INITIATIVE ON
Asian Mega-Deltas

Governance of the Food System in the Mekong Delta, Cambodia: Rice, Fish, Water and NRM

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November, 2023

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1. Background

cambodia is rich in river systems, which provide abundant water resources and produce a lot of food for its people. The Mekong River and Tonle Sap Lake are sources of water for agriculture, fisheries, and natural resources, which sustain the livelihoods of rural communities. The Mekong River and Tonle Sap Basin are surrounded by floodplains which are potential for agriculture and rice farming.

Natural resources, land, water, and river produce tons of food and sustain the livelihoods of many Cambodian populations. Governance of natural resources, land, water, and fisheries will contribute to food production. Rice and fish are the backbone of the Khmer Society, supplemented by vegetables, fruits, and livestock.

Rice farming is the main food production engine. Rice also is the main food item for rural Cambodian families. Cambodian people eat rice three meals a day. In 2015, RGC promoted a one million tons policy of rice production for export. RGC has rehabilitated the irrigation system to support rice production, meeting the one million policy. Rice production in Cambodia has evolved from one crop a year to three crops a year in some provinces such as around Tonle Sap Lake and the Mekong Delta, following the improved irrigation system. Rice production has been facing significant changes at the community level, including massive migration, rice intensification, mechanization, increased water use, informal rice trade, and private sector involvement in providing agricultural services to farmers. The rice production policy remains uncertain between rice export and consumption.

Fish is the source of protein, accounting for about 70% of protein intake. The annual fish production is estimated at around 600,000 tons a year. The fish consumption per capita is 54.2 kg per person per year.

However, the increased population and development pressures have undermined the productivity of the river system, ecosystem functions, and natural resources. The rapid exploitation of natural resources for the increased population and development needs jeopardize the food production system. The Mekong Delta in Cambodia is under the threat of increased population pressure, urban development, and climate change. Small farmers have struggled in the changing environments to sustain their living and support their support.

Climate change has occurred and has affected the food production system. There is no infrastructure in place to support production in the context of climate risks. These have affected the food systems to support millions of people and small landholders. The food systems are transforming rapidly to multiple demands and supply-side drivers, resulting in changing consumption and production practices.

WP4 identifies three key barriers to more inclusive, sustainable, and climate-resilient food systems governance: (1) Policy disconnect, (2) Lack of institutional coordination and capacity of various natural resources (NR) and food systems sectors, and (3) Lack of capacity and agency of grassroots actors, particularly marginalized communities to engage effectively in NR-water-agriculture governance. The WP4 of the AMD Project is designed to support the governance of water and land resources to maintain/recover landscape functionality. It examines the siloed policies and interventions, the fragmented landscapes, eroded ecosystem services, and lost multi-functionality & resilience to intensified trade-offs, aiming to improve the governance of the food system.

The key approach that WP4 will undertake is to carry out research that could support the Joined-up governance through vertical and horizontal interactions between national, local, and community scales. It will also promote the harmonization-integration and effectiveness of more integrated and stakeholder-sensitive water-land management serving food systems. To do so, at the national level, the WP4 will analyze the political economy of national to sub-national status quo: policies, laws, structures, histories, attitudes, challenges-drivers, vested interests-power, and implications for landscapes and people. Second, the WP4 will involve in the bottom-up interventions (4 sites max), validate the above and demonstrate solutions to key challenges, build community and district-provincial capacities, and promote gender and inclusion more broadly will be cross-cutting and use resulting evidence to promote reform/more informed policy/plans at the center.

2. Objectives

1. to build an understanding of the food production systems among relevant stakeholders and facilitate key stakeholders to engage collaboratively in identifying actionable strategies for more integrated NR-water-food systems governance to support climate resilient, GESI food system outcomes.
2. To build the connectivity between the CFR, the irrigation system, and rice farming as an integrated food production system through improving water governance.
3. To promote the collaboration between the CFRs and FWUC, and Fishery Administration (FiA) and Ministry of Water Resources and Meteorology (MOWRAM) to work together to manage a fishery, water, rice farming and irrigation management based on collective approaches and interests to produce foods and support the livelihoods of local communities.
4. To support District offices effectively implementing the recent decision to combine water, agriculture and environmental management functions, and assess what investments are needed to support this key reform that potentially enables more integrated landscape management and food production.
5. To protect rivers, streams, water bodies and ecosystems that provide water to support crop farming, fish production, on livelihoods of local communities through a strategic landscape rather than siloed approach.

To build the capacity of local communities, concerned stakeholders, and government agencies at the provincial and district levels

- In 2023, the WP4 intends to generate knowledge on the following three research themes:
- Opportunities presented by the integration of water, agriculture, and environment in a single District office and challenges and key investments needed concerning realizing these opportunities.
- Evidence of trade-offs within village food production systems resulting from the introduction of irrigation infrastructure into traditional RFF landscapes, and opportunities and challenges for re-connecting fish into existing village and commune level water infrastructure.
- Understanding of key sustainability challenges faced by CFRs including underlying causes, and potential solutions.
- This knowledge will be communicated and leveraged for multi-stakeholder dialogs with decision-makers, planners, and other development actors as follows:
- At least 2 Policy Briefs produced in 2023 as the key outputs of the WP4. In the study sites, food is produced from land, water, farming, and fisheries. The food production policy has led he modernized agriculture for exports and economic development through the development of irrigation systems, setting up institutional arrangements, and using chemical pesticides and fertilizers. First, the challenges to food production result from the lack of integration of water, fishery, and irrigation systems; overlapping institutional arrangements, and the pesticide and chemical uses in agriculture. Second, there are implications of the food production systems on the ecosystems, changing connectivity of land-water-fishery and rice farming from a disconnect of policy and approaches. Third, there is a need to adopt a more strategic landscape rather than a siloed approach to the food production system where commune scale upstream downstream conflicts over water could be addressed.
- One journal submission: Being conservative given we have not hit the ground for implementation and uncertainty over the level of data and insights to formulate and support messages. This submission may be on documenting the drivers and costs (production, social) of landscape fragmentation and the segmented institutional approaches at community and higher scales that mirror and perpetuate this. We may also explore with Paul a second AMD-RAqFS paper with AMD providing case studies of how a lack of storage impacts CFRs and links to commune-level political economies and power structures.
- At least one multi-stakeholder dialog around the theme of how more integrated water-land resource management can be supported to achieve Cambodia's national development priorities and SDGs.

3. Conceptual Frameworks

this study examines the food production system and its governance. It is part of the food system. The food system is perceived as a set of activities to produce food, process and package it, and consume it. The increase in productivity and efficiency of food systems would result in reducing the prevalence of hunger and improving nutrition. The aims of the food system are to improve food security (Ingram, 2011). Thus, the food security status of any group can be considered the principal outcome of food systems (World Food Summit, 1996). However, food security encompasses components of availability, access and utilization.

Both food systems and food security are fundamentally characterized by environmental, social, and economic factors. Land, water systems, and ecosystem are part of the environment that produce foods to sustain livelihoods of communities. Manohar et al., (2023) refers these components of environment as the 'food environment', and Ericksen (2006) views these as the main components of the food systems. Food environments can be characterized as built or natural, comprising both cultivated and wild food environments. Cultivated natural food environments make a significant contribution to the diets of subsistence farmers and rural communities through the production of staple crops, supplemental gardens that produce fruits and vegetables, the rearing of livestock and aquaculture, and the utilization of their by-products, such as eggs and milk. Cultivated food environments are often dependent and intrinsically linked with wild natural food environments, which include forests, jungles, rivers, and lakes. These environments are particularly important for increasing access to nutrient-rich foods, including animal source foods, leafy greens, other vegetables and fruits, and can increase the resilience of households to shocks. Rivers act as wild food environments from which food (fish and edible aquatic plants) is procured and agriculture is cultivated food environments where staple crops are grown as the main engine of food production, using land, fertilizer, seeds and water (Manohar et al., 2023).

There are multiple actors involved in food systems, the broad array of environmental and social interactions encompassed in food systems, and the multiple policy challenges posed. Actors are involved in producing, processing, distributing, and consuming foods. These are shaped by their influences, power relation and interests of actors across scales and levels. Actors' values and interests and their respective power and agency (Long and Long, 1992), the ideology, discourse and narratives establish and legitimize their positions and influence the food system, and the interests of certain actors (Schmidt, 2008; Schmidt, 2010; Schmidt, 2011; Huitema et al., 2011), patterns of access to and control over key productive resources (Ribot and Peluso, 2003) and the formal and informal institutional arrangements (e.g. North, 1990). Policies and institutions determine the roles, functions and activities of actors in food systems. Food production and consumption are long processes of interaction, influence, negotiation, contestation and cooperation. These processes are complex and often represent and reflect markedly different social interests, assumptions, power relations and views of involved actors. While we recognize this level of complexity of food systems, it is the attention to the key axes through which change in food systems are shaped by the political dimensions of how benefits and costs are created and distributed (and by whom). These changes can be directly concerned with the food system, as in the case of the introduction of new technologies, or in how they impact the system, such as in the case of hydropower development. Food system activities and outcomes are influenced by processes of internal change as people, individually and collectively, respond to these drivers.

Environmental and socio-economic changes are happening simultaneously and involving rapid and complex processes, affecting the food systems and food security. Environmental changes encompass changes in the bio-geophysical environment, which may be due to natural processes and/or human activities. Food systems also contribute to environmental change, and future trends such as increased demand for food with increases in incomes and populations will have consequences for further environmental change processes. Any change in key drivers would affect the services that any given ecosystem can then provide, both for its own maintenance and for services such as food provisioning that contribute directly to human well-being (Millennium Ecosystem, 2003). The land use modification for food production has significant and widespread impacts on ecosystem functioning, including biodiversity losses. Water availability and access have been heavily modified for agricultural use (Wood et al., 2005; DeFries et al., 2005). Climate change has induced increased floods and droughts, which in the short run it damages the agricultural produce, resulting in less food, and in the long run, it lowers agricultural productivity and low yields.

In the food systems, agriculture has been intensified, fisheries have been and privatized and commercialized, and river systems have been dammed with negative implications for the communities that rely on them, accompanied by increasing fragmentation among marginalized small holders (Manohar et al., 2023). The environmental concerns over these trends are increased demands on water availability for irrigation and electricity generation (Molden and Fraiture, 2004), an increase in pollution from agricultural inputs and soil loss (Pretty et al., 2005), and a large increase in the energy demands throughout the food production sectors. The raw food materials undergo many transformations and travel long distances before they reach retail markets (Pretty et al., 2005) and the role of markets is rapidly increasing, with considerable vertical and horizontal concentration among the major owners (Reardon et al., 2002; Lang and Heasman, 2004). Furthermore, there have been significant changes in how food is consumed. Overall growth in incomes has caused a worldwide dietary transition to more meat (with a concomitant rise in demand for grain production), dairy, sugars and oils. Consequently, nutrition concerns relate

to malnutrition in some places and obesity in others, as there is inequitable distribution of the quality as well as quantity of food, and negative consequences arise from multiple eating patterns (Popkin, 2004). This is exacerbated by the growth of urban populations who rely almost completely on purchasing food (Kennedy et al., 2004).

Approaching food from a system perspective reveals and in turn enhances important governance challenges and opportunities because it requires more holistic forms of governance. Governance in the context of food systems 'refers to processes and actor constellations that shape decision-making and activities related to the production, distribution and consumption of food'. Governance is more than the formal functions of government but also includes markets, traditions and networks, and non-state actors such as firms and civil society highlighting how agency and power relations between a multitude of actors are key to any transformative change in food systems. Transformation refers to 'a change in the fundamental attributes of natural and human systems. By its nature, food governance institutions are fragmented and cut across the usual boundaries between sectors, administrative jurisdictions, public and private domains, temporal and spatial scales and diverse normative frameworks. The interdependencies of actors, activities, and problems within the food system challenge the efficacy of traditional modes and strategies of governance (Siddiki et al., 2015).

Van Bers et al., (2019) provide the framework for the governance in food systems, including: (1) developing more comparable research designs for building generalizable explanations of the governance elements that are most effective in realizing food systems goals; (2) using the lens of polycentricity to help disentangle complex governance networks; (3) giving greater attention to the conditions and pre-conditions associated with historical food system transformations; (4) identifying adaptations that strengthen or weaken path dependency; and, (5) focusing research on how transformations can be supported by institutions that facilitate collective action and stakeholder agency. Termeer et al., (2018) have provided a framework for food system governance that consists of five principles: 1) system-based problem framing to deal with interlinked issues, drivers and feedback loops; 2) connectivity across boundaries to span siloed governance structures and include non-state actors; 3) adaptability to flexibly respond to inherent uncertainties and volatility; 4) inclusiveness to facilitate support and legitimacy; and 5) transformative capacity to overcome path dependencies and create adequate conditions to foster structural change.

4. Methods

4.1. Site Selection For WP4

Four field sites were identified after visiting several locations across Prey Veng, Takeo and Kampong Thom provinces. Prey Veng and Takeo are located within the Mekong delta and Kampong Thom is part of the Tonle Sap floodplain.

- Four sites in three provinces are selected namely (1) Beung Sneh Area, (2) Beung Phlang, (3) Beung Ream and (4) Ta Soung (See Table 1). Overall, these four sites will enable us to produce the following insights that offer evidence-based policy and methodological contents:
- Testing community and district-based interventions to re-connect fragmented landscapes to restore especially Rice Field Fisheries that is a mainstay of rural animal protein
- Related to the above, testing approaches to strengthen CFR/CFi sustainability, including conflict management such as relating to fish vs irrigation at both local (CFR/CFi-FWUC) and broader (MoWRAM-FiA) scales and engendering more active stakeholder participation in maintenance including fundraising.
- Providing insights on the question: what will it take to give effect to the Prime Minister's decision to integrate water, agriculture, and environment at the District level, for landscape and ecosystem service and food production benefits, taking into account distributary questions.
- There is firstly a need to document the true nature of the integrated/holistic management challenge that applies to all of the above. This is not well understood and is thus a first barrier to change. The next question applicable to all of the above is what we learn from attempting reconnection in terms of further illuminating the nature of the challenge, but also the efficacy of tested interventions.

Working at the a) local institution (e.g. CFO, FWUC); b) cross-institution (e.g. CFO-FWUC), and c) district scales will highlight the connects/disconnects across different scales of governance both below and above the district level, thus speaking to a core WP4 question of how decentralization affects water-land/landscape management and how this can be improved. The links with other WPs (especially in Beung Sneh) provide an opportunity to place governance within a more systemic/holistic One CG approach that can generate learning on the advantages of more transdisciplinary interventions in line with the demands of dealing with social-ecological systems.

Figure 1. The targeted provinces for the WP4 Site.

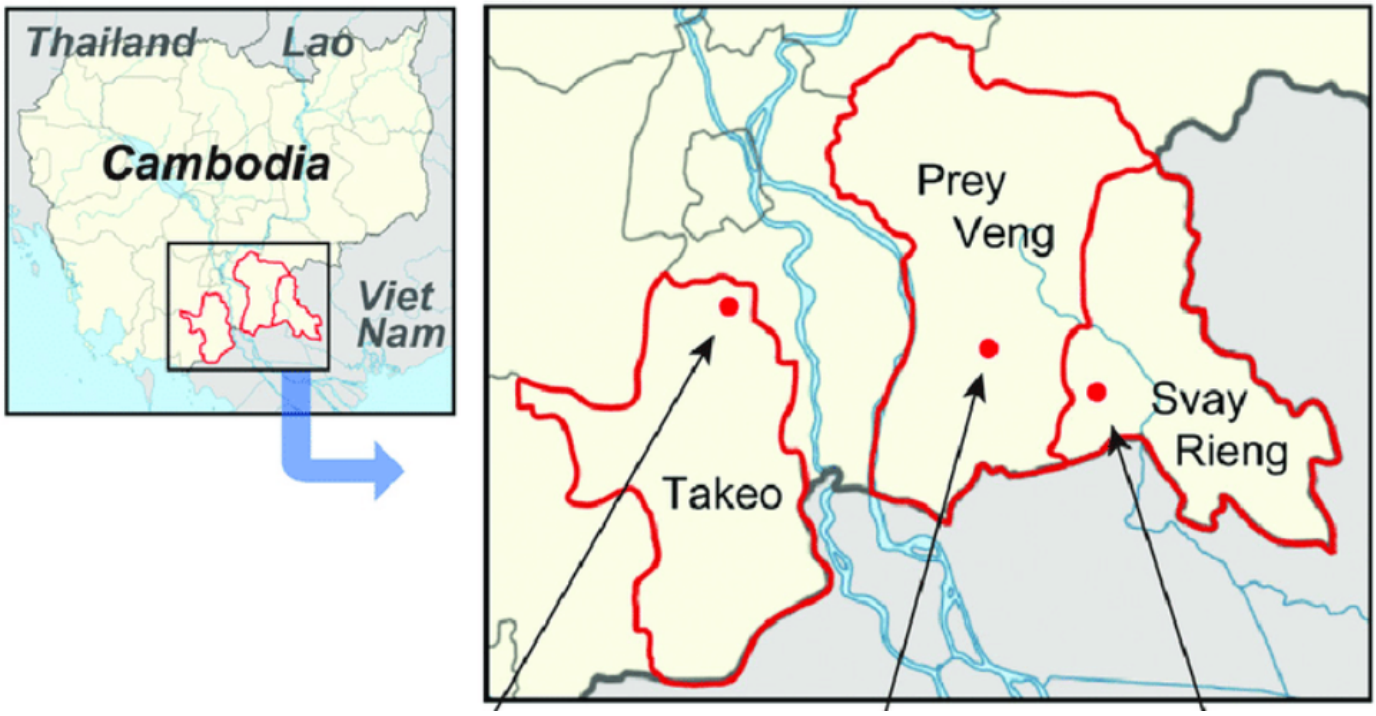


Table 1. Sites selected for WP4 interventions.

Province	Site	District/ Commune	Irrigation / FWUC	CFR	CFi	WP4 Focus
Prey Veng	1. Beung Sneh	Theay Commune, Ba Phnom Distric,	X	no	X	• Linking CFi with the Irrigation system by exploring how the FWUC-CFR-CBE can collaborate for more integrated water-land management to increase especially water productivity and diversity of water values (i.e. more MUS). Strengthen the work of the integrated district office. • By aligning site-level work with the new District office that now integrates Water, Agriculture, and the Environment (i.e. MoWRAM, DoA and DoE), we will explore and document what it will take to put into practice this very important shift from siloed to integrated landscape management. By working with the District office, we will document and communicate: – the opportunities, challenges, and conditions for success viz a viz key landscape management challenges in the district – supporting evidence on knowledge/tools/capacity and structural needs, attitudinal dimensions and overall political economies involved to inform national policy that will need to invest in this transition. – How sensitivity to national (and SDG) goals around poverty and gender can be strengthened in how individual community institutions operate and how integrated the planning at District level can account for these.
	2. Beung Phlang	Ampil Krau Commune, Sithor Kandal District	Farmer pumping	X	no	• Strengthen CFR management, especially building capacity to better engage with local CFR beneficiaries towards more effective collective action that can also generate some of the funds needed for CFR maintenance. • This issue of maintenance emerges as a common challenge across CFRs and reflects a deeper weakness in the way this CPR is managed (i.e. an absence of true collective action given a disconnect between the management committee and the beneficiaries and other stakeholders. • Connect CFR and irrigation scheme to strengthen RFF/aquaculture to stem the sale of land to the brick industry. Link to strengthening integrated district office land-water management.
Takeo	3. Ta Soung Irrigation Scheme	Ban Kam, Prey Lvea, Kampong Reap, and Pou Romchuk Communes, Prey Kabbas District	X	no	X	• Primary site for exploring the opportunities, challenges, and conditions for successfully implementing the recent decision to integrate DoA, MoE and MoWRAM. See above for details. • Exploring the possibility of integrating fisheries into the irrigation system, linking the CFi with the irrigation system, and promoting the rice field fisheries. • Influencing the design of the irrigation system to include fisheries in the system.
Kampong Thom	4. Beung Ream	Kokoh Commune, Santuk District	X	X	no	• Explore how the Rice Field Fishery (RFF) landscape (a traditional open-access seasonal system) can be restored by linking the irrigation scheme and CFR (and reconnecting this landscape). • Again, explore how the integrated District office can support such activities, and use this activity to build capacity within the District office for more integrated thinking about water-land values, use, and how these link to key socio-economic goals.

FWUC = Farmer Water User Committee; CFR = Community Fish Refuge; CFi = Community Fishery; CBE = Community-Based Ecotourism

4.2. Synergies with other WPs

Links with other WPs discussed at the first coordination meeting held on 23rd January at the WF-Cambodia office (organized by WP4) with representation from all WPs:

- WP1 in Beung Sneh—Collectively strengthen FWUC and CFR to revise/add water management rules in line with alternative dry season cropping.
- WP2 in at least 2 of our sites:
  - Identify the underlying causes of differences in food consumption patterns between groups in WP1's HH survey cohort, using qualitative tools to unpack potential drivers such as HH dynamics and norms, relationships between class, power, and access to productive resources; gaps in extension and other external services and other dimensions of poverty such as the impact of low literacy on understanding relationships between different foods and nutrition
  - From the above analysis, identify entry points and investments to address at least some of the identified socio-institutional barriers at HH, community & different administrative layers.
- WP3
  - By using our site-level baseline survey to understand social stratification, inform more socially inclusive climate advisory (and potentially insurance) service design and implementation (building on IWMI's substantial work under CCAFS and WLE).
  - End-line survey insights on accessibility/inclusion and implications of WP3 interventions and recommendations for refinement, if these are rolled out in any of the districts where WP4 works (depending on when these are rolled out, maybe 2023 or 2024)
- WP5—Specific sites are not yet clear for WP5, and will emerge only after the WP5 risk maps at province and district scales are done and validated with stakeholders including the identification of risk management priorities and entry points.

4.3. Links with RAqFS

Given combining AMD and RAqFS funds, there is significant fish/aquatic resource content at the field site and overall scales. The underpinning foci here are:

- Addressing the landscape fragmentation that impairs RFF in particular, while also seeking to link CFRs and CFis in this reconnection process, and
- Addressing weaknesses in CFR management at the site level and using site-based case studies to advocate for investments in more CFRs fundamentally as dry season multiple-use storage.
- Ensuring that fish is not left out as District offices move to a more integrated resource management footing, given fish is not a sector that was identified in the policy decision to create an integrated District office.

Therefore, one of the Policy Briefs (see Work Plan) and potentially one dialog may focus on the relevance of CFRs and the need to shift thinking on CFR investments more strategically, placing water scarcity and its water storage function at the center of a more landscape-oriented approach. While honoring the core role of CFRs as fish refuges, we will emphasize the multiple use values of CFRs when thought of as water storage infrastructure. This links directly to Paul's hydrology/water availability assessment for selected provinces (including Prey Veng and Takeo where 3 of the 4 WP4 sites are) funded by RAqFS, given his analysis, places CFRs at the center.

4.4. Data Collection

Understanding these systems and reconnecting them will require us to gather information and data. Both secondary and primary data will be collected from the sites selected above.

- The secondary data will be collected from National, Provincial, and local levels. These data could include the number of villages around Beung Sneh area, farmland areas, rice yield, rice irrigated areas, fish catch, no. of fishermen, and others. Some of this data nay need to be recall data given the need to understand the production of RFF systems prior to the formal irrigation schemes.
- This is explorative research. Thus, the primary data will be collected using Informant Interviews (KIs) and Focus Group Discussions (FGDs). The information and data to be collected include practical insights on the operation and impacts of policies and legal frameworks; institutional arrangements, roles, and responsibilities; planning process; designs; the management system, and maintenance; benefit sharing mechanism; the participation of local communities and underlying drivers; budgeting, staffing, and capacity; and coordination issues. The research questions will be developed for each of our four case study sites based on the three research themes listed above.
- In some sites, fish catch and consumption may be surveyed to assess fish availability and its abundance in the areas. The household survey may be conducted if funds are available to assess the degree of chemical pesticide and fertilizer uses in the sites.
- The dialogues with stakeholders will be organized at the district/provincial and national levels. It will allow us to validate the key finding with key stakeholders and government agencies.

4.5. Data Analysis

- The data collected will be recorded in Excel. It will be analyzed using Excel and also SPSS.

4.6. Research Team

- The research work will be carried out by the research team. The team would compose 3 researchers from WorldFish and IWMI, 04 students from RUA/RUPP and 01 researchers from IFReDI/FiA, and CDRI. We will select four students to do the thesis research with the WP4 Team, one placed in each site.
- At the provincial level, the research team will involve one staff from FiAC and one staff from PDoWRAM in each province.
- WP4 shall sub-contract the Inland Fishery Research Development Institute (IFReDI)/Fishery Administration (FiA) to facilitate research works at four different sites and organize the provincial dialogues.

Table 2. Sites selected for WP4 Synergies with other WPs (PV = Prey Veng; T = Takeo and KT = Kampng Tom).

Sites	WP1: Productivity	WP2: Nutrition	WP3: Climate advisories	WP4: Governance	WP5: Risk mapping
1. Beung Sneh (PV)	Drought and floods risks and solutions. Experimenting with dry season crops replacing rice - veg, rice and rice-fish culture/inland fisheries. **Sarah** documenting economics for rice-fish. Chong commune, Rhong village (spelling!)	WP2 – WP4 (Potentially): • Following WP2 HH survey, WP4 to use qualitative tools to explain nutritional gaps of sub-groups in WP2 cohort e.g. access to productive assets and underlying power asymmetries; gender and other norms, etc.	WP3 – WP4: • Social disaggregation informing design & delivery of advisories for equitable access. • Institutional strengthening to support risk mgt. • Contribute to end line surveys exploring effectiveness of services and delivery mechanisms from inclusion perspectives, with feedback loop for refinements.	• Linking Cfi with the irrigation system. FWUC, CFR, CBE strengthening & collaboration. • Support integration (water-ag-fish-env) at district level office. • Capacity needs assessment for shifting from silos to more holistic landscape management. • Capacity development • Demonstration of how this new direction towards sector integration can work, conditions there for, attendant political economies, etc.	WP5 – WP4: Not clear at present. Dependent of WP5 mapping results and decisions thereafter on entry points and geographical and administrative scales.
2. Ta Soung Irrigation Scheme (T)	X	X	Same as Beung Sneh – also see note below.	Demonstrating how to integrate DoA, MoE + MoWRAM at community and district levels and benefits thereof, and support water-ag-env-fish integration at District level	TBD
3. Beung Ream (KT)	X	Same as Beung Sneh – see notes below	Same as Beung Sneh – see note below.	Potential to link scheme and CFR and re-connect this landscape for RFF. Current WF site with significant data. Strengthen work of integrated district office (as per Beung Sneh).	TBD
4. Beung Phlang (PV)	X	X	Same as Beung Sneh – see note below.	Connect CFR and irrigation scheme specially to strengthen RFF/aquaculture to stem sale of land to brick industry. Link to strengthening integrated district office (as per Beung Sneh).	TBD

5. Results

5.1. Food Environments and Socio-Economic Characteristics

5.1.1. Geographies

In Cambodia, the WP4 studies the food system in the Cambodia Mekong Delta covering in three provinces: (1) Prey Veng, (2) Takeo and (3) Kampong Thom. Prey Veng Province is 4,883 square kilometers big. It's located in the south of the country. The province consists of the typical plain wet area for Cambodia, covering rice fields and other agricultural plantations. The province also features two of the biggest rivers of the country the Tonle Bassac and the mighty Mekong. Agricultural land constitutes 79% of the land in Prey Veng Province (Table 3).

Takeo Province is one of the 24 provinces (including Phnom Penh Municipality) in the Kingdom of Cambodia. This province is located in the south of the Phnom Penh Municipality. Takeo borders Kampot to the west, Kampong Speu to the northwest and Kandal to the north and east. Its southern boundary is the international border with Vietnam. The province consists of the typical plain wet area, covering rice fields and other agricultural plantations. The Kandal and Takeo province is divided by the river known as the Kampong Preah river which is a tributary of the Bassac river. The Takeo river is also a tributary of the Bassac River originzed in the Mekong Delta in Vietnam. About 74% of the total land area in Takeo is used for agriculture (Table 3).

Kampong Thom is Cambodia's second largest province in area. Kampong Thom Province borders Siem Reap to the northwest, Preah Vihear to the north, Stung Treng to the north east, Kratie to the east, Kampong Cham and Kampong Chhnang to the south and the Tonle Sap to the west. Its capital is Kampong Thom, a picturesque town on the banks of the Stung Sen River. There are a number of significant Angkorian sites in the areas such as Prasat Sambour Prei Kuk and Prasat Andet temples. Kampong Thom is one of the provinces that border the Tonle Sap Lake and is in Tonle Sap Biosphere Reserve. About 20% of the land area in Kampong Thom is used for agriculture, and large areas fall under the fishery domain, located close to Tonle Sap Lake (Table3).

In Prey Veng Province, WP4 studies two sites—Beung Sneh and Beung Phlang, which are important food production areas. Also, in Takeo province, WP4 studies the Tasung Irrigation System in Prey Kobas District. Furthermore, in Kampong Thom Province, the Beung Ream is also studied as a food production site.

Table 3. Geography of the studied provinces.

Province	Total area (ha)	Agriculture (ha)	%
Prey Veng	488,300	386,966	79.25
Takeo	356,300	264,000	74.09
Kampong Thom	1,381,400	282,796	20.47

5.1.2. Beung Sneh

Beung Sneh is a water body located in Prey Veng Province, connecting to the Mekong River. It covers four districts—(1) Ba Phnom, (2) Peam Ro, (3) the Provincial Town of Prey Veng and (4) Svay Anthor. In the wet season, water from the Mekong River flows into the Beung Sneh, and floods the areas, which create a vast water body, covering an estimated 5,000 ha. It provides habitats for fish, birds, biodiversity and humands. Beung Sneh is surrounded by large areas of ricefields.

In the dry season, water recedes the Beung Sneh to the Mekong River, but large volume of water is retained in the lake for the rest of the year. The Beung Sneh covers 3,924 hectares of the land surface in the dry season, but it expands to about 5,000 ha in the wet season. In the wet season, due to rainfalls, the total water volume of Beung Sneh is about 85 million cubic meters. However, in the dry season, it decreases to around 40 million m^3. A large volume in the upstream watershed areas discharges into Beung Sneh and maintains the functionality of the lake.

Beung Sneh consists of different landscapes—river, water, fish, land, farming lands, flooded lands, and biodiversity habitats; which provide environmental services to communities living around the areas, including water for domestic and agricultural uses, fish for foods, shelters, fuel woods, and rice farming. It forms a food system that produces food for many local people living around the area. It has been governed by different systems—Irrigation System, FWUCs, CFis, CBET and others. These systems are challenged by weak coordination and institutional constraints, which to some degree limit the connectivity of the entire landscapes and undermine productivity of the landscapes. Under the context of climate change, water in the Beung Sneh will be changed, and this will affect water availability, fishery, and agriculture. It will further affect the system—FWCU, CFi, and CBETs. The study will examine how these will affect the operation of the system.

Table 4. Studied Sites in Cambodia Mekong Delta Provinces.

Site	Province	Commune	No. of village	No. of HHs
1. Beung Phlang	Prey Veng	1	3	1238
2. Beung Sneh	Prey Veng	7	44	10911
3. Boeung Ream	Kampong Thom	1	10	3325
4. Ta Soung	Takeo	4	15	3731
Total	**3**	**13**	**72**	**19205**

Source: *Commune Database 2021*

5.1.3. Beung Phlang

Beung Phlang is located in Ampil Krav Commune in Sithor Kandal District, Prey Veng Province. Ampil Krav Commune has 5 villages with a total population of 17,572 people from 2112 HHs. Farming is a main source of income. About 85% are doing farming and 20% are fishing. There are 8 brick industries in the commune that could employ 5,000 people from within the commune. About 70% of them are working as laborers in the textile industry.

The Beung Phlang was used to be flooded by the hydrology from the Mekong River. The development along the Mekong River has undermined the hydrology in the floodplains of the Mekong River in Kampong Cham and Prey Veng Province. The development of the Vaiko Irrigation Schemes by Chinese Companies in 2015—02 main canals and 10-12 sub-canals—has significantly changed the flood regimes around Beung Phlang and in Ampil Krav Communes. The connectivity between the Mekong River, Tonle Touch River in Kampong Chang and the floodplain in Sithor Kandal District in Prey Veng Province has been disrupted. The changes in flood regimes have affected farming, fishery and agricultures in around Beung Phlang.

In 2017, the CFR Beung Phlang is established by 3 villages in the commune—Svay Tep, Penea, and Kbal Beung to protect fishery and rice-fish in the areas so that villagers could access to foods for their families. The Beung Phlang is still rice in the fishery and it is surrounded by ricefield. The fish catch is estimated at about 25kg/ha. About 10% of villagers are doing fish raising. People consume more fish in their daily foods. Around the Beung Phlang, there are about 20 ponds, which raise fish by the pond owners.

The rice yield is 3 tons/ha—wet season rice, which is done by many households. The dry season rice yield is about 4 tons/ha. In 2023, water shortage and drought have affected rice farming. Water from the Tonle Touch in Kampong Cham has been diverted, and so less water coming to the Vaiko irrigation canals. Conflict over water has affected rice farming in 2023. There is no FWUC yet, but it is under the consideration of the Commune Administration.

5.1.4. Ta Soung

The Ta Soung is an irrigating community located in Prey Kobbas District, Takoe Province. The water from the Bassac River flows into the Kampong Preah Stream and flood the lower reach of the Ta Soung Community, which fertilizes the rice farming areas. In 2017, CAVAC rehabilitates the irrigation system to reduce flooding and improve water management to support rice farming in 15 villages in 4 communes (Ban Kam, Kampong Reap, Prey Lvea and Por Romchak) in Prey Kobbas District to manage three irrigation schemes namely 1) Kampong Chaok, 2) Kampong Reap, and 3) Prey Lvea. CAVAC has named this irrigating community after the Ta Soung Irrigating Community, which is home to 3731 households.

Also, water for irrigating the Ta Soung Community is pumped from the Kampong Preah Stream. Kampong Preah Stream is a tributary of the Bassac River, which is now formed as a boundary between the Takeo and Kandal Provinces. At the Kampong Preah Stream, four Community Fisheries in Prey Kambas District are established to manage fisheries resources, namely (1) CFi Kampong Reap; (2) CFi Pour Romchaok, (3) CFi Ban Kam, and (4) CFi Prey Lvea. These CFis were established in 2000 and 2002 by FiA/FiAC. It covers 844,793 ha with 1016 households as members. Traditionally and naturally fish migrates from the streams and rivers into the rice fields and villagers catch fish and collect aquatic resources in their rice fields. However, at present, the fishery area is separated from rice fields by irrigation canals, sub-canals, and water gates.

5.1.5. Beung Ream

The Boeung Ream is a small water body, which retains water for the entire, covering 13 has in the dry season, but it expands into larger areas in the wet season. It is located in Kor Koh Commune, Santuk District, Kampong Thom Province. The Beung Ream is connected to the floodplain areas of the Tonle Sap Lake. In the wet season, from May to November, the water level in Tonle Sap Lake rises up and floods the floodplains, reaching also most of the Beung Ream, making it rich in fisheries that local villagers around Beung Ream relied on for fishing. In 2018, Beung Ream was established into the Community Fish Refuse 2018, covering 13 ha, with the core areas of CFR covering 2ha for conservation to protect fisheries for local people's uses for their foods.

Around the 2015s, around Beung Ream in Kah Koh Commune, Santuk District, the irrigation canals were developed. Three canals flow into the CFR area: (1) O' Praing, (2) Beung Karav, another natural pond, connecting with Beung Ream; and (3) Irrigation canals built by MoWRAM. The O' Praing has been rehabilitated by a Private Company that took the soil/earth to build the roads. The irrigation canal enters the CFR Beung

Ream and supplies water based on the requests from CFR Committee. The irrigational canal is part of the Stung Chinit Irrigation Scheme built by MoWRAM, and financed by ABD.

About 995ha of rice fields surround the CFR Beung Ream. Farmers have used water from the irrigation canals and Beung Ream to irrigate rice farming, particularly in the dry season. Farmers having rice fields around the Beung Ream cultivates 2-3 rice crops per year. First, from May to July/August, farmers cultivate rice, based on rainfall; second, from September to November/December, farmers cultivate rice using water from irrigation; third, from January to March, farmers use the water from the irrigation canals to cultivate the rice farming, but usually not enough, and therefore, they pump water from the CFR Beung Ream to supplement their rice farming.

There are about 572 households that do regular fishing, harvesting fish and aquatic animals, usually in the catchment area, which is flooded by the field fisheries system during the rainy season. Among them, 294 households do fishing in the CFR area. They fish for about 5 months a year. However, fish products from the field fisheries system benefit 716 families, about 20 percent of whom are poor farmers. The annual estimated fish catch from the rice field fishery is about 88kg/household/year. In addition, the annual estimated catch of other aquatic animals (OAAs) is about 48kg/household/year.

5.1.6. Population

Prey Veng Province is home to about 1.24 million people, living in 1149 villages. About 78% of its population are engaged in farming as primary occupation (PASDP-PV, 2020). Takeo Province is home to about one million people living 1119 villages. About 75% of its population are engaged in farming as primary occupation (PASDP-TK, 2020). Kampong Thom Province is a second largest province, but the population is smaller than the previous two provinces. About 73% of its population are engaging in farming and 4.6% are fishing, mostly in the Tonle Sap Lake (PASