maize has an upper limit of 30 °C) - affect pollination (self- and cross-pollinated crops).
Perennial tree crops: Mango, Longan, Cashew	- Negative effect on yield (estimates of 30% crop loss for this year). - Negative effect on flowering.	- Negative effect on yield. - Negative effect on flowering.	- Negative effect on flowering.

¹⁰ Average yield 6,000-8,000 kg/ha, potential yield 10,000-11,000 kg/ha. Market price USD 3-4/kg (MoC, 2012)

¹¹ Impact assessment of climate change on rice productivity in the Indochinese peninsula using a regional-scale crop model. Li Sanai et al, 2017.

	- off-season rain can cause severe flower and immature fruit abortion		- Changes in spectrum and intensity of pests and diseases ¹² . - Potential impact on fruit production. -Negative effect on pollinators.
Poultry	- availability and price of local feed sources. - increase of stress, affecting productivity - increase the occurrence and risks of diseases, causing higher mortality, and losses of incomes	- availability and price of local feed sources	- increase of stress, affecting productivity
Soybean	- high humidity could change the pest and disease complex affecting soybeans	- yields could drop due to the combined effect of heat and drought.	- Temperature above 35 °C limits growth and yield
Vegetables	- affect pollination (self- and cross-pollinated crops).	- water stress during vegetative/ early reproductive growth reduces yields.	- leafy vegetables such as lettuce may start bolting (flowering and setting seed) earlier - affect pollination (self- and cross-pollinated crops).

The effect of increasing periods of drought and the occurrence of serious flooding have been observed for several years on annual crops, especially rice. A complicating factor is the effect of La Nina (currently influencing rainfall) and its counterpart El Nino (more likelihood of droughts). The La Nina and El Nino effects are amplified by climate change but by themselves create temporal climate effects. From FGD, it seems that most farmers are aware of climate change only in terms of rain intensity and the length of the rainy season. Increasing warming was not mentioned often.

C.3 Actors' involvement in supporting the uptake of climate resilient practices

C.3.1 Private sector involvement

There are few stakeholders from the private sector providing products or services that contribute to the adoption of climate-smart practices (a table with existing private sector companies in the climate resilient sphere is available *Annex 14. Private companies in the climate resilient sphere*).

Among existing companies, **SmartAgro** provides seeds for a variety of staple and cover crops (to prevent erosion and restore soil fertility), organic input solutions, conservation agriculture tools, together with consultancy services. The company's goal is to implement innovative cropping systems, regenerate soils and make crop and livestock production more resilient against climate change. SmartAgro is working closely with local authorities and other relevant institutions or projects (such as CIRAD, Swisscontact, CASIC, MetKasekor) to pursue the research efforts, to conduct experimentations and pilot projects, to facilitate the scale up and adoption of regenerative

¹² Early season rains during flowering of cashew caused serious flower and immature nut abortion in early 2020. An estimated 30% crop loss is being reported. If these early rains during cashew flowering become a permanent feature of climate change in Cambodia this will seriously impact the cashew value chain.

agriculture practices by farmers. The company is therefore at the stage of building the market and demand for such products and services, educating the stakeholders, with a limited scale of operations (activities were conducted in Battambang and Preah Vihear through projects, but not in Oddar Meanchey or Banteay Meanchey). Now, SmartAgro is targeting aggregators or farmer leaders, as smallholder farmers have limited investment capacity, land, knowledge.

Larano is an agriculture machinery manufacturer, importing from Brazil and distributing zero-tillage machinery for cassava, rice, and maize cultivation, engaged in the piloting of MetKasekor model. Larano strategy is to sell to service providers, usually commercial farm owners who invest and provide services to smaller farmers in their communities. However, Larano is also providing services to farmers working with the Conservation Agriculture Service Centre (CASC), as their sales remains limited. The price of no-till machinery is higher than local machinery, which is their main constraint to provide access to climate resilient services. Indeed, conventional planters cost around 2,000 \$US, compared to CA machinery which costs 10,000 \$US, and there is no difference in the price for service provision to farmers, which is why service providers are reluctant to invest.

There are other local machinery distributors, such as **BB2C Innovations** and **Lunheng manufacture**, distributing low cost locally made direct seeders for rice. BB2C Innovations is also designing a zero till seeder for rice, in cooperation with WAT4CAM in Battambang. Also supported through CAVAC, **Nuon Kong** is a tractor importer and distributor, importing and distributing laser land levelling equipment, which is important for water management improvement in irrigated crops. So far, the laser land levelling machinery units have been distributed in Battambang and Banteay Meanchey provinces. Through this Australian supported programme, there is also women-led agribusiness offering drone services for spraying that was established in Battambang.

Several companies such as **Pteah Baitong** are distributing solar water pumps and promoting its use among smallholder farmers. The main constraint of the company is related to the farmers' limited investment capacity, which is why Pteah Baitong is currently distributing solar water pump with IoT technology integrated, to experiment pay-go payment mechanism. This model is currently being tested with 30 customers, mostly in provinces around Tonlesap. Other companies involved in the Switch to Solar Project are distributing solar technologies for productive usage such as **Harvest the Sun** distributing solar dryer domes, but also **SOGE** or **AgroSolar** offering solar powered irrigation systems.

Finally, during the field survey, input suppliers distributing organic inputs were met. One of them, located in Oddar Meanchey province (Banteay Ampul district, Ko Bang commune), sells organic fertilizers. The main constraint he mentioned was related to the price of such input, and the capacity of farmers to purchase such product. In addition of being more expensive, the efficiency of organic inputs, compared to chemical fertilisers, has not been demonstrated which limits even more its adoption.

C.3.2 Public sector involvement

As described earlier in the section B.3.1., the public sector involvement in supporting the uptake of climate change practices is mainly provided through the extension services system in place, which remains inadequate.

The **Conservation Agriculture and Sustainable Intensification Consortium (CASIC)** is a national mechanism, under MAFF supervision, that have been established in 2020 to coordinate a network of organisations working on the promotion of CA practices in Cambodia, through knowledge management, coordination, promotion, and research. CASIC contributes to raise

awareness of the constraints and challenges that are faced by various stakeholders when implementing CA, but is not an implementing organisation. Therefore, CASIC is supported by other organisations: **CE SAIN / RUA** is responsible for the knowledge management component, combining data through demonstrations conducted in Agri Technology Parks; The **department of Agricultural Engineering (DAEng)** is responsible for the coordination component, connecting CA stakeholders and market actors, together with available resources; The **department of Agricultural Extension** is responsible for the promotion component, supporting research, trainings and practical support at local level; The **department of Agricultural Land Resources Management (DALRM)** leads the research component, with support from **CIRAD**, conducting on-field experimentations and demonstrations to identify priorities (cropping systems, mechanization, water management, etc.), facilitating the visibility of scientific results, engaging with the private sector, and contributing to the improvement of resources at Bos Khnor. In parallel, the **MetKasekor** model aims also to reinforce extension system for sustainable agricultural intensification, collaborating with government, private sector actors, agricultural cooperatives, and farmers.

C.3.3 Involvement from development partners

As briefly introduced, most of ongoing initiatives in the sector are project-based and supported by development partners. For instance, **AFD, IDE, SNV or AVSF**, through their programs (WAT4CAM, C-SMART, CHAIN and Paddy Selling Group Model), have introduced numerous climate-resilient practices. **WAT4CAM** aims to implement water and irrigation management, support water resources monitoring and management as well as support innovative farming practices in the rice value chain. **C-SMART** is a 5-year US\$5 million program aiming to boost the incomes of local farmers, build value chains and strengthen farmer resilience to changing weather patterns, by training farmers to use climate-smart technologies and connecting them to robust market systems. AVSF, through the **Paddy Selling Group Model**, is working with ACs to implement agroecology practices. Thus, WAT4CAM, C-SMART and the Paddy Selling Group Model are examples of programmes that implement agroecological practices in the target provinces and Nurture interventions could be coordinated with them. The **CHAIN** programme, set to help develop greater climate resilience through promoting year-round production, smart water solutions, and water resource management, will have finished but there are also important lessons learned.

To promote sustainable practices among smallholder farmers, the **DEI MEAS Project** is also exploring opportunities around access to finance. The **CIRAD**, together with SmartAgro, Swisscontact and Metkasekor, are currently developing a methodology, looking at the potential to refinance farmers through the voluntary carbon market. The idea is to calculate each carbon credit that could be generated by changing a particular farming practice. The money induced from avoided emissions would then be paid back to rural farmers, allowing them to produce more profitably and responsibly, while receiving additional income to reward their efforts. CIRAD is currently implementing 2 pilot projects in Battambang, one on rice cultivation, which emits a lot of methane, and the other on cassava.

C.4 Existing digital tools and resources for climate resilient agriculture

Existing digital tools and solutions were characterised, looking at the service providers, profiles of farmers targeted, accessibility of the services, etc. The main constraints and remaining gaps that limit the identified digital tools' access and usefulness were identified, to finally outline opportunities for digitalisation that can play a key role in addressing climate change challenges at farmers' level.

C.4.1 Information services

A central mechanism in the development of adaptive strategies to climate change is the strengthening and effective utilization of information channels. Despite this critical need for accessing climate-related information, many of the most vulnerable are often on the periphery of receiving practical information. Therefore, it is extremely important to develop appropriate information services that can help insulate farmers from shocks and that can enable them to make informed decisions, to manage risk and adapt to change. As such, information services that exist in Cambodia were further examined, to understand how they are functioning, being used and accessible (a detailed description of each tool is provided in *Annex 15. Detailed description of digital tools & resources for climate-resilient agriculture*). Few services have been deployed in the previous years, through development projects but also directly by private actors.

The main climate information service currently in place is the Early Warning System (EWS) 1294 developed by People In Need (PIN), which is now operated and supervised nation-wide by the NCDM, and disseminating climate information and risk from natural hazard to 120,000 users. This service enables rural households to get climate information on real-time, but it doesn't include yet orientations that would enable farmers to adapt their practices based on the alerts received. This EWS 1294 was supported by a UNDP Program "Strengthening Climate Information and Early Warning Systems to Support Climate-Resilient Development", along with the reinforcement/development of other information services. For instance, automatic weather and hydro stations were installed and are now being used by MoWRAM to disseminate online forecasts, National Curriculum for Farmers Field School (a training program) has been developed for MAFF, Drought Information Hubs (InfoHubs) have been established to disseminate drought-resistant agricultural knowledge among provincial officials, ACs and farmers. Other digital information tools were developed through development programs, such as Chamka App initiated through ASPIRE, which provides climate, technical and agricultural inputs information, as well as AngkorSalad, an app supported by ICCO Cooperation that provides technical advice, knowledge and market information for vegetable farmers. Lastly, few services were developed directly by private actors to support their business activities, such as the Knowledge Transfer Platform from East West Seed, which provides technical knowledge to vegetable farmers through a Youtube channel, as well as their CropWiki App which is a detailed catalogue app, but also the Tonlesap App, developed by AMK in order to disseminate technical and market information to its clients.

C.4.2 Data-driven agriculture services

Digitisation of the food system can enable greater efficiency, transparency, profitability, and equity through ground-breaking technologies such as sensors, Internet of Things (IoT), automation, Blockchain, artificial intelligence (AI), and computer vision (Chandra and Collis, 2021). Particularly, investing in data-driven agriculture is expected to increase agricultural production and productivity, help adapt to or mitigate the effects of climate change, bring about more economic and efficient use of natural resources, reduce risk, improve resilience in farming, and make the agricultural and food sectors not only more efficient but also more sustainable (Maru et al., 2018). Such data-driven agriculture services already exist in Cambodia, but those initiatives are either at very early stage, or are still too complicated to be used by smallholder farmers (a detailed description of each tool is also provided in *Annex 15. Detailed description of digital tools & resources for climate-resilient agriculture*).

For instance, Aruna is the main geospatial service company located in Cambodia offering GIS, GPS, remote sensing, and related technologies services that can be applied to improve the management of farming systems. However, even if such high-tech solutions have a significant potential to increase the productivity in a sustainable way, sufficient knowledge are required to interpret and use properly such mapping solutions, which limits its adoption potential by farmers. Other data-driven solutions have been launched by private stakeholders, such as BlocRice, a digital system developed by Amru Rice which aims to ensure transparency and digital tracking of organic rice transactions from farmers in Preah Vihear province. Or as its core business, Smart Farm Assistance supplies irrigation technologies connected to IoT system, which enables farmers to better control on-farm irrigation systems. Aside from that, other data-driven agricultural tools are emerging from development programs, like the Khmer Agriculture Suite (KAS) platform, as part of the IFAD-funded SAAMBAT project. The KAS platform aims at combining existing agriculture data, tools, and intelligent components in one single platform, with multiple KAS satellite applications connected to the core platform.

C.4.3 Digital financial services

The Cambodian government has long acknowledged the importance of agricultural insurance in de-risking weather-related threats to farming communities. These threats are predicted to increase over the next decades. Therefore, making farmers less vulnerable to increasingly frequent natural hazards is a critical priority. Yet, FIs and insurance companies have so far been reluctant to invest in the agricultural sector. The reasons are insufficient experience and implementation capacity, a lack of relevant infrastructure and the necessary data. However, because of the high cost of assessing losses, traditional insurance based on paying indemnities for actual losses incurred is usually not viable (UNDP, Private Sector Engagement in Climate Information Services and Early Warning System in Cambodia, 2021). In this context, the establishment of index insurance could mitigate the impacts of weather shocks, especially for the poor. Index-based insurance underwrites a weather risk as a proxy for economic loss: when the index falls below a certain level, farmers automatically get a payment (Falco et al., 2021).

A growing number of digital payments, credit and insurance products are now emerging in Cambodia to address the financial needs of smallholder households, as further described hereafter (*Annex 15. Detailed description of digital tools & resources for climate-resilient agriculture*). One key example is the index-based insurance schemes that are currently piloted by Syngenta, Forte Insurance and AMK Microfinance. The schemes tested, focusing on rice, maize and cassava, are i) a yield index insurance, covering yield losses for rice farmers using satellite generated data, ii) a weather index insurance, covering cassava farmers against drought and flood using data from automatic weather stations, iii) a weather index insurance covering maize farmers. Another example is the credit scoring system developed by Agribuddy, which connects farmers to input suppliers, crop buyers and credit sources, facilitating contracts and transaction processes through the e-buddy wallet app.

C.4.4 Key constraints in terms of access and usefulness

Developing countries face additional challenges in terms of adoption of digital tools, as it might require not only changes from one technology to another (which entails additional costs, new skills, behaviour changes), but also considerable investments in the development of infrastructure or research & development (e.g.: extension services), necessary to support smallholders in the technology uptake process.

Various initiatives were implemented in recent years; however, these efforts were mostly small-scale, project-based, and not connected to each other. Yet, there is no unified platform developed for digital agriculture technologies that can be used jointly by the government, farmers, private sector actors and development partners. Limited knowledge and capacity were also mentioned as being key factors hindering the digitalisation effort, on one hand from the service providers, who face challenges to update online platforms with quality information, to promote apps or digital tools among farmers, or who have to cover expensive operational costs to run the digital services; and on the other hand from the smallholder farmers, who are often not aware of the potential benefits of digital services, who do not have the digital capacity to use their smartphone properly, or the necessary knowledge to interpret or use the information or service. The lack of knowledge is also accompanied with a lack of trust from the farmers, who are more confident to use in-person services or cash-payment, which limits the adoption of online payment systems or e-commerce services for now. Besides, another key challenge highlighted was the underdeveloped internet infrastructure in rural areas. Even if phone and internet coverage has reached a wide segment of the rural population, internet is mainly used for entertainment and communication. The slow internet speed is a key challenge that discourages farmers from using digital payment services. Finally, the lack of meteorology infrastructure, accurate and accessible data, across the entire country was also mentioned as a significant constraint, especially to predict outcomes and to develop legitimate commercial index-based crop insurance schemes.

C.5 Recommendations to scale-up adoption of climate-resilient practices

Dissemination of climate resilient practices is slow, and the transition process requires changes at different levels: field practices, day-to-day management, planning, marketing, connection between producers and consumers, etc. The project should support these different aspects and facilitate experience and knowledge sharing about innovations, awareness raising at different level (farmers, AC, private sector, local authorities, policy makers), facilitate the involvement of research institutions, support the integration of regenerative farming principles in extension system, identify political and economic mechanisms to facilitate transition, etc.

C.5.1 Promoting changes of the agriculture practices

To enhance the capacity of Cambodian agroecosystems to cope with climate change, there are a lot of existing adaptation and mitigation measures, in term of practices, that could be promoted during the Nurture project implementation, as further described below.

Rice

- Introduce **direct mechanical seeding** and scale-up the adoption of mechanical direct seeding of rice using locally manufactured, low-cost seeders through service providers. The traditional practice of hand transplanting rice has practically disappeared due to labour shortages in rural areas. Today most rice is hand broadcasted using very high seed rates of up to 400 kg per hectare, with low germination rate. There are currently 4 different mechanical rice seed drills commercially available both for wet and dry seeding and suitable for two or four-wheel tractors. The advantages are that the rice can withstand short periods of drought, develop a stronger root system, and being planted in rows allowing for better air circulation in the crop, lowering pest and disease incidence.
- Scale-up the adoption of **drought and flood tolerant varieties** like Phka Mealdei through demonstrations and seed production within districts. Phka Mealdei is a fragrant rice variety and could obtain a premium in the market. Although some projects have promoted the

variety and started seed increases, the variety is practically unknown in the four target provinces.

- Where irrigation schemes exist, introduce **Alternate Wet and Drying (AWD)** technology. This technology reduces the amount of water used by draining the field at regular intervals and then reflooding the field, which reduces methane emissions.
- Encourage cultivation of **cover crops** between two rice crop seasons to bring organic nutrients to the soil and to reduce the inorganic fertilizers requirement. Cultivating cover crops bring additional benefits, as it also reduces soil erosion and conserves soil moisture.
- Promote **laser land levelling** through service providers. In Battambang and Banteay Meanchey service providers already supply this kind of service. Properly levelled land leads to water conservation and better use of fertiliser.
- **Shift planting dates** and adjust crop planting calendars.
- Discourage the burning of straw after harvest. Introduce **straw baling** through service providers.

Cassava

Cassava being the second largest crop, there is a need to make cassava more sustainable, especially considering the increasing demand for sustainable and organic cassava products.

- Demonstrate the use of **zero or minimum tillage, cover crops, contour ploughing and planting in hilly areas** to reduce erosion and improve soil fertility.
- Use of **Healthy Planting Materials**. Pests and diseases, particularly the mealy bug and cassava witches' broom, can reduce cassava yield, starch yield, and the quality of both. The production of clean seeds is vital in achieving sustainable cassava production, especially for smallholder farmers. The outbreak of cassava mosaic disease (CMD) poses a threat to Cambodia's cassava sector, with its potential reduce yields by up to 80%. Techniques such as integrated pest management can help cassava farmers achieve a sustainable production by avoiding chemical pesticides.
- Two cassava varieties from Thailand (KU50 and Rayong 5) have been identified as being less susceptible to SLCMV and initiatives are underway with Korean and Australian support to **establish clean seed production schemes**. Considering the importance of cassava in the Nurture target provinces, integrating clean seed production schemes within the informal seed networks might be a good intervention.
- Maintain a protective **cover of vegetation** over soil as opposed to conventional tillage – ploughing – reduces weed, water loss from the soil surface, maintains soil moisture, moderates soil temperatures, and protects bare soils reducing soil erosion and compaction. **Organic mulches** also provide soil nutrients and encourage beneficial soil organisms and worm activity.
- Promote **mixed cropping** and **crops rotation**, as opposed to monocropping, to increase soil fertility, yield, nutrients, and reduce erosion, stress of weeds, pollution as well as to limit the concentration of pests and diseases.

Maize

Maize is mainly grown as a rainfed upland crop in Cambodia and the biggest climate change effect would be extended drought periods.

- Encourage addition of irrigation such as **sprinklers**.
- Use of early maturing hybrids, or use of **drought resistant varieties**. Encourage CARDI or the private sector to use drought resistant lines developed by CIMMYT under the Asia Maize Network.
- Promote **crop rotation** with planting of different crops sequentially on the same plot of land to optimize the nutrients availability in the soil, and to limit pest and weed pressure.

- Demonstrate **conservation agriculture practices** to facilitate adoption of its principles, which are minimum soil disturbance, permanent soil cover and optimum crop rotation or intercropping.
- Support the adoption of **integrated pest management** (IPM) strategy, which consists in a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

Tree crops: Mango, Cashew, Longan

- Practice **high density planting** to make maximum use of land and improve irrigation management.
- Promote **mulching** and/or **permanent ground cover** over the soil to reduce weeds, water loss from the soil surface, maintain soil moisture, reduce soil erosion and compaction.
- Long term (mango): breeding of better adaptable varieties.

Soybean

- Focus on improving cropping practices (mulching to maintain soil moisture and suppress weeds; **inoculation with Rhizobium**), and access to inputs to improve productivity (especially better adapted varieties).
- Promote soybean as a diversification crop, to be included in a **rotation** with maize and/or cassava.

Vegetable

The emphasis should be on the improvement of water-use efficiency to adapt to the hot and dry conditions, but also alternatives to chemical inputs spraying.

- Shift planting dates and adjust **crop planting calendars** to combat the likely increase in temperature or water stress.
- Promote **mulching** to maintain sufficient soil moisture.
- Introduce **drip or micro sprinkler irrigation** to reduce water evaporation losses and provide the necessary water needed directly to the plants.
- Scale-up the adoption of **drought tolerant varieties**.
- Support investment in **net houses** to enable vegetable growing throughout the whole year, to ward off insects without applying pesticides, and to protect vegetables from direct rainfall.

Backyard chickens

- Prevent the introduction of new diseases by improving **biosecurity measures**, this includes the investment in adapted housing, regular removal of manure, hand washing, regular cleaning, etc.
- Promote **diversification** and encourage farmers to cultivate vegetables, to generate additional revenues.
- Support investment in **water storage solutions**.

C.5.2 Support access to finance

As introduced in the section B.3.3., access to finance remains a significant bottleneck for smallholder farmers and agricultural cooperatives. It is not only a question of hard collateral in the form of land or buildings, banks and MFI are requesting soft collateral in the form of audited accounts, bank statements, etc. It is therefore essential that cooperative management becomes financially literate and start creating soft collateral.

To facilitate access to finance, several interventions could be considered. For example, CAVAC worked with Banhji and AMK MFI to develop a software specifically tailored to agricultural cooperatives, to ensure they use a proper financial management system. AMRU Rice put in place a system whereby an MFI pays the farmers as soon as AMRU confirms that delivery has taken place at their mills. This streamlines the payments to farmers who previously had to wait 2-3 weeks. AgroSolar manufactures and sell solar pumps for smallholder farmers. They have reached an agreement with AMK and Chamroen MFI whereby farmers receive up to 12-month credit at affordable rates. Similarly, Nurture activities could include the testing of loan mechanisms by collaborating with an MFI and a service provider, by linking the credit to a digital app for example, that will connect the farmers to stakeholders involved in the value chain (input supplier, crop buyer, etc.).

As further described in the section C.4, a growing number of digital tools and resources are now emerging in Cambodia to address the financial needs of smallholder households. This represents an opportunity for the Nurture project as well, which could consider developing such tool, or supporting ongoing and promising solutions. For example, warehouse receipt systems are not widespread in Cambodia, but could be used in tri-partite agreement (farmer, trader, bank), and considered as a risk mitigation mechanism to secure the repayment of a transaction. Another opportunity would be to collaborate with Syngenta to pilot an index-based insurance scheme in the project target areas, or to reinforce the existing schemes by installing additional weather stations in strategic locations, to ensure accurate data is available.

As such, financing mechanisms must be designed and deployed as incentives and enabling tools to trigger desired changes in agricultural systems. The availability of well-thought financial products is a condition sine qua non to achieve the project's objectives, considering that agricultural production systems promoted by the project are requiring investments and are bringing benefits to farmers only after few years. A list of concrete and actionable activities to support access to finance is suggested in the following Table 6: Possible interventions around access to finance.

Table 6: Possible interventions around access to finance

Opportunities around emerging digital tools or solutions		Potential¹³ (feasibility X impact)
Short-term	Testing digital loan mechanisms by collaborating with an MFI and a digital service provider, by linking the credit to a digital app that will connect the farmers to stakeholders involved in the value chain. Low interest or special conditions could be offered if coupled with financial literacy. In addition, piloting digital tool collaborating with FIs would enable to gather sufficient data and track information related to loans (farmers profiles, loan purpose, justification for refusal, repayment, etc.). Such historical data series are not existing/available now but would be necessary to define appropriated strategies for FIs on the long term.	XXX
Medium-term	Looking at the potential of warehouse receipt financing scheme. Amru Rice collaborated with SNV to implement a warehouse receipt system to help	XX

¹³ The intervention potential is assessed based on the level of effort required (feasibility) and the expected benefits (impact). The colour code highlights the potential: X (Low, Red), XX (Medium, Orange), XXX (High, Green).

	small-scale farmers cultivating rice, cashew, cassava in Kampong Thom and Preah Vihear. The goal was to store, create collective marketing and financing for agricultural equipment and fertilisers. This could be replicated in the target provinces.	
Medium-term	Collaborating with Syngenta to pilot an index-based insurance scheme in the project target areas or reinforcing the current initiative by installing additional weather stations in strategic locations, to ensure accurate data is available. The availability of historical financial data through the use of digital tools would also facilitate the implementation of insurance schemes.	XXX
Medium-term	Analyse the potential and support the testing/implementation of innovative group-based financing schemes with ACs (group-based lending, self-help group, cooperative loan...).	X
Long-term	Catalyse financial support towards the scaling-up of innovative mechanisms to facilitate the access to smart technologies for ACs (e.g.: through risk-sharing agreements, leasing, pay-go mechanism, etc.). To do so, facilitate interaction between FIs, technology providers and ACs; bring technical and financial support to design and experiment these mechanisms; communicate on success-stories. Mechanisms to facilitate investment in no-tillage machinery directly by an AC could be tested.	X
Long-term	Look at the findings from DEI MEAS Project and support the development of finance mechanisms for smallholder farmers through carbon markets, if relevant. Contract farming could also represent an opportunity to enter the carbon market.	X

Financial literacy

Short-term	Training and capacity building to enhance ACs understanding of financial products and services, as well as proper use of financial resources, to promote effective and targeted use of financial resources. Financial literacy activities could be combined with lending.	XXX
Short-term	Replicating or using tools developed as part of the campaign “Let’s Talk Money” by the National Bank of Cambodia, contribute to the development and implementation of financial education programs through digital platform, including social media.	XXX
Medium-term	CAVAC, Banhji and AMK developed an app specifically for use by ACs and trained AC staff on its use. The app provides real-time data which can be used as “soft collateral” by the AC to obtain loans. This could be replicated as part of the Nurture project, using similar tool, or developing a new one, piloting it with engaged ACs. This is key to support ACs to become bankable clients.	XXX

C.5.3 Foster market development for specific sustainable produced crops

Market development appears as a potential development path for several of the considered sectors, especially as smallholder farmers' interest towards sustainable production is likely to be driven by financial incentives such as higher prices offered by the market.

Sustainable production is becoming more and more important in overseas markets, especially in Europe, but also in Cambodia. This concerns sustainable production practices such as fertiliser and pesticide use, protecting the environment but also improving the end products quality, as well as social factors such as child labour and gender. The Sustainable Rice Platform (SRP) is one of the few institutions that works on sustainable production and several local rice millers/exporters

have joined SRP. In addition, there are several fruits producing companies that work on sustainable production and conservation agriculture (Angkor Harvest, HESED, Indochina Agriculture Processing Ltd.).

The Nurture project should consider a focus on quality production, processing, and identifying niche market opportunities to conduct pilot operations. The project should also support the development of linkages between existing buyers and producers, through agriculture cooperatives or other aggregators. To support the development of both value chains and climate resilient practices, there is a need to invest on the marketing of agroecological products. A list of concrete and actionable activities to consider to enhance market development for agroecological products is suggested in the following Table 7: Potential interventions to facilitate access to markets.

Table 7: Potential interventions to facilitate access to markets

Identify niche market opportunities		Potential (impact X feasibility)
Short-term	In Preah Vihear, AVSF supported Preah Vihear Meanchey Union of Agricultural Cooperatives (PMUAC) and two rice millers to produce organic rice, to implement internal control system, to obtain certification, to sign contracts for export to Europe. The project should consider identifying similar niche market opportunities, potentially within the cashew, rice, soybean sectors. Once identified, support the establishment of linkages between existing buyers and producers, through ACs or other aggregators to better respond to market opportunities. This could require a combination of: increased productivity through improved production techniques; better organization and formation of producer groups; investment in appropriate collection, transport, storage equipment and facilities.	XX
Short-term	Assist with the promotion of flood and drought tolerant varieties, through field demonstration or supporting the commercialisation of such seeds. For example, CARDI is working on a non-photoperiod sensitive version of Phka Rumdoul rice variety, which could be released late 2022 or early 2023. Phka Mealdei, the first flood and drought tolerant variety released in Cambodia. Also, in the past 5 years there has been an influx of Vietnamese varieties such as OM5451 which are preferred by Vietnamese traders. The OM varieties are usually of short duration, 95 – 100 days and can be cropped twice where irrigation is available.	XX
Long-term	Attract investment in processing factories, where there is a need to anchor local demand, if it has potential to support the transition to regenerative farming practices among farmers. For example, Green Leader is setting up a cassava processing factory in Kratie province, securing the supply through contract farming scheme with 30 farmer associations that commit to adopt conservation agriculture practices. Similarly, the project could mobilise support to develop the local processing industry, in relevant sectors (e.g.: cassava, mango, cashew).	XX
Marketing for sustainable produced crops		
Short-term	Promote sustainable products by organising fairs and local events.	X

Medium-term	Support for certification strategies (1): support the adoption of Sustainable Rice Platform (SRP) standards ¹⁴ by agricultural cooperatives and rice millers.	X
Medium-term	Support for certification strategies (2): NAV implemented Participatory Guarantee Systems (PGS) among vegetable farmers. PGS is a voluntary quality assurance system for locally based productions. Such system could be replicated and implemented in the target provinces, collaborating with NAV or other potential buyer.	XX
Medium-term	Support for certification strategies (3). Promote certification procedures to relevant ACs, which can apply for international certification (e.g.: organic), and support them to develop and implement the required internal control system.	XXX
Medium-term	Develop a digital and traceability system to link agroecological products to premium and secure markets. This could be piloted through a collaboration with the KAS platform initiative for instance, or by supporting stakeholders such as AMRU Rice to expand tool already in use to other crops, or in new areas.	XXX
Medium-term	Support for local, territorial, or regional branding. Similarly to iDE, the project could support vegetable farmer groups investing in climate resilient practices to sell specific niche product under a local label, e.g.: “sustainable melon” (iDE helped small-scale farmers taking advantage of new market opportunities by establishing a melon association, and creating a brand for melons produced with climate-smart practices).	XXX

C.5.4 Support the development of adapted extension services

The Nurture Project should contribute to reinforce existing extension systems, by integrating economic aspects and managerial advisory to farmers for instance. Extension services today are still often based on the delivery of standardized technical guidelines, whereas it should take into consideration the specificities of each farm (such as the resources, availability of production factors, exposure to risks) to deliver tailored advisory services that have more potential to bring benefits to the farmers.

Specific attention should also be given to business development and regular support of agriculture cooperatives and private sector actors, in relation with the development of targeted value chains and potential transition needs. This could be done through regular support to develop and implement the business plans, but also by supporting the involvement of private sector actors in the provision of climate resilient products or services to farmers, through market development and capacity building. Agriculture cooperatives have the capacity to facilitate the integration of smallholder farmers into the value chains, which is why the project should work with cooperatives to support their transition with a potential role in aggregation, processing, and marketing of products, knowing that cooperatives could also provide machinery services to farmers.

¹⁴ SRP was introduced in Cambodia in 2016. It is an initiative by UNEP and IRRI and has found recognition with some of the biggest international traders (EBRO, OLAM etc.) and leading retailers (Lidl, MARS etc.) It responds to the consumer interest (especially in Europe) for sustainable and socially responsible rice production. SRP has a national chapter in Cambodia since 2021 and several rice millers (AMRU, IBIS, CITY Rice) are members and try to introduce SRP with their paddy suppliers

The development of adapted extension services would come together with institutional support, for instance by supporting the CASIC platform facilitating the organisation of awareness raising events, facilitating regional visits for national and local stakeholders to learn from other agroecological initiatives.

Finally, the improvement of extension services to farmers should include the use of information and communication technologies (as further described below in the section C.4.), but also the deployment of well-trained extension agents to provide tailored advisory services to farmers. As an example, the development of rice monitoring, rice and climate forecasting, mapping of rice areas that are mostly affected by droughts, floods, and other negative impacts of climate change, would also reinforce the advice and recommendations given by extension agents. A list of concrete and actionable activities to consider to support the development of adapted extension services is suggested in the following Table 8: Potential interventions to support existing extension services

Table 8: Potential interventions to support existing extension services

Institutional support		Potential (impact X feasibility)
Short-term	Collaborating with local authorities, develop participatory farm-level engagement (e.g.: Farmer Field Schools, meetings with multiple stakeholders) to enhance pro-active learning and participatory management.	XX
Short-term	Support the CASIC platform by facilitating the organisation of awareness raising events, facilitating regional visits for national and local stakeholders to learn from other agroecological initiatives.	XX
Short-term	Multi Stakeholder Platforms (MSP) were launched as part of ASPIRE to gather stakeholders involved in a value chain (farmers, product/ service suppliers, buyers, local authorities) and are centred around information sharing, contract farming, business services, and are an opportunity to alert about key issues. Synergies could be developed to increase awareness around climate change, available products, or services, etc.	XXX
Short-term	Strengthen knowledge and use of climate information and early warning systems at MAFF level, to ensure climate data are used for extension and advisory services.	XX
Short-term	Create linkages with CE SAIN, their ATPs, and ACs in Battambang and Preah Vihear for farmer training on sustainable agriculture.	XX
Short-term	CE-SAIN managed a project called Conservation Agriculture for a Fee. This ended in 2021. Nurture should study lessons learned from this project and see how such service provision for a fee could be integrated in Nurture.	XX
Medium-term	Collaborate with MAFF to consolidate and structure the demand for sustainable products and services through a national digital marketing campaign under the ministry, to increase awareness and understanding of farmers on the techniques and technologies, to promote the technologies in existing research or demonstration sites (e.g.: Agri Techno Parks, Centre of Excellence as part of ASPIRE AT, etc.)	XX
Medium-term	Organise trainings both at the PD AFF and the District Agriculture Offices levels, involving CEWs, to strengthen extension systems for incorporation of climate resilient practices. Provide learning	XXX

	opportunities for extension services providers on the interpretation and application in local contexts.	
Medium-term	Support existing initiatives (e.g.: CASIC) to enhance multi-level cooperation and multi-stakeholder partnership with national and international climate and agriculture research institutes, as well as with local decision-makers, communities.	X
Business development (AC & private service providers)		
Short-term	Establish and strengthen ACs to develop their markets through activities such as contract farming, drying, provision of high-quality seeds, certification, etc. for market driven production.	XXX
Short-term	Several input supply companies do extension work through their sales force (Angkor Green and East West Seed are good examples). Although their priority will be to promote their own products, they also train farmers in cross-cutting subjects such as the proper use of PPE or the production of vegetable seedlings. Nurture could encourage such companies to start serving currently under-served districts.	XX
Short-term	Develop and implement digital literacy trainings among ACs, service providers or individual farmers as persistent challenges remain on the digital services demand-side, impacting the adoption and safe use of digital services, such as overall low financial literacy, limited awareness of digital services by consumers, understanding of benefits, poor perception and lack of trust in digital services, perceived complexity of digital services, and general illiteracy.	XXX
Short-term	Disseminate technical knowledge about climate-smart practices that exist for the vegetable sector, using technical guidelines and content developed as part of projects (e.g.: CHAIN, CSmart), extend the work in underserved areas (e.g.: replicate CHAIN successful activities in Banteay Meanchey and Battambang provinces).	XXX
Medium-term	For the potential unstructured value chains (e.g.: soybean, sesame, longan) conduct value chain studies to confirm the buyer demand, mapping, and analysis of the different players. Support the development of local clusters/associations if relevant.	XX
Medium-term	Promote climate smart irrigation solutions, such as solar water pumping systems. This could be done through long-term and business development support provided to companies, or through grants for technology providers to install technology demonstration sites.	XX
Medium-term	Strengthen existing FWUC to properly operate and manage irrigation schemes that are under performing in the targeted areas.	XX
Long term	Develop a model to expand private sector extension and advisory services as a means of improving knowledge and information support to smallholder farmers.	XX
Opportunities around digitalisation		
Short-term	Support the promotion of digital tools among the smallholder farmers (e.g.: EWS 1294) by collaborating with local authorities, service providers and ACs to disseminate information about the benefits of using such tools, but also by providing training and capacity building on their use to farmers.	XXX

Short-term	Organise Training-of-Trainers to champion farmers, AC leaders, or input suppliers on digital literacy, so that they can promote the use of relevant digital tools and services to farmers.	X
Medium-term	Create scenarios that will strengthen the climate monitoring and information systems that exist to improve the farmers' adaptation to climate change. For example, the Nurture project could supplement the EWS 1294, supporting local level planning and smallholders' adaptation strategies, creating production scenarios based on climate historic data and alerts they received; or specifically improve the development of rice monitoring, forecasting, mapping of rice areas that are mostly affected by droughts, floods, and other negative impacts of climate change, to reinforce the advice and recommendations given by extension agents.	XXX
Long term	As a huge amount of data is generated, combining it in one single platform has potential to benefit to the government, farmers, and private sector actors. Nurture could consider contributing to the KAS platform initiative, as a service provider, developing and piloting one KAS application, e.g.: supporting the development of the KAS-AI application: recommendation on crop planning, risk analysis, market, etc.	XXX

C.5.5 Support for policy implementation

Crop specific national policies for rice and cassava have been adopted by the RGC while several other national policies (mango, cashew, CA) are under preparation. In addition, there is a national seed policy, a Prakas on Quality Declared Seed and the recently adopted food safety law. At provincial and farmer level there is little awareness of these policies and dissemination is still problematic. The main barriers are the limited staff (capacity and availability) at the sub-national levels in implementing adaptation and mitigation actions, as well as coordination with line ministries and other stakeholders, to ensure that efforts and resources are concerted, and synergies are leveraged. The Nurture project could play an important role in awareness creation and dissemination.

Table 9: Potential interventions to support policy implementation

Policy support		Potential (impact X feasibility)
Short-term	Develop case studies on successful sustainable farming solutions in Southeast Asia that could act as inspirations to the government, farmers, and private sector actors.	X
Medium-term	Improve policy dialogue and build the capacity of public institutions on regenerative farming. Reinforce the institutional capacity at the national, provincial, and local levels by engaging with the Climate Change Technical Working Group (CCTWG). Support to enhance their capacities with a strong emphasis on conservation agriculture and regenerative farming to boost agricultural productivity.	XX
Medium-term	Support the implementation of the Roadmap of CASIC 2022 -2026, by assisting MAFF in developing an action plan to lead the advocacy efforts needed.	XX
Medium-term	Develop policy briefs advocating for policies and resource allocation to promote uptake of climate resilient agriculture practices.	XXX
Long-term	Stimulate policy dialogue supporting the adoption of climate resilient practices, working with key public and private sector actors. Key policy	XX

aspects that require increased policy dialogue include for example financial inclusion and digitalization (increase uptake of digital financing in rural areas), guarantees and other risk sharing mechanisms.

D Conclusion

The climate resilient agriculture study confirms that farming activities are being affected by increased frequency and severity of climate events, manifested in yield loss or crop failure, and that are becoming more and more common, especially for smallholder farmers. The Nurture project aims to improve the resilience of smallholder farmers and the vulnerable groups in Battambang, Banteay Meanchey, Oddar Meanchey and Preah Vihear provinces.

Facilitating smallholder farmer adaptation to climate change will require a combination of technical, research, market, and policy solutions to address the main barriers¹⁵. This will include the creation of incentives, credits, and other financing mechanisms to support farmer adaptation efforts, the development of research to identify the most effective adaptation options, the strengthening of extension services to provide technical support to farmers on how to enhance their resilience to climate change, and the support of private sector actors to facilitate the availability of adapted products and services, among other activities.

Besides, there will be a need for detailed and geographically based information to ensure that recommendations are provided on adaptation strategies and practices for smallholder farmers working in different crop systems. Indeed, tailored adaptation strategies must be considered and deployed to ensure it will be accessible for the target group, adapted to the agroecological and socioeconomic contexts. A wide range of adaptation options have been identified (e.g.: adoption of improved varieties, introduction of smart water solutions, adoption of integrated pest management practices, adjustment of crop planting calendars, adoption of conservation agriculture principles, etc.), all being relevant for inclusion in the strategies. However, it will be important to promote adaptation strategies considering the diversity of farming systems and socioeconomic conditions in the 4 different provinces.

¹⁵ A recent study in Vietnam came to similar perceptions/conclusions. *“Facing with disasters in the context of climate change, farming households have applied some models of CSA such as minimal tillage, intercropping, crop rotation, crop transformation, and the use of plant varieties. Binary logit regression analysis indicated that age, education level, household income, membership of local associations, training attendance, and support policies were variables significantly influencing the farmers' decision to apply CSA. Challenges for CSA adoption include lack of capital, information, technical support, and land ownership institutions in Vietnam. The study also made recommendations to promote CSA in Vietnam, including reforming the legal system, strengthening agricultural extension services, and providing technical and capital support to farmers”*.

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Annex 1. List of key stakeholders interviewed

Organisations	Sector	Contact	Date
SNV	CHAIN Project - Horticulture	Sokundarun Lim	3/5/22
Swisscontact	Innovation for Sustainable Agriculture - Regenerative agriculture	Mr Rajiv Pradhan	4/5/22
MAFF	Department of Extension for Agriculture, Forestry and Fisheries	Dr Mao Minea	5/5/22
IDE	Climate Smart Commercial Horticulture Cambodia (CSmart) Program	Kong Sophoan	6/5/22
MAFF	Conservation Agriculture and Sustainable Intensification Consortium (CASIC)	HE. Dr. Chan Saruth	9/5/22
CIRAD	Conservation agriculture, regenerative agriculture - WAT4CAM, Boknor, etc.	Mr. Florent Tivet	9/5/22
GDA	Agriculture Engineering Department	Mr. Ngin Kosal	10/5/22
Syngenta	Climate insurance	Mrs. Sophary Long	10/5/22
GDA	Department of Climate Change	Mr. Om Phirum	11/5/22
GDA	The Nurture Project Working Group	Mr. Seng Tuy	11/5/22
GDA	Department of Agriculture Cooperatives	Mr. Chea Saintdona	11/5/22
SmartAgro	Conservation agriculture/Regenerative farming - product and service provider	Marc Eberle	19/5/22
USAID	Harvest 2 - Horticulture	Ms. Ith Kallyan	30/5/22
GIZ	Project Strengthening the Climate Resilience of Agricultural Systems	Astrid Faust	24/5/22

PIN	Early Warning Systems	Ms. Anouk Chaptal	26/5/22
AngkorSalad	Digital tool	Sam Bona	25/5/22
Larano Workshop	Machinery importer (No-till planter)	Mr. Ou Chhoeum	26/5/22
UNDP	Strengthening Climate Information and Early Warning Systems to Support Climate-Resilient Development Program	Mr Sovanny	20/5/22
AVSF	Support Union of cooperatives (PMUAC) in Preah Vihear to produce and trade organic rice	Mr Meang Savoeurn	7/6/22

Annex 2. List of stakeholders met during the field survey

BATTAMBANG

Districts	Interviews conducted
Rukh Kiri	2 FGDs with farmers. Crops cultivated: vegetable, maize, cassava, rice, mango, pineapple
Kroas Krala	1 FGD with farmers. Crops cultivated: rice, cassava, maize
	1 FGD with women farmers
	1 inputs supplier
	1 local NGO
	1 commune officer
Sangkae	Project manager of CE SAIN
	FWUC, receiving support from WAT4CAM
Battambang	Deputy director of PDAFF
	Technical team MetKasekor

PREAH VIHEAR

Districts	Interviews conducted
Rovieng	3 FGDs with farmers. Crops cultivated: rice, cassava, cashew, vegetable, corn, banana, mango
	1 local service provider
	2 inputs suppliers
	1 representative of AC
Choam Ksant	1 FGD with farmers. Crops cultivated: rice (organic and non-organic), cassava, cashew
	1 FGD with women farmers
	2 AC

BANTEAY MEANCHEY

Districts	Interviews conducted
Monkol Borey	2 FGDs with farmers. crops cultivated: rice
	1 FGD with women farmers
	1 natural fertilizer seller
	1 commune officer
	1 AC
Preah Netr Preah	2 FGDs with farmers. crops cultivated: rice and cassava
	1 chemical fertilizer distributor
	1 cassava collector

ODDAR MEANCHEY

Districts	Interviews conducted
Banteay Ampil	3 FGDs with farmers. Crops cultivated: cassava, rice, maize
	1 AC
	1 cassava collector
	2 inputs suppliers
	1 machinery provider
Anlong Veng	1 FGD with farmers. Crops cultivated: cashew
	1 FGD with women farmers

Annex 3. Summary of production estimates in the 4 targeted provinces

Crop	Production in Battambang	Production in Oddar Mancheay	Production in Preah Vihear	Production in Banteay Meanchey
Rice	133,000 ha of rice planted and 302,700 tons harvested (CIAS, 2019)	54,200 ha of rice planted and 45,800 tons harvested (CIAS, 2019)	35,200 ha of rice planted and 53,400 tons harvested (CIAS, 2019)	132,700 ha of rice planted and 238,600 tons harvested (CIAS, 2019)
Cassava	Battambang itself 1/3 of national production in 2019. 55,200 ha planted and 665,000 tons harvested (CIAS, 2019)	40,600 ha planted and 525,300 tons harvested (CIAS, 2019)	17,000 ha planted and 118,700 tons harvested (CIAS, 2019)	42,800 ha planted and 778,000 tons harvested (CIAS, 2019)
Maize	Battambang represents more than 61% of the total maize cultivated area. National estimate 185,000 ha of maize planted, and 895,000 tons harvested (CIAS, 2019)	500 ha planted 130 tons harvested (CIAS, 2019)	3,000 ha (CIAS, 2019)	6,600 ha of maize planted and 39,165 tons harvested (CIAS, 2019)
Cashew	3,780 ha planted and 280 tons harvested (CIAS, 2019) 2,800 tons produced (GDA/MAFF, 2018)	18,390 ha planted (CPSA, 2021) and 1,930 tons harvested (CIAS, 2019)	36,743 ha planted (CPSA, 2021) and 4,100 tons harvested (CIAS, 2019)	810 ha cultivated, 1,360 tons (2018, GDA/MAFF)
Soybean	Total production of 175,977 tons per year in 2019. In recent years, soybean production has increased in north-western Cambodia, especially in Battambang, Siem Reap, Kandal, and Takeo. However, the main production area for the past five years has been in the provinces of Ratanakiri and Preah Vihear (Nget R, 2021)			
Sesame	3-4,000 mt. Mostly black sesame with export potential to Japan. White sesame used in bakery is more popular in European/ US markets.	less than 1,000 mt	less than 1,000 mt	less than 1000 mt
Mango	13,000 ha planted and 40,400 tons harvested (CIAS, 2019). 2 districts renowned for producing larger volumes: Banan & Ratanak Mondol	8,000 ha planted and 21,700 tons harvested (CIAS, 2019)	1,400 ha planted and 1,000 tons harvested (CIAS, 2019)	4,100 ha (CIAS, 2019)

Vegetables	In 2021, Cambodia produced about 750,000 tons of vegetables annually, on an area of ~63,000 ha. Data per province is not available.			
Sugarcane	19,243 ha and 109,105 tons harvested in 2015 in Cambodia			
Banana	1,770 ha planted and 9,000 tons harvested (CIAS, 2019)	No data available	750 ha planted and 1,600 tons harvested (CIAS, 2019)	No data available
Pepper	The total planted area for black pepper in Cambodia was estimated at 9,219 ha with 8,616 ha harvested. The quantity produced from black pepper was estimated at 22,926 tonnes. Very low production reported in the 4 targeted provinces.			
Longan	2,720 ha planted (CIAS, 2019)	no data	no data	Longan cultivation is increasing with plantations spanning more than 13,600ha, mostly in Battambang, Pailin and Banteay Meanchey provinces.
Poultry	~31,000 households raising livestock and poultry ~1,186,605 chickens More than half of Cambodian households raise poultry (CIAS, 2019)	~31,000 households raising livestock and poultry ~ 685,130 chickens (CIAS, 2019)	25,000 households raising livestock and poultry ~581,300 chickens (CIAS, 2019)	~25,000 households raising livestock and poultry ~669,483 chickens (CIAS, 2019)
Aquaculture	There is uncertainty about the volume of production. According to the official statistics, freshwater and marine aquaculture production reached 170,000 mt in 2016			
Pig	~3,000 households raising pigs ~32,300 pigs (CIAS, 2019)	~4,000 households raising pigs ~10,870 pigs (CIAS, 2019)	~12,000 households raising pigs ~47,370 pigs (CIAS, 2019)	~4,000 households raising pigs ~29,800 pigs (CIAS, 2019)
Rubber	2,150 ha (2013 data only)	15,000 ha (2013 data)	Rubber plantation on 5,000 hectares (2019)	330 ha (2013 data)

Annex 4. Summary of information collected at district level through FGDs

BATTAMBANG	KOAS KRALA	RUKH KIRI
RICE	Market organisation - Farmers usually sell their products to local collectors. - They are not directly aware of market trends, and they follow demand from the collector. - Rice cultivation is systematic for them, it represents 80% of their crops. Level of organisation - They belong to an AC, Toul Balang rang Reung. - The AC helps recovering farms, supports to select fertilizers, and facilitates access to credit. Access to inputs - Inputs are purchased to local distributors. For the machinery they rely on service providers. It is very convenient: they also provide technical assistance in case of flood or drought, that ensure farmers good return on investment. Access to information - They obtain weather information on Facebook and the TV. - They do not receive market information and depend on the collectors. - They receive a training about climate change from agents of the Ministry of Environment. Access to finance - The AC provides informal finance. However, they do not have access to specific loans for agriculture.	Market organisation - A collector comes regularly to buy the harvest. They assume he resells the products on Phnom Penh, Siem Reap and Battambang markets. Level of organisation - Farmers are members of ASPIRE cluster. - The cluster allows them to increase their negotiation power with the collector. (Many farmers around, that did not belong to the cluster, did not survive the COVID crisis and dropped off from this occupation.) Access to inputs - They get inputs from partner cooperative "Tamarkol". - For those who are not member of the cluster, they usually buy it on the local market. Access to information - They have access to weather information from district governors, TV and Facebook pages. - They rely on the collector for market information. They sell rice whatever the price is. - They received training from MOE twice: i) a training about climate change, "long time ago"; ii) another one about climate change, they don't remember the details. - Harvest 2 project provided training and associated material like dripping system and plastic cover for their crops, 6 years ago. They received subsidies (40%) and farmer contribute to 60%. Only a few adopted it despite the subsidy, they were afraid it was not relevant and profitable on the long term. Access to finance - They have access to agriculture loans. Usually, for the start of the season and payback during the harvest season. About 10 MFIs lend to farmer in their area.
MAIZE	Level of organisation	Level of organisation - There is also a maize ASPIRE cluster.

	- The AC Toul Balang Rang Reung also gather farmers producing maize crop. Market organisation - Farmers do not have any fixed crop calendar; they cultivate maize based on the market trends and orientation received by the collector. Maize represents 10% of their farming.	Market organisation - Farmers do not have any fixed crop calendar for non-greenhouse crop; thus, maize is grown according to market trends and information from the collector.
CASSAVA	Level of organisation - The AC Toul Balang Rang Reung also gather farmers producing cassava. Market organisation - Farmers do not have any fixed crop calendar; they cultivate cassava based on the market trends and orientation received by the collector. cassava represents 10% of their farming.	Level of organisation - There is also a cassava ASPIRE cluster Market organisation - Farmers do not have any fixed crop calendar for non-greenhouse crop; thus, cassava is grown according to market trends and information from the collector.
VEGETABLES	n/a	Level of organisation - ASPIRE is particularly active in the vegetable sector, and promotes the uses of greenhouses to increase sustainability of the production systems. Market organisation - The vegetables cultivated in greenhouses benefit from a price fixed in advance at each cycle. As the price is fixed in advance, for each type of vegetable, farmers can choose which one to grow for the cycle. Access to information - Harvest 2 project also provided all the necessities equipment (e.g.: greenhouses). Only 3 to 5 households adopted it, they had very profitable production and the other farmers wanted to adopt the same equipment. They want to switch to GH vegetable, but the project is currently stopped, and the current level of price is low, they think such investment would not be profitable on the short / mid-term.
PREAH VIHEAR	ROVIENG	CHOAM KSANT
RICE	Level of organisation - Farmers are members of one AC, Lerk Kompos Sadtreay Cooperative. - This AC provides technical knowledge and manage contracting with buyers. - Main constraints: There are many collectors in the area, but there is a lack of supply for commercial crops.	Market organisation - Farmers sell their production to local collectors and ACs. - Price of non-organic rice is 800-1000 riels/kg; organic is 1180 riels/kg. There are high price fluctuations (2 to 3 times per day). Farmers said there is no solution to deal with price fluctuations. The crops cultivated are selected based on the market trends, not for agronomic reason. Level of organisation

		- Farmers are members of 2 ACs, Romdosh Srae cooperative, and Teuk Kraham farmers AC (organic rice). They are also beneficiaries of ASPIRE and AIMS Projects. - ACs and clusters enable the farmers to received technical trainings and capacity building, access to markets, financing support (loans, input supplies, including organic fertilizer for Teuk Kraham AC). Access to inputs - Main suppliers are retailers, ACs and through development programs (e.g.: ASPIRE). Access to information - Farmers look for weather information on their smartphones. - They do not have access to market information.
CASHEW	Level of organisation - Cashew farmers are members of 1 AC, Lerk Kompos Sadtrey Cooperative. - This AC provides technical knowledge and manage contracting with buyers. Access to information - Farmers receive weather information on a Telegram channel producers' group.	Level of organisation - Farmers are members of 2 ACs (gathering organic producers): Romdosh Srae and Teuk Kraham - Those ACs provide technical training, linkage to market, contract buyers, small loans (from 125\$ to 1000\$), market information, the collection of 2.5 tons of dried cashew, and the supply of organic fertilizer.
CASSAVA	Market organisation - Farmers sell their production to collectors. - Price for fresh is 200-380 riel/kg; dried is 600-990 riel/kg. There is oversupply because all the farmers harvest at the same time, which corresponds to the collectors' demand. Prices can fluctuate 2 or 3 times a day. - There is no solution to deal with the price fluctuation, farmers need money and have to sell even if the price is low (e.g.: no warehouse, no drying options during the rainy season). Post-harvest technologies could allow farmers to sell products at a higher price. Level of organisation - Cassava producers are members of 1 AC. - The AC provides technical training, the collection of the production, and input supply (fertilizers). - Main constraints: They receive higher prices (compared with local collectors), but the AC always buy at the end of the harvest season and payment is always delayed. Access to inputs	Market organisation - Farmers sell their production to local collectors and an AC. - Price for fresh is 270-330 Riels /kg; dry is 650-820 riels/kg. Farmers said there is daily price fluctuations. - They do not have solution to deal with the price fluctuation because they do not have stock or any drying method post-harvest during the rainy season. - The crops cultivated are selected based on the market trends, not for agronomic reason. Level of organisation - Farmers are member of one AC, Romdosh Srae cooperative. They are also beneficiaries of ASPIRE and AIMS. - ACs provides technical trainings and capacity building, access to market opportunities, financing support (e.g.: loans, input supply). Access to inputs - Main suppliers are retails stores, AC, and development programs such as ASPIRE, provide small equipment: plastic net, chicken cages and other.

	- Main suppliers are local input shops and the AC. - Type of inputs: Pesticides, fertilizers, and machinery are available. - Constraints: The labour force is not always available, and the price is high (10\$/day/person, plus food). Access to information - Farmers do not have access to weather information. - Farmers do not have access to market information, only through the local collector. - Farmers received trainings about composting, fertilizers' usage, and plant disease management from agriculture governor or AC. Access to finance - Farmers benefit of payment schemes from AC and MFI, with low interest rate for agriculture machinery. - AMK, ACLEDA, LOLC, and Armet are active in this district.	- Inputs available are seeds, fertilizer, pesticides, equipment, machinery. Access to information - Farmers have access to the weather information online, using their smartphones. - They do not have access to market information.
VEGETABLE	Market organisation - Vegetables are sold to local collectors or on local markets. - Price fluctuation is due to regular oversupply on the market, and farmers do not have solution to deal with the price decline (import from provinces around). Level of organisation - Members of a farmer community (សហគមន៍កសិកម្មស្រូវ) and one AC (Leuk kompos satrey agriculture), and programs' beneficiaries (CHAIN, ASPIRE). - These organisations support them with technical knowledge (compliance with GAP), dividend from savings, and access to markets. Access to inputs - Input suppliers provide fertilizers, pesticides, seeds, tractor renting services, plastic net, planting trays, drip sprinklers, and electric pumps. - The labour price is too expensive for most of the farmers in the area (\$7.5 to \$10 for 6 hours/day, and food). - Poor quality of seeds was reported. - There is a lack of finance support for expensive products or technologies adapted to climate resilience. Access to information	n/a

	- Farmers use agri-staff apps to receive weather information on their smartphones. - They do not receive market information; the price is defined by the collector. - Farmers received trainings about how to prevent climate change impacts, but not about how to adapt on the long term. Access to finance - MFI are available in this area. - Amret, Vision fund, ACLEDA, LOLC, and the community saving are the main stakeholders providing financial support.	
ODDAR MEANCHEY	BANTEAY AMPIL	ANLONG VAENG
RICE	Market organisation - Farmers sell their production directly on local market, or to collectors. - There is a high demand but not enough supply, and not enough production to fill the market. There is a high price volatility. - They adapt by reducing their expenses (food, studies for children) and cultivating vegetable to have other revenues. Level of organisation - There is one AC in the area. - They have contracts with collectors to sell the rice at a higher price. Moreover, all farmers can exchange their knowledge and ideas about the farming practices. Access to inputs - The main suppliers are in the local market near the village. The AC provides inputs too. Sometimes, farmers buy inputs from other farmers, who bought their products from Thailand. - Seed, fertilizer, and pesticides are available as well as transportation services, machinery rental (115k riels/ha for the preparation of the land and the seeding), and factory to process the rice. However, there is no climate change adapted equipment available. Access to information - Farmers have information about the temperatures and the forecast for the week by TV, telephone, or radio. - Farmers do not receive market information; the buyers come and give their prices. - They receive 1 training per year from the MOE at provincial level as well as 1 training about climate change, provided for a	n/a

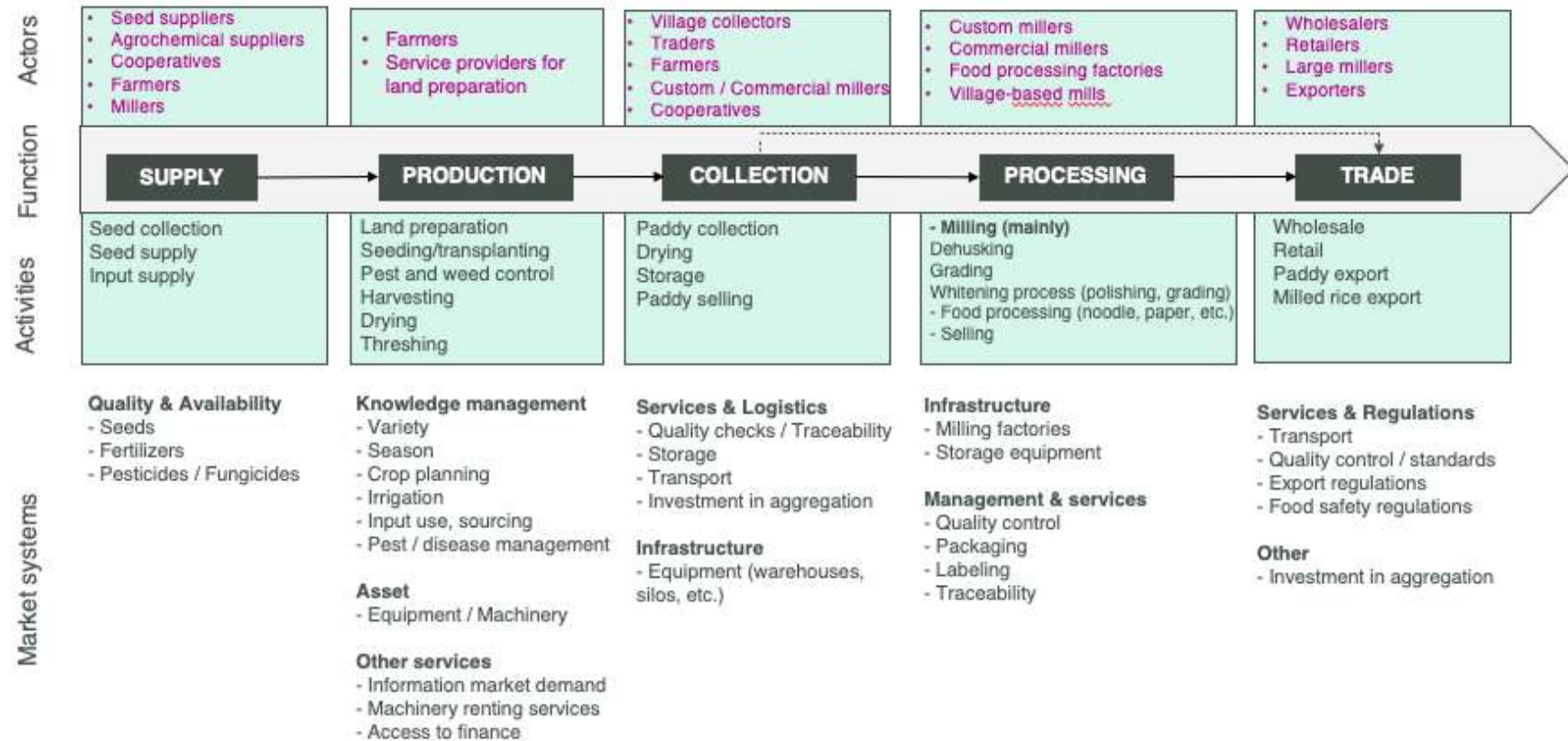
	few people only because of a lack of fundings. FH and CIDO are NGOs that provide trainings too. Access to finance - MFI and Banks provide some loans.	
CASSAVA	Market organisation - Farmers sell their production directly in local markets, or to collectors who sell it to Thailand. - There is a high demand but not enough supply, and not enough production to fill the market. There is a high price volatility. Price for 1 kg of cassava is about 270 riels. - They have no solution to deal with the market failures. Level of organisation - Farmers do not belong to any cooperative. Access to inputs - The main suppliers are in the local market near the village. Sometimes, farmers buy inputs from other farmer, who bought their products from Thailand. - Type of inputs: Seed, fertilizer, and pesticides are available as well as transportation services and machinery rental (530k riels/ha for the preparation of the land and the seeding). However, there is no climate change adapted equipment available. Access to information - Farmers do not have access to weather information. - Farmers do not receive market information; the buyers come and give their prices. - They receive 1 training per year from the MOE at provincial level as well as 1 training about climate change. The training for climate change was provided for a few people only because of a lack of fundings. Access to finance - MFI and Banks provide some loans.	n/a
MAIZE	Market organisation - Farmers sell their production to collectors. - The irregular supply leads to price fluctuations, 1 ton of maize is usually sold for 100\$. - Farmers try to diversify their value chains and produce cassava, pigs, and chickens. Level of organisation - Farmers are not members of cooperative.	n/a

	Access to inputs - Farm inputs are available in the local market. - Farmers rent tractor to prepare the land for 315k riels/ha. Labour to cultivate and harvest the maize is available for 140k riels/ha. Organic fertilizers are available, but it is too expensive for most of farmers (1 pack of 50 kg is 85,000 riels). Access to information - Farmers have access to information about weather through their phones. - The only access to market information is directly from the collector. - They do not receive any training about agriculture or climate resilience practices.	
CASHEW	n/a	Market organisation - Distribution channel is through collectors that come to buy at the farms, mainly from the district and some from Siem Reap - The supply is quite low compared to the demand. - Farmers do not know how to adapt to market failures. Level of organisation - They do not belong to any cooperative or farmer group. Access to inputs - Farmers buy inputs in big local shops. - Harvest is sold 1000 riels/kg. The price of fertilizer is 30,000 riels/ha, to apply pesticide for one day is 50,000 riels, and prune the trees is 20,000 riels/ha. Access to information - Farmers have access to weather information on their phone. - Farmers have access to market information through collectors. - They received training from provincial program on how to cultivate the crops, and how to use chemical products. Access to finance - Farmers don't have access to financial services.
BANTEAY MEANCHEY	MONGKOL BOREI	PREAH NETR PREAH
RICE	Market organisation - Most of farmers sell their rice to a middleman who sell the production to local rice millers, or to Battambang. - The demand is always high, but the prices are low and fluctuate a lot (from 560 to 680 riels/kg in O Dangkao Village, and from 680 to 790 riels/kg in Banteay Neang Commune).	Market organisation - Most of the rice production is sold to collectors (Kampong Chnang, or Vietnam). - Farmers sell their production to a middleman. The demand always exists, but prices fluctuate a lot (from 650 to 710 riels/kg).

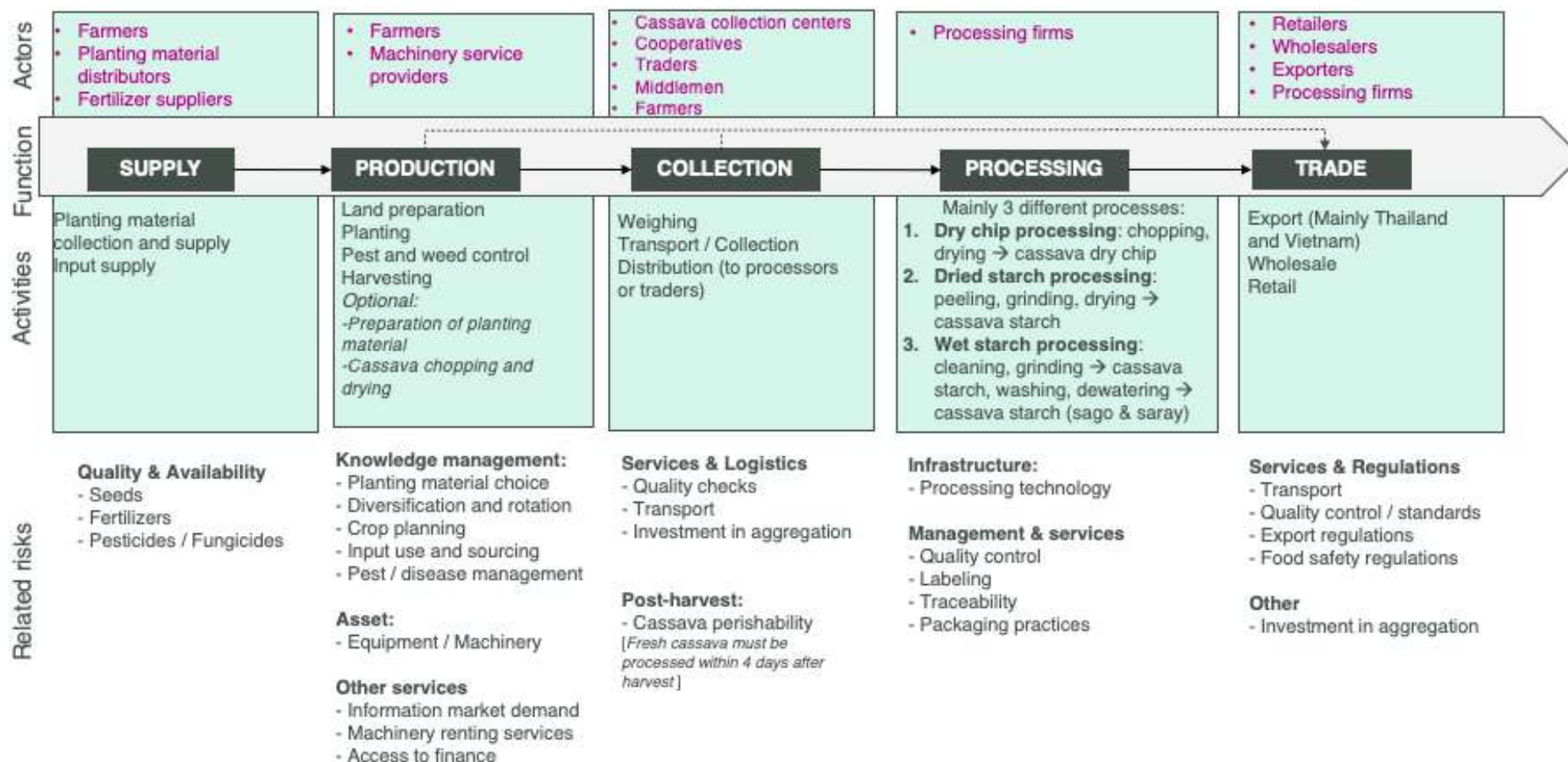
	Level of organisation - One farmer association exists: Rum Reung Farmer Association. - This association provides saving group for farmers, and better seeds (Jasmin rice). They try to experiment on natural fertilizer to replace the chemical fertilizer. - The association do not have enough capital to develop its activity. Moreover, farmers start their farming cycles at different dates which make it hard to sell the harvested products together. Access to inputs - Local shops provide most of inputs needed. Farmers usually rent the machinery from local service provider. - Most of the fertilizers available in the area are chemical fertilizers, but there is one input supplier who sell organic fertilizer. Nevertheless, most of farmers do not know about such product, or cannot afford it. Access to information - Farmers have access to weather information using telephones and TV. - Farmers have access to market information in advance from the neighbouring districts because it is the same middleman who buy rice in different districts. - There did not receive training about agricultural practices in O Dangkao Village, but it happens from provincial department in Banteay Neang Commune. Access to finance - MFIs are available in the area (Hartha, Chamroeun, and ACLEDA).	Level of organisation - There is no cooperative or farmer group. Access to inputs - Local shops provide most of inputs needed in the area. Farmers usually rent the machinery from a local service provider. - Constraints: Fertilizers is getting too expensive for farmers, who cannot afford it. Access to information - Farmers do not have access to any information about the weather in advance. - Farmers have access to the information about market in advance from the neighbouring districts because it is the same middleman who buy rice in different districts. - There is no training provided about agricultural practices in the area. Access to finance - Loans are accessible, but a few farmers did not pay the loan after harvesting because they were not able to. - MFIs are available in the area: Hartha, Chamroeun, and ACLEDA.
CASSAVA	Access to inputs - Most of the fertilizers available in the area are chemical fertilizers, but there is one input supplier who sell organic fertilizers. Nevertheless, most of farmers do not know about the existence of this product, or are not able to afford it.	Market organisation - Farmers sell their production to a collector, who exports to Thailand. - The demand is always existing. The price of cassava depends on Thai traders (from 650 to 710 riels/kg). Level of organisation - There is no cooperative or farmer group. Access to inputs - Local shops provide most of inputs needed. Farmers usually rent the machinery from a local service provider. - Fertilizers are getting too expensive and farmers cannot afford it.

		Access to information - Farmers have access to weather information and forecast on Facebook,. - Farmers have access to market information in advance from the neighbouring districts, it is the same middleman who buy cassava in different districts. - There is no training provided about agricultural practices in the area. Access to finance - Loans are accessible, but a lot of repayment issues. - MFIs are available in the area: Hartha, Chamroeun, and ACLEDA.
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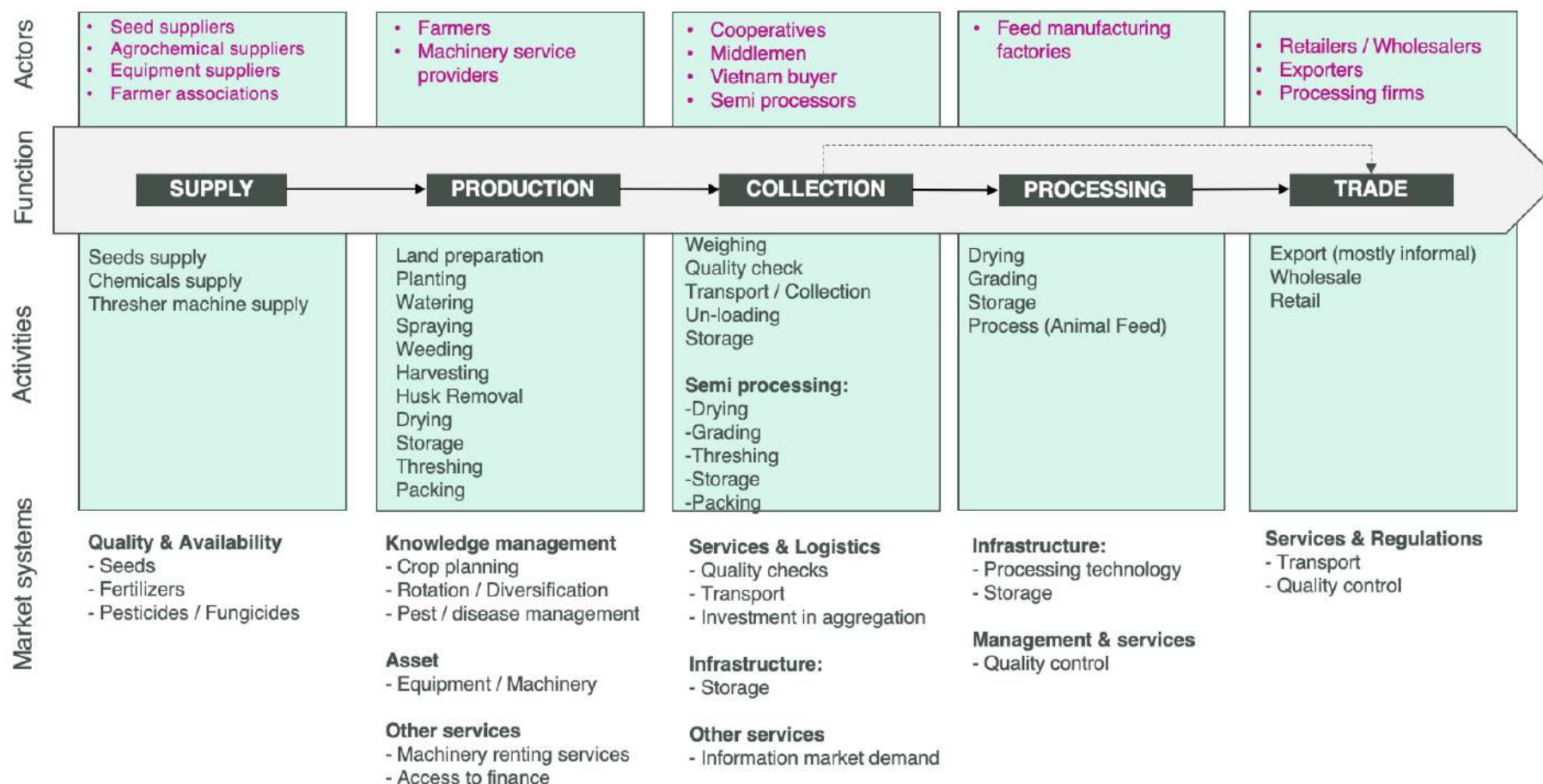
Annex 5. Rice production and market systems



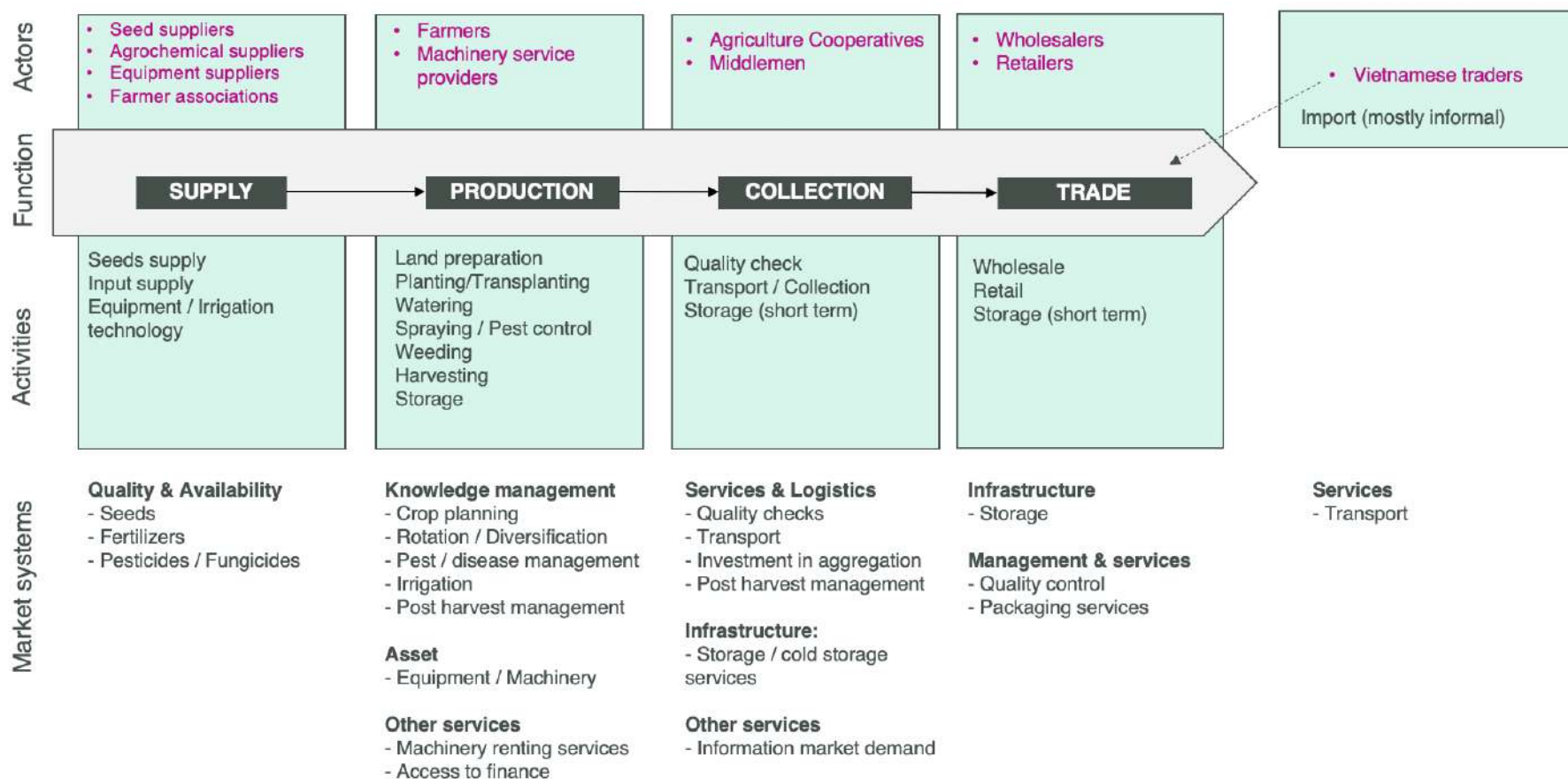
Annex 6. Cassava production and market systems



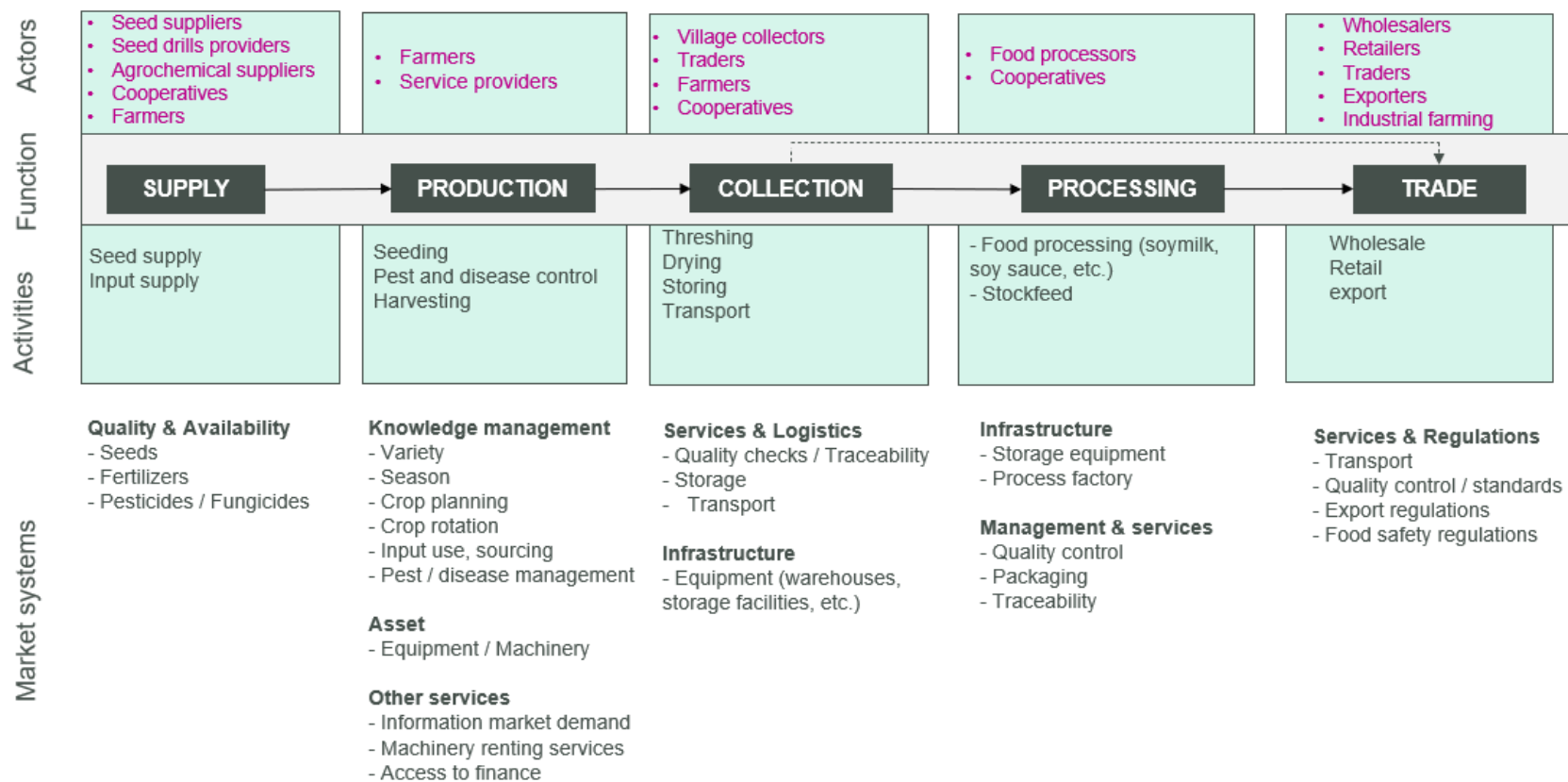
Annex 7. Maize production and market systems



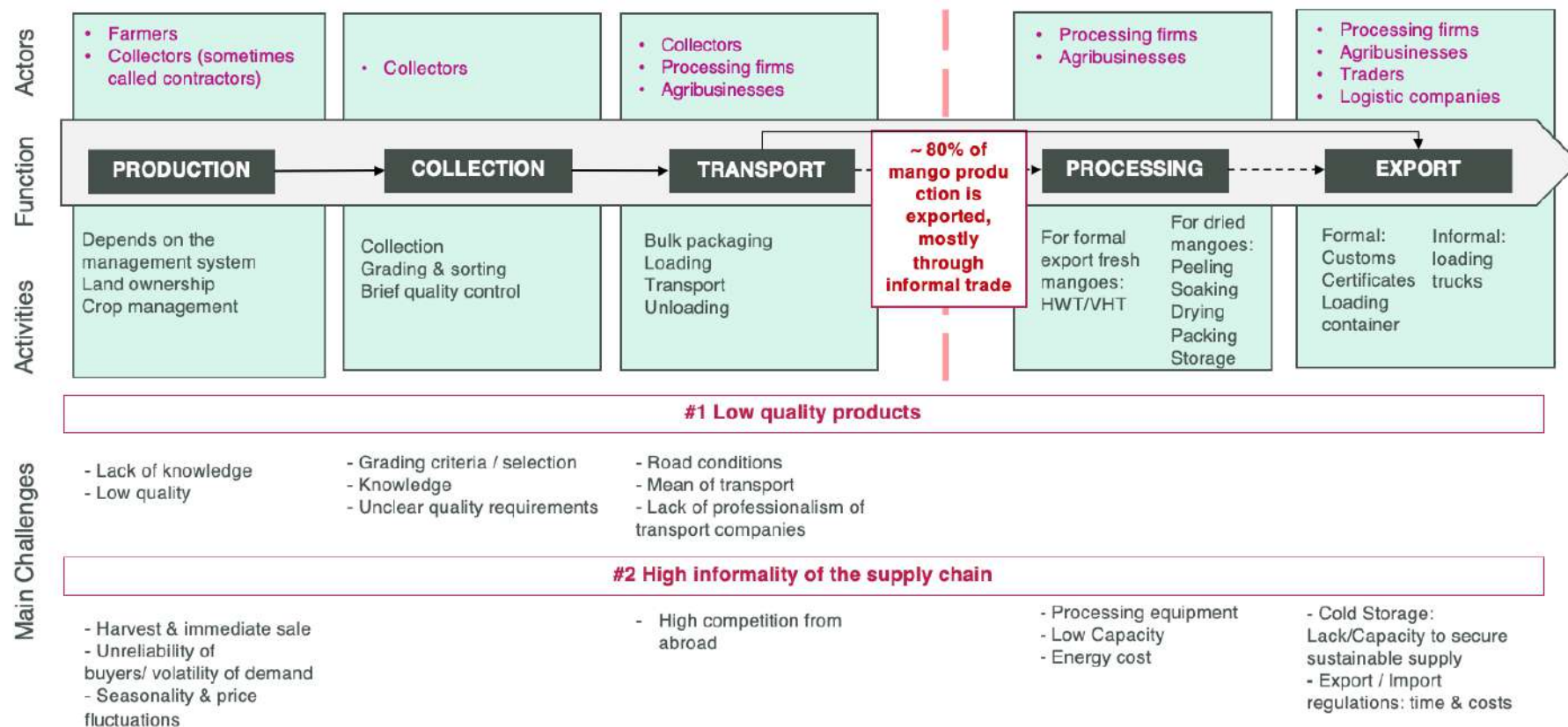
Annex 8. Vegetable production and market systems



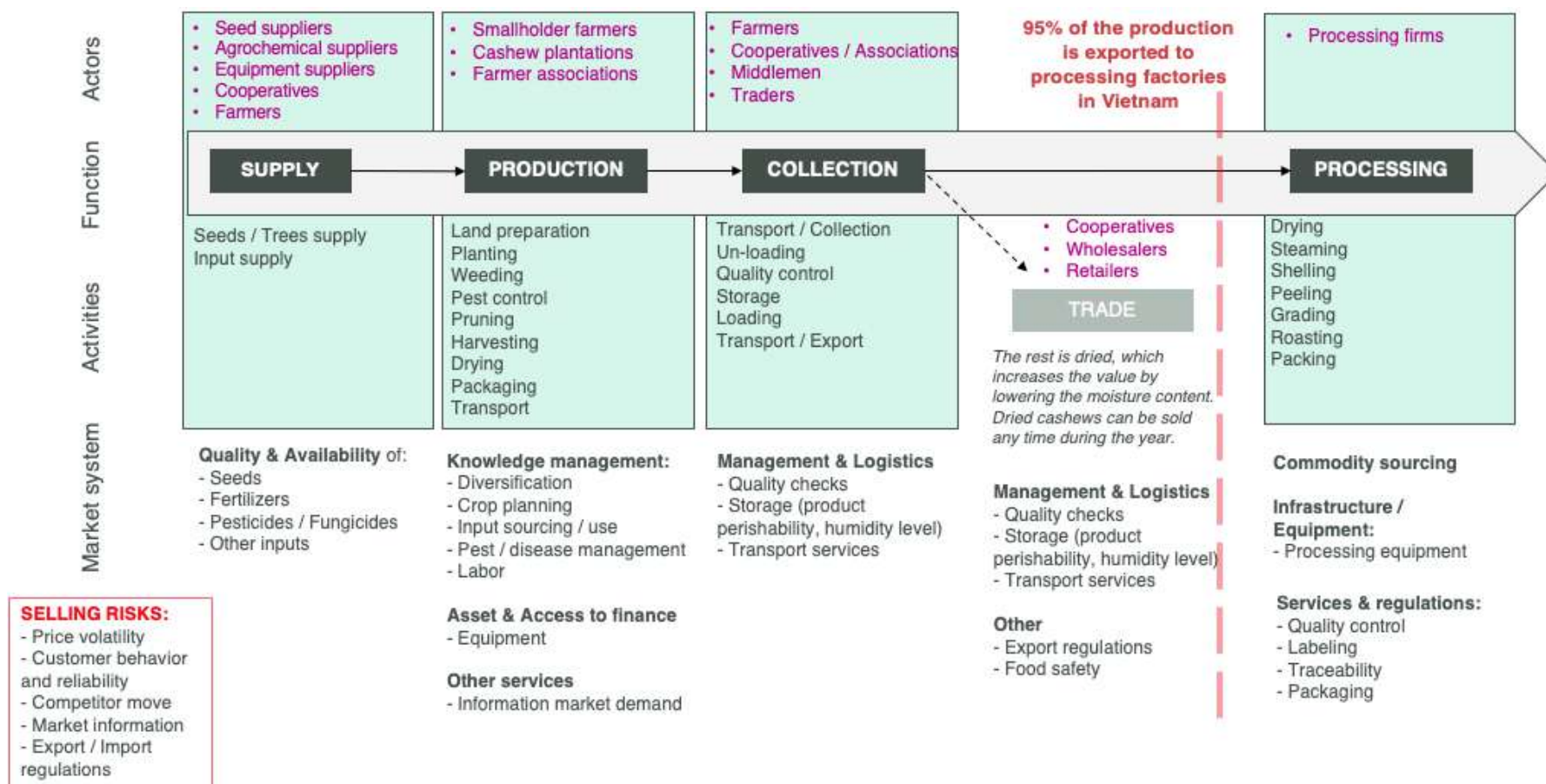
Annex 9. Soybean production and market systems



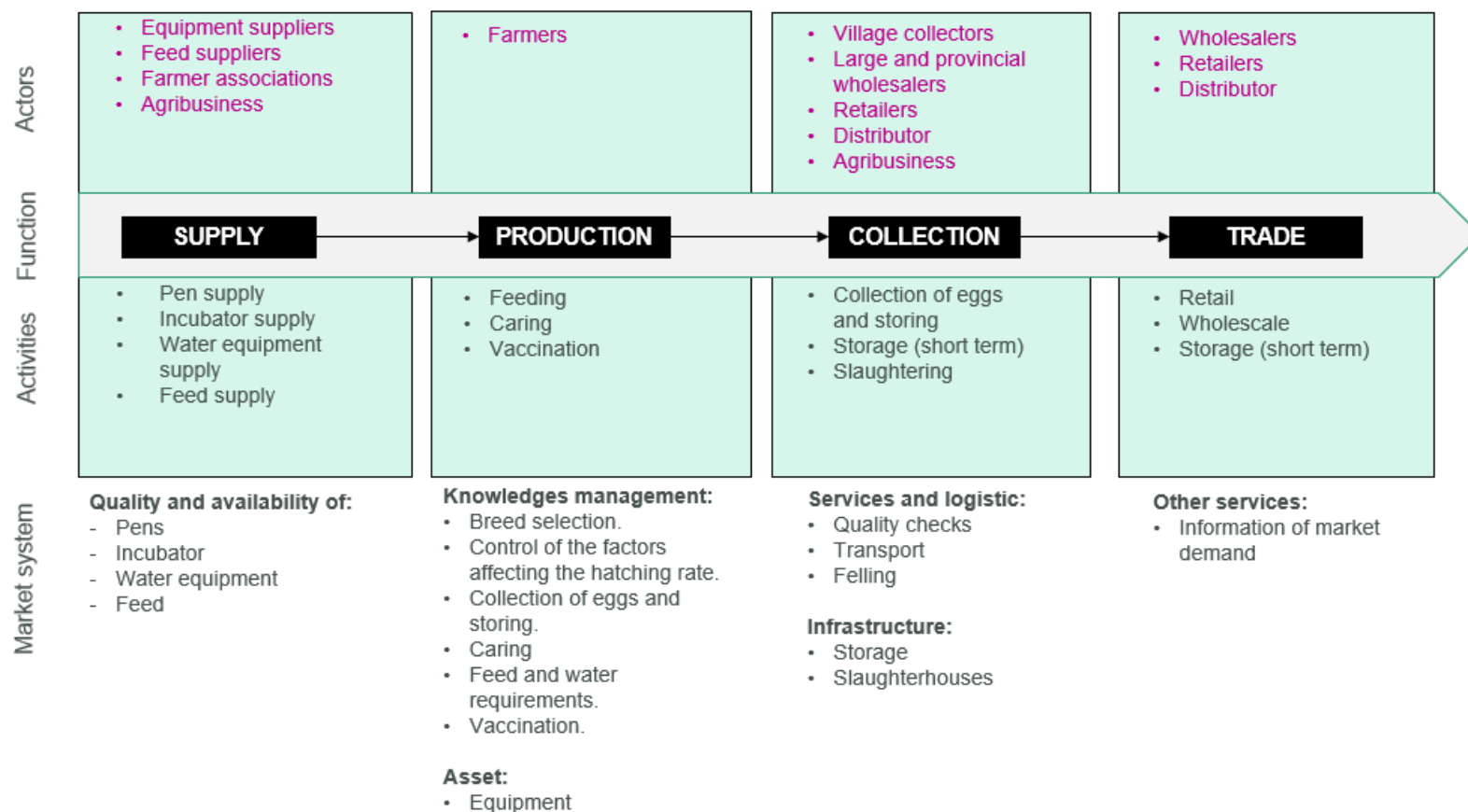
Annex 10. Mango production and market systems



Annex 11. Cashew production and market systems



Annex 12. Poultry production and market systems



Annex 13. Policies for climate resilient agriculture

Date	Policy/Strategy	Summary
Contract farming		
2011	Sub-decree on Contract Farming (2011)	It provides guidelines governing contract farming arrangements, and procedures for solving disputes arising out of contract farming. The Sub-decree also outlines the roles and responsibilities of different authorities to monitor contract farming and assist farmers. Although the Sub-decree provides a foundation for regulating contract farming, given the increasing number of farmers and companies involved in contract farming schemes, there is a need for legally enforceable contracts to strengthen trust between the parties involved (Ngo and Ngin, 2022).
2022	Law on Contract Farming (currently in drafting phase)	The law will be based on the Sub-decree and the experiences gained from the practices of contract farming so far (Ngo and Ngin, 2022).
Seed		
2008	Law on Seed Management and Plant Breeder's Right (Seed Law)	The law regulates production and trade of seeds and protects breeders' rights (USDA Foreign Agricultural Service, 2022). Despite this law, there is no regulations in place and an added complication is that the law determines that the competent authority is MISTI, but the executive Ministry is MAFF.
2017	Prakas on Procedure for Providing Seed Quality Certification	This Prakas establishes formalities and procedures to get certificates for seed quality for managing business activities involving seeds. Concerned businesses include the production, processing, importing, and exporting of seeds, and must apply for a certificate for seed quality and seed registration in the national list of seed varieties to be obtained from the GDA of the MAFF.
2021	National Cassava Policy (2020 – 2025)	This policy aims to position Cambodia to be a home of cassava processing industries and a reliable supplier of cassava-based products for global markets. To achieve this goal, this policy defines three main objectives: - To transform from subsistence to commercial cassava production, where the profitability of farmers is enhanced to generate incomes in the context of price volatility, sustainable land use and climate-smart agriculture - To support active processors and attract investment to produce value added cassava-based products to supply diverse markets

		- To enhance trade competitiveness by turning from market access to market presence, in improving trade facilitation and reducing trade-related costs.
2022	Prakas on Quality Declared Seed (QDS)	The GDA under the MAFF recently launched the QDS standard for rice products. The QDS system consists of documentation screening, field inspections and quality checks. The PDAFF is in charge of all inspections at the provincial level, while GDA staff supervise them nationally. The Department of Crop Seeds at the GDA was officially established to supervise and promote the QDS system.
2022	The Cambodian Seed Policy	The policy is set to provide a long-term vision and framework for seed sector development to ensure food security and agricultural productivity. The primary objective of this policy is to ensure that farmers have access to high quality seeds and a range of varieties through the most reliable and economic supply channels (USDA Foreign Agricultural Service, 2022). The Crop Seed Department (CSD) under GDA will be created and there is now, under the Seed Policy, a variety release committee, and a National Seed Council of which the CSD is the secretary. Aspects like processing, milling, storage, packaging, and quality control will be formally regulated. This regulation will help farmers to have greater confidence in the seeds they buy and will have wider choices in terms of quality, varieties, and suppliers, allowing them to maximize the potential of their crops (IRRI, 2022).
Climate change		
2010	Cambodian Climate Change Alliance	Even if in place since 2010, the Alliance is now in Phase III, which aims at strengthening national systems and capacities to support the coordination and implementation of Cambodia's climate change response and contributing to a greener, low carbon, climate-resilient, equitable, sustainable, and knowledge-based society. There are three key results to be achieved: - Relevant climate information is generated in a reliable and timely manner, suitable to sectors and targeting specific needs. - Tools are developed and implemented for the effective mainstreaming of climate change into policies, regulatory frameworks, programs, and budgets of priority sectors. National capacities for the mobilization, coordination and tracking of public and private climate change resources are strengthened.
2013	Cambodia Climate Change Strategic Plan (CCCSP) 2014-2023	It is the first-ever strategic plan produced by the RGC to mainstream climate change policies into NSDP (National Strategic Development Plan) to have a national response to climate change adaptation from all relevant ministries and government agencies.

Within the CCCSP, national adaptation programs and policies are mainly implemented through the National Adaptation Program of Action (PANA).

The CCCSP lays out eight strategic objectives:

1. Promote climate resilience through improving food, water, and energy security;
2. Reduce sectoral, regional, and gender vulnerability to climate change impacts, and minimize risks to health;
3. Ensure the climate resilience of critical ecosystems (the Tonle Sap, the Mekong River, coastal ecosystems, and highlands, etc.), biodiversity, protected areas and cultural heritage sites;
4. Promote low-carbon planning and technologies to support sustainable development;
5. Improve capacities, knowledge and awareness for climate change responses;
6. Promote adaptive social protection and participatory approaches in reducing losses and damage due to climate change;
7. Strengthen institutions and coordination frameworks for national climate change responses; and
8. Strengthen collaboration and active participation in regional and global climate change processes

2013	National Policy on Green Growth	The National Policy on Green Growth aims to strike a balance between economic development and protecting environmental resources, seeking to enhance the well-being and livelihoods of the population. It develops a green growth-enabling environment, thereby improving people's access to services, such as sanitation, water resources, and food security. Other objectives include job creation through green growth finance, regional green growth cooperation, and knowledge-sharing.
2015	Cambodia's Climate Change Financing Framework (CCCCFF)	The CCCCCFF for Cambodia presents a framework for governance-wide management of climate change finance. The CCCCCFF builds on Cambodia's national climate change policy, cross-sectoral action planning mechanism for climate change, and expenditure analysis (using tools such as the Climate Public Expenditure and Institutional Review (CPEIR)). It provides additional analyses of climate spending costs and benefits, an evaluation of climate financing scenarios, and an analysis of various modalities for channeling climate finance at the national and local levels. The CCCCCFF formulates guidelines for handling climate change finance. It also highlights the need for targeted approaches to create capacity.
2017	National REDD+ Strategy 2017 - 2026	Cambodia's REDD+ program is consistent with decisions adopted by the United Nations Framework Convention on Climate Change (UNFCCC) that recommends three phases

		of readiness, implementation, and results-based payments for greenhouse gas (GHG) emission reductions from the forestry and land use sector. This national policy aims to reduce Cambodia's annual deforestation by half by 2030.
2020	Updated National Determined Contribution	The NDC is divided into 2 main parts, adaptation and mitigation. The adaptation part mainly includes: - Implementing management measures for protected areas to adapt to climate change - Developing and rehabilitating flood protection dykes for agricultural and urban development - Increasing the use of mobile and permanent pumping stations in response to mini-droughts, and promoting groundwater research in response to drought and climate risk The mitigation part includes the management of Land Use, Land Use Change and Forestry (LULUCF) with actions to achieve the target of increasing forest cover to 60% of national land area by 2030, which is expected to reduce 7,987 GgCO₂eq by 2030.
Sustainable Agriculture		
2010	National Green Growth Roadmap	Its goal is to stimulate the economy through low carbon options, savings and creating jobs, protecting vulnerable groups, and improving environmental sustainability. Cambodia has therefore selected a number of priority actions, which include: - Developing climate-proof agriculture systems for adapting to changes in water variability to enhance crop yields. - Promoting climate resilient agriculture in coastal areas through building sea dykes and scaling-up of climate-smart farming systems.
2015	Agricultural Extension Policy	The goal of this policy is for all Cambodian farmers and farming communities to access and adopt improved agricultural knowledge, information, and technologies to enhance agricultural productivity, diversification, commercialization, and sustainable natural resources management.
2016	Master Plan for Crop Productions in Cambodia 2030	A plan to transition to modern agricultural system capable of generating high value and develop effects in the rural and urban economy through the development of agroindustry, agribusiness, and sustainable agriculture.
2018	Rectangular Strategy Phase IV	This strategy aims to set the main development plans and strategies in all priority areas for Cambodia and is the cornerstone of Cambodia's policies. The last of the four sections is related to inclusive and sustainable development through:

		- Promoting the agriculture sector and rural development - Improving the sustainable management of natural resources and culture - Strengthening urban planning and management - Improving environmental sustainability and the response to climate change
2019	Agricultural Sector Strategic Development Plan, 2019-2023	It includes the enhancement of agricultural productivity, diversification, and commercialization through different means including sustainable ones.
2020	Agricultural Sector Master Plan 2030	It aims at enhancing sustainable management of land, forestry and fisheries resources.
2021	Roadmap of Cambodia Conservation Agriculture and Sustainable Intensification Consortium (CASIC) 2022 - 2026	Aims to translate the vision and mission of CASIC into a high-level plan by defining strategic objectives and outlining priority actions and milestones to be achieved by 2025. Support the Steering Committee to guide, supervise and monitor the performance of CA and SI related interventions in Cambodia. Provide strategic direction to the Executive Board to plan, implement, monitor and review activities to address the main challenges and priorities in CA and SI. Serve as the coordination masterplan to guide the CA and SI activities to be carried out by different stakeholders in Cambodia. Establish priority areas for cooperation, coordination and networking among existing members and potential stakeholders in the country as well as in the region.
2022	Policy on Promoting the use of Renewable Energy Technology in Agriculture 2021-2030	This policy is planned to be implemented during the year and will promote and encourage the use and investment of renewable energy technology in the agricultural sector

Annex 14. Private companies in the climate resilient sphere

COMPANY	BUSINESS CONCEPT
SmartAgro	SmartAgro provides seeds and cover crops, organic input solutions, and conservation agriculture tools. They work closely with local authorities and other relevant institutions or development partners such as CIRAD, Swisscontact, CASIC, and MetKasekor. The goal of SmartAgro is to implement innovative cropping systems, regenerate soils and make crop and livestock production more resilient against climate change. The company is mainly active in Battambang and Preah Vihear.
Larano	Larano is an agriculture machinery manufacturer, importing from Brazil and distributing zero-tillage machinery for cassava, rice, and maize cultivation. The company is engaged in the piloting of MetKasekor model. Larano strategy is to sell to service providers, usually commercial farm owners who invest and provide services to smaller farmers in their communities. They also provide services to farmers working with the CASC.
BB2C Innovation	This is a local machinery distributor, commercialising low cost and locally made direct seeder for rice. The company is also designing a zero till seeder for rice, in cooperation with WAT4CAM R&D component in Battambang.
Lunheng manufacture	It is a local machinery distributor, distributing low cost and locally made direct seeder of rice.
Nuon Kong	Nuon Kong is a tractor importer and distributor. They are importing and distributing laser land levelling equipment, which is important for water management improvement for irrigated crops. The company is active in Battambang and Banteay Meanchey provinces.
Pteah Baitong	PB is a company distributing solar water pump, and promoting its use among smallholder farmers. They are currently experimenting pay-go payment mechanism through IoT technology integrated in their solar water pump, mostly in provinces around the Tonle Sap.
Harvest the Sun	HTS distributes solar dryer domes. The company aims to develop a sustainable ecosystem and postharvest value chain to encourage Cambodian farmers/ processors, communities, investors and other support groups to promote premium and hygienically dried commodities such as spice, herbs, fish and seafood.
SOGE	SOGE provides high quality and standard products and services with highest responsibility. They sell all kind of Solar systems such as Solar OFF & ON Grid, solar water pumps, etc.
AgroSolar	Agrosolar Cambodia is a wholly owned subsidiary of Agros Pte Ltd, headquartered in Singapore. The company distributed solar powered irrigation systems.
Solar Cold Storage	Solar cold storage supplies solar cold storage solutions, to fish harvesting businesses to reduce the cost and increase food quality.
Khmer Green Charcoal	KGC produces and sales environmental friendly char-briquettes from recycle biomass wastes. They have been tested and now used for poultry raising (chicks brooding).
ATEC	ATEC distributes biodigesters to process farm waste (animal manure & green waste) into free biogas for clean cooking and organic fertiliser, for better crops and healthier soil.

ECOSUN	EcoSun is a social enterprise working toward to energy/ electricity solution for people and communities in Cambodia. The company distributes mobile solar water pumps that are used by vegetable smallholder farmers.
GREEN INNOVET CAM	Green Innovet Cam (GIC) created a model for intensified smallholder production for traditional breed chickens, among their range of services and products, the company distributes solar egg incubators.
SE CAMBODIA	SE Cambodia distributes solar grinder solutions, to support smallholder and commercial farmers with easy-to-use and economic solutions to feed and protect their animals.
East West Seed	Vegetable seed supplier, distributing hybrids and introducing varieties that allow farmers to be more productive.

Annex 15. Detailed description of digital tools & resources for climate-resilient agriculture

1. INFORMATION SERVICES

EARLY WARNING SYSTEM (EWS) 1294

EWS 1294 is a Cambodian national early warning system, operating in all provinces, disseminating early warning information to vulnerable communities at risk from natural hazards. People in Need (PIN) and the National Committee for Disaster Management (NCDM) began developing EWS 1294 in 2013 with the support of the Provincial Committees for Disaster Management (PCDMs). The system currently has over 120,000 unique registered users. The subscription to the system is free, by calling the 1294. EWS 1294 covers four services:

- Hazard monitoring: there are 25 active weather stations measuring water levels that send out data to the EWS dashboard, available online. Then, NCDM controls water levels through the entire country.
- Warning dissemination: PCDMs disseminate alerts to the population, under the supervision of NCDM. The current means of dissemination include Interactive Voice Response (IVR), radio broadcasting, loudspeakers (only in Battambang).
- Preparedness and response: safety instructions are included in the messages, capacity building trainings on EWS 1294 are conducted, Village Disaster Management Groups (VDMGs) are formed, etc.
- Disaster risk knowledge: PCDMs collaborate with District Committees for Disaster Management (DCDMs) and Commune Committees for Disaster Management (CCDMs) to facilitate dissemination of local knowledge, to promote safety measures, to contribute to information sharing with ministries, etc.

To be extended to all provinces of Cambodia, new sensors were installed across the country, collection and sharing of data to the data management platform have been replicated (as it relies only on Cambodian cell phone network), capacity and willingness of disaster management authorities were reinforced to use and promote the system.

Building Cambodia's EWS has involved constant coordination and strong working mechanisms between different stakeholders: Intergovernmental agencies such as NCDM and Ministry of Posts and Telecommunications (MPTC), international development agencies, civil society, private companies, and local communities. The NCDM provides overall supervision of the system at the national level. At the local level, provincial and sub-provincial disaster management authorities have been responsible for the dissemination of warnings and maintenance of sensors, as well as addressing the concerns of local communities. Private companies have been heavily involved in software and hardware operation and improvements to the system, resulting in successful public-private partnerships.

STRENGTHENING CLIMATE INFORMATION AND EARLY WARNING SYSTEMS TO SUPPORT CLIMATE-RESILIENT DEVELOPMENT (UNDP PROGRAM)

This project, implemented by UNDP (2015-2020), focused on enhancing the inclusion of climate change considerations in short and long-term planning, and reinforced existing/developed new information services during its implementation phase.

First, the project introduced climate information to Cambodia in an accessible, timely and relevant way that enhances planning and early warning systems. It has been achieved through the installation of meteorology and hydrology infrastructure and software (monitoring and forecast): 24 automatic weather stations and 29 automatic hydro stations have been installed. Infrastructures are now being used by MoWRAM to disseminate 3 days and 7 days forecast on

their website¹⁶ and Facebook. Regular advisories are being developed and published online¹⁷, and capacity building has been delivered to local authorities, women, children, farmers, and community leaders on the use of climate information.

Second, a National Curriculum for Farmers Field School has been developed for MAFF, which was part of the Climate Change Action Plan of MAFF. This is a standard training programme for the use of climate information in agricultural practices. The curriculum includes regular discussions between farmers, extension workers and meteorological authorities.

Third, they established Drought Information Hubs (InfoHubs) in Takeo, Kampot, Kampong Chhnang, Pursat, Battambang, Kampong Speu, Kampong Thom and Siem Riep provinces. Through this initiative, i) provincial officials and partners were trained on drought monitoring and response; ii) agricultural cooperative leaders were trained in drought-resistant agricultural techniques (such as water conservation and crop diversification) using a ToT methodology; and iii) farmers were trained in drought-resistant agricultural techniques. This partnership was established with Dan Church Aid. Overall, the hubs present best practices for provincial-level drought coordination and early response and mitigation.

Fourth, collaboration with Action Aid has been initiated to train "women champion" in disaster risk reduction and climate change adaptation.

SMS FOR FARMERS – IMPROVED AGRICULTURAL MARKETS INFORMATION

With the Broad focus on improving the marketing system and thereby improving the well-being of rural households and other participants in the non-rice cropping industry, FAO set up this project in partnership with the Domestic Trade Division of the Ministry of Commerce, Department of Agro-industry of Ministry of Agriculture, the Forestry and Fisheries (MAFF) and the Cambodia Development Resource Institute (CDRI). Electronic Marketing Communication System (EMCS) is a SMS service designed to improve communication and exchange for Maize, Soya Bean and Cassava in Cambodia. The service was designed to facilitate communication and exchange between farmers and traders in remote regions of the country (FAO, 2017).

The EMCS coverage is nationwide, and currently includes 26 markets in all 24 provinces of Cambodia, as well as in Phnom Penh municipality. By providing a simple and inexpensive way for traders and farmers to share and access timely and reliable price information, the SMS system

helps users make better-informed decisions. However, this project seems to be still in the pilot stage.

EAST WEST SEED DIGITAL KNOWLEDGE TRANSFER

East-West Seed Knowledge Transfer is dedicated to improving the on-farm skills of smallholder vegetable farmers through sharing evidence-based knowledge on profitable and sustainable farming practices. Videos are uploaded in a Youtube channel¹⁸ which aims to show small scale farmers how to grow vegetables for the best results.

In addition, CropWiki EWS is East-West Seed's detailed catalog app, filled with physical and genetic crop information. Detailed descriptions and features of each seed variety, including days to maturity, color, sizes and weights of crops are provided.

CHAMKA APP

Chamka has been initiated through IFAD-funded agricultural development project ASPIRE, it was launched in May 2020 and the app is still in development. It aims to help farmers improve their production practices and market their agricultural produce. Through the app, farmers can report issues they face in their crop production. The inquiry will be passed through to technical

¹⁶ <http://www.cambodiameteo.com/forecast?menu=116&lang=e%20n>

¹⁷ <http://www.cambodiameteo.com/articles?menu=114&lang=en>

¹⁸ <https://www.youtube.com/c/EastWestSeedKnowledgeTransfer/videos>

experts and advice will be transferred back to the farmers via the app. The platform also includes early warning system, technical material, access to input suppliers who sell their products to farmers, etc.

As of 2022 there are more than 42,000 users already registered and active in using Chamka App to access online training videos. Around 6,000 users have used extension service support through the support service and around 4,000 users have already accessed the virtual market to purchase input supply via the app. Chamka is currently rolled out in 20 provinces in Cambodia

TONLESAP APP

AMK, a private microfinance institution, has developed Tonlesap App to serve its clients. This free app has three functions: i) to disseminate agricultural extension services and market information; ii) to serve as an e-marketplace for agricultural products and agricultural inputs; and iii) to provide linkage to experts in agriculture to farmers. Farmers and agricultural input suppliers can use the app to share technical knowledge and information about technical agricultural information. The app provides the opportunity to link farmers and agricultural experts who voluntarily join the program to provide advice while selling their farming products to farmers. Farmers can find agricultural input suppliers online and learn how to use those inputs better. The Version 2 of the app launched in late 2019 enables farmers to place input orders online and allows suppliers to display products for sale on the app. However, payments can only be completed via the cash on delivery model.

ANGKOR SALAD

AngkorSalad is a Geodata information services for vegetable farmers in Cambodia¹⁹. This mobile application has been designed to be used by vegetable farmers, collectors, and dealers. The app provides i) daily advice on irrigation and fertilisers for the vegetable crops, based on soil and satellite data; ii) a crop management system with an access to wide technical knowledge on vegetable cropping, from planting to harvesting; iii) a market information system enabling the connection between farmers, collectors, and dealers in the area. AngkorSalad app is available on Google Play for free of charge.

2. DATA DRIVEN AGRICULTURE SERVICES

ARUNA – GEOSPATIAL SERVICES

Aruna could be considered one of Cambodia's leading Geomatics firm, which offers GIS, GPS, remote sensing and related technologies applied and adapted for use. However, most of these services would be difficult to use for farmers (especially smallholder), who currently are often not aware of the potential benefits of digital services, or who do not have the necessary knowledge to interpret or use mapping services and solutions. Therefore, partnering with the government and the private sector to provide sufficient advisory and trainings seem essential to untap the potential of these ground-breaking technologies.

BLOC RICE

The BlocRice initiative has been set up in 2018 by Amru Rice, Cambodia's leading rice exporters, in an attempt to implement an agricultural product monitoring and traceability system. This initiative was supported by Oxfam, with the aim to increase production of organic rice. The system digitally tracks orders and contracts between farmers, exporters, and buyers, increasing the transparency in market prices and contractual terms. Over the last couple of years, the platform has become commercially viable, assigning digital identities to individual farmers, and ensuring their goods can be tracked from rice paddies all the way to the consumer. In 2020, BlocRice technology was scaled up to 500 households in two communities in Preah Vihear province.

¹⁹ <https://www.angkorsalad.com/>

It is predicted that the influx of buyers and sellers on the same platform will allow data to be gathered on yields, best practices, and other practical challenges. The collected data could be tapped to build predictive models that can eventually forecast price fluctuations, weather conditions, and future yields.

SMARTFARM ASSISTANCE

Smart Farm Assistance (SFA) is a start-up (very early stage) providing digital technologies and supplying tools to farmers to control the water systems in their farms through app and SMS. Ultimately, this aims to allow farmers to reduce water consumption (which is controlled through a mobile app) and better control on-farm irrigation systems.

SFA provides smart valve and smart pump, which are IoT devices that connects with the water pipe and allows to control the irrigation system and motor pump remotely. The product costs from \$100 - \$1000, depending on the size of the farm and services needed (installation, maintenance, etc.).

KHMER AGRICULTURE SUITE (KAS) PLATFORM – SAAMBAT PROJECT

As part of SAAMBAT Project, Techno Startup Center (TSC) is developing the KAS digital platform which is a data-driven platform containing agriculture data, tools and intelligent components for data analysis and visualization. The objective of this platform is to harness the power of emerging technology and innovation to address main challenges in productivity and distribution. KAS platform will be launched in 2022, and will be linked to the KAS satellite applications, which will provide extension to the core platform. The KAS satellite application will be developed under different service providers, whose applications will share the data with the core platform. Several services are anticipated through different applications, such as i) KAS-FRESH: a platform connecting farmers to consumers, ii) KAS-KONTRA: smart contracts between suppliers and farmers, iii) KAS-TRACK: traceability system, iv) KAS-AI: recommendation on crop planning, risk analysis, market, etc., v) KAS-WALLET: a digital wallet for trading in the platform, and many other relevant applications.

RIICE PROJECT

As part of the RIICE Project (Remote Sensing-Based Information and Insurance for Crops in Emerging Economies), IFAD promoted the use of sensors and GPS to generate data used for crop-mapping. The technology enabled to monitor changes in surface roughness, soil tillage and crop-specific field activities, to define appropriate practices or interventions for the crops. This project gathered accurate crop yields data which supports the development of index insurance products, used to secure farmers' incomes.

3. FINANCIAL SERVICES

SYNGENTA INDEX-BASED INSURANCE AND FINANCIAL EDUCATION PROJECT

Syngenta, partnering with Forte Insurance, is currently piloting 3 commercial index-based crop insurance schemes, which include rice, maize, and cassava in the provinces of Pursat, Battambang, and Pailin. The project focuses on:

- Area Yield Index Insurance (AYII). This scheme covers yield losses for rice farmers from drought and dry spells, flooding, storms, and cyclones. Yield data are satellite-generated. Payouts are based on the average yield of the commune in question.
- Weather Index Insurance (WII) protecting cassava farmers against drought and excess rainfall. The scheme uses 'CHIRPS 5 km' data and automatic weather stations.
- WII for maize farmers facing drought or excess rainfall. This scheme uses the same data sources as the cassava WII.

The project aims to reach 6200 smallholders, and if the schemes succeed, this should encourage agricultural input aggregators, lending institutions, rice millers and exporters, cooperatives, development agencies, and donors to engage in crop index insurance. Syngenta's work will help to scale up commercial AYII and WII schemes in the long run and improve the regulatory and policy framework for agricultural insurance (Syngenta, 2022).

Concurrently, Syngenta is also running financial education and awareness creation for crop insurance schemes project. The main objectives of the education project are to raise smallholders' financial literacy and insurance awareness and to train financial institutions on crop insurance. This project consists of i) the development of educational videos and materials on financial literacy, including crop insurance and good agronomic and farm management practices, ii) Training-of-Trainers at partner organizations and other key stakeholders. The latter include government agriculture and extension departments, input/output dealers, and aggregators. They will also receive training on financial literacy, crop insurance, and modern farm management for rice, maize, and cassava.

Cambodia Micro Agriculture Insurance Scheme (CAMAIS)

This pilot project, led by the government and receiving funding from the Netherlands, was implemented by the Cambodian Centre for Study and Development in Agriculture (CEDAC) across nine districts in three provinces: Kampong Chhnang, Takeo and Kampong Speu.

The aim of the project was to offer micro-insurance to help rice farmers cope with the risks of flooding and drought, looking to build on the success of its first season by scaling up beyond three existing provinces. The CAMAIS, launched in 2015, aims to support local smallholder farmers by providing insurance pay-outs to those affected by severe weather-related events attributed to climate change. Rice farmers who join the scheme pay an insurance fee at the start of the growing season based on the size of their farm, type of paddy grown, and technical tools used. In return, they receive consultation on farming techniques and get an insurance pay-out if their crop is damaged either by flood or drought.

One of the goals of the CAMAIS project was to reduce cases where families whose crops are damaged or destroyed by climate disasters are forced to take out loans from FIs to rebuild their farms. Often, smallholder farmers unable to afford the high interest rates on these loans sell their land to settle their debts. This initiative could however be further scaled both in terms of number of farmers involved and geographical areas.

Agribuddy

Agribuddy provides services to farmers, that they help to connect with the entire ecosystem. As part of e-commerce and digital payment promotion, Agribuddy has tied-up with Acleda Bank to use a credit scoring system to lend to farmers at reasonable interest rates, using their field network of "buddies". Agribuddy implements an e-buddy wallet app to facilitate transactions (focusing on corn, cassava, and rice) and linking input suppliers to credit sources. Their integrated system connects farmer groups to input suppliers, processors, crop buyers, input manufacturers, and credit sources. The company has buddy enterprises at the commune level to coordinate credit contracts between farmers with credit sources and input suppliers. By being part of the supply chain for agro-inputs, Agribuddy can control the use of funds and ensure to a significant extent that crop loans are used only to buy materials for farming.

Annex 16. Interview guides

FARMERS

1. Market systems

1. Current market organisation	
What are the main distribution channels? To whom are they selling their agricultural products?	
What are the market trends? (demand, supply, etc.)	
Are they facing challenges with competitiveness or price volatility?	
How do they adapt to potential market failures (e.g.: drop in prices)?	
2. Level of organisation with other farmers	
Do they belong to a cooperative or any farmer group?	
If yes, what are the benefits? (e.g.: access to services, better selling price, etc.)	
Are they satisfied with the way it functions, and why?	
Is the cooperative supporting the uptake of climate resilient practices from its members?	
3. Access to services and products	
Where do they have access to farm inputs (seeds, fertilisers or pesticides, equipment, and machinery)? Where, and from who are they buying inputs?	
Do they have access to information on weather? If no, from who do they think they should receive weather information services?	
Do they receive training/capacity building? If yes, about what, from who, how often?	
More specifically, have they ever received training about climate resilient practices? What kind of support is still needed to adopt climate smart practices? (i.e.: adoption of climate smart technologies, transitioning to agro-ecological or conservation agriculture practices, etc.)	
Do they have access to finance services? If yes, what type of financial services, from who? (e.g.: loans from MFI, payment scheme offered by technology providers, input advance from buyer, etc.)	
Do they have access to market information?	
Do they have access to other business services (e.g.: transportation services, renting services for machinery or other relevant equipment, labour)? Is there climate change adapted equipment available for rent in your area? (e.g.: no-tillage machinery)	
Do they know or have insurance to cover climate risk? If no, would they be interested to explore insurance opportunities? (e.g.: Yield index insurance, Weather index insurance, or would they be more interested in revenue protection, price protection mechanisms, etc.)	

2. Production systems

1. Climate change perceptions	
Have the farmers heard about climate change? What does it mean to the farmers?	
According to the farmers, what are the main causes of climate change?	
2. Existing agricultural practices and techniques	
What are the cropping calendars?	
How do they prepare the land?	
How do they manage pests/diseases?	
How do they irrigate their crops (what is the irrigation system in place)? Do they face issue related to water access?	
3. Sustainable and climate-smart techniques	
Do they know and use methods to cope and adapt to floods/droughts? (e.g.: improving drainage, usage of resistant/tolerant seeds, plant cover crop or reduce tillage practices to reduce soil erosion, etc.)	
Do they practice crop rotation, intercropping or mixed cropping? If yes, please explain the cropping pattern?	
Do they use cover crops, mulching, composting?	
Do they use techniques to improve moisture and improve water management? (e.g.: organise water distribution, shaping the land, contour lines, adding manure...).	
Do they know and use sustainable pest management practices? (e.g.: use of locally suited varieties, crop association and rotations, ...).	
If the farmers use any of the above-mentioned method: why are farmers using these practices? What is the value added for them?	
4. Climate change trends and impacts experienced	
Did they observe changes in weather patterns over the last years? Do they perceive changes in terms of frequency and intensity?	
What are the perceptions in term of yield decrease and potential correlation with climate extreme events?	
5. Willingness to adopt climate resilient practices	
Are farmers willing to adopt sustainable practices?	
What are their perceptions of such practices?	
6. Women involvement	
Do they perceive gender inequalities in the farming systems?	
Are there any differences concerning the adoption and perceptions of climate smart practices between men and women?	

Rice

- How many rice cycles are produced per year by the farmers, and when?
- What is the topography of their farms (lowland or upland)?
- Did they face specific challenges to produce rice due to floods/droughts in the last years? Have they ever shifted the transplanting date due to climate change?

Cassava

- If farmers cultivate cassava under mono-cropping scheme, after several cycles, did they notice soil fertility depletion?
- Do they face any challenge during post-harvest stages?

Maize

- Are the farmers producing red maize (stockfeed market) or white maize (human consumption)?
- What are the main weather impacts noticed on maize production? Do they face lodging problems?
- Do they face any challenge during post-harvest stages?
- Are farmers involved in any part of processing or products are directly sold to processing facility?

Cashew / And other fruits trees

- Have recent climate events (heavy rains) increased pest and diseases infestation, impacted yields?
- Do they face challenges with labour shortage (for pruning, harvest, etc.)

Vegetable value chain

- What vegetables are you cultivating? Why did you choose to cultivate those vegetables?
- Do they face challenges during post-harvest? Can they estimate % of losses?
- How do they store; pack; transport the vegetables?

Livestock

- Are environmental conditions affecting livestock health? (e.g.: frequency and intensity of heat waves, changing rainfall patterns, etc.). How do you manage diseases?
- Is water scarcity affecting your productivity?
- If wet periods extend, do you have resources to keep livestock indoors for longer periods?

Aquaculture

- Is water scarcity/flooding is affecting your productivity?
- Are climate change extreme events generating additional challenges on your farm?
- What are the main post-harvest challenges? How do the fish are transported (alive, in ice)?

WOMEN FARMERS

1. Roles and contributions in the farming activities	
What are the activities women are taking care of?	
What is their workload?	

Are they autonomous in the production? (are they leader in the farming system?)	
Do they own assets? (e.g.: land title, machinery, other?)	
What about the role and contribution from young and elderly people?	
2. Roles and contributions in the decision-making process	
Are they directly purchasing inputs?	
Are they selling farm products?	
Do they have access to and decide on credit?	
What is their control over resources? Do they decide how to use incomes?	
Do they decide which technology to use on farm?	
Do they decide how they will produce?	
3. Women access to services	
Do they have access to technical support services? If yes, about what, from who, how often?	
Do they have access to finance services? If yes, what type of financial services, from who?	
Do they have access to market information systems? Where/from who? Are women responsible of access to information (price, location, etc.)? What is the role of women to establish market linkage and taking care of negotiation?	
Do they have access to information on weather? If no, from who do they think they should receive weather information services?	
Are they members of farmer groups? If yes, what are the benefits?	
4. Factors influencing access to and control of resources/services	
At community level, how are decisions taken about the use of resources and the planning of activities? (i.e. climate resilience agriculture, water management, related technologies, alternative skills & income generation, etc.).	
What are the key barriers/challenges for women to take leadership and participate in the water governance bodies, farmer associations/ AC, etc.?	
5. Women usage of technologies or digital tools	
What types of technologies and digital tools do they use? (e.g.: on-farm technologies such as water pumps and drip irrigation systems, sensors to control moisture, phone to get information about market prices, etc.)	
What about younger generation (from 18 to 35 years old), are they using digital tools for the farm activities or taking any initiatives?	
6. Women perceptions of climate change & climate-resilient practices	

Did they observe changes in weather patterns over the last years? Do they perceive changes in terms of frequency and intensity?	
What are the perceptions in term of yield decrease and potential correlation with climate extreme events?	
Do they think climate-resilient practices could support their resilience increase?	
What are the efficient practices that they heard about, or use themselves?	
Are there specific skills needed by women to increase their resilience?	
7. Women involvement	
Do they perceive gender inequalities in the farming systems?	
Are there any differences concerning the adoption and perceptions of climate smart practices between men and women?	

GOVERNMENT REPRESENTATIVES AT LOCAL LEVEL

What are their roles, main missions, and activities?	
What are the overall objectives in the province? What are the key value chains / production systems considered in their activities?	
What are the most important constraints affecting farmers' growth and profitability?	
What kind of agricultural extension / supporting service do they provide to farmers? i.e.: training? access to finance? advocacy? inputs control? other? Can they provide concrete examples?	
What other services would you consider as a priority to strengthen climate resilience of smallholder farmers? (e.g.: Access to finance). What are the main challenges/bottlenecks in these systems?	
How are organised extension services at provincial level? Are activities that contribute to increase climate resilience included in extension services?	
Do they collaborate with other partners to implement extension, and if yes, who?	
What are the active projects working on increasing sustainability of the agricultural systems? Can they provide some information about what has been done?	
What are the current technologies used by farmers for the different steps of production? What are the sustainable and climate-smart techniques already used by farmers? What are the farmers' perceptions of such practices, and interest/ willingness to change?	

Have you heard about digital tools or resources used to mitigate the impacts of climate change? Do you have information about how these services are being delivered today?	
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PRIVATE STAKEHOLDERS

Business and operation information:

In which value chains are they involved	
Brief description of their activities. 1) If selling farm inputs: what products are they selling to farmers (seeds, fertilisers, pesticides, other)? Among the products sold, are they selling inputs that are specifically increasing farmers' climate resilience, such as resistant/tolerant seeds, cover crop seeds, natural or organic fertilisers, compost, or other? 2) If selling farm equipment/ machinery: what technology are they selling to farmers? Among the technologies sold, are they selling equipment that is specifically increasing farmers' climate resilience, e.g.: solar water pumps, drip irrigation systems, sensors to control moisture, or other? 3) If selling services for mechanised field operations, what type of machinery are they using? Have they considered investing in sustainable agriculture machinery, such as no-till planters? What is their interest/opinion on that matter? What are the key challenges toward investing in such machinery? 4) If buying agricultural products: Do they offer premium for sustainably cultivated products? If yes, what are the conditions ensuring higher price for the farmers (specific label such as GAP or organic, simple quality checks during transaction, close relationship with farmers?)	
How are the current relationships with their clients (do they have contract with farmers, formal/ informal; do they advance inputs; basic commercial relationship, etc.)?	
What is the scale of their operations?	
Are they increasing climate-resilient practices adoption? Are they willing to work on supporting the development and adoption of climate-smart agri-practices?	
What are the limits and constraints to provide access to CSA products or services? What systems should be improved to better reach target groups with your product/ services (financial, market information, infrastructure..)	
Is there any opportunity for them to tap into subsidy schemes or financing (national/international) that can reduce the costs for end-buyers?	
What are the main climate risks perceived by the private sector?	

DEVELOPMENT PARTNERS

General information

Relevant project / program:

- Objectives
- General information about the value chains considered, production characteristics, vulnerability of the production systems to climate change.
- Brief description of the main activities (describe components that include CSA especially around smart water solutions, climate smart technologies or sustainable practices)
- Experience with extension service systems (both public and private), especially to support improvement of smallholder farmers' climate resilience. Suggestion to improve current extension service systems.
- What other systems would they consider as a priority to strengthen climate resilience of smallholder farmers? What are the main challenges/bottlenecks in these systems?
- Who were the beneficiaries / targeted population of the project?
- What were the results so far? Are there any specific learnings in our targeted provinces?
- What were the challenges?
- What would be their recommendations to increase the capacity of Cambodian smallholder farmers to cope with climate change?
- Did they notice gender differences about the adoption & perceptions of CSA practices?
- Would they recommend working on or promoting specific products, services or techniques? Why?
- Would they recommend private or public sector actors we should i) met to get useful information for the study; ii) consider for potential collaboration on the project?
- Have you heard about digital tools or resources²⁰ used to mitigate the impacts of climate change? Do you have information about how these services are being delivered today?

²⁰ Information services, such as weather forecast, early warnings systems or market prices disseminated through digital channels; ii) Data-driven agriculture services, for instance the provision of tailored advisory services that are based on localised and time data, or precision agriculture using AI to optimise on-farm activities, or solutions for market linkages; iii) Financial services, which include digital insurance or digital credit.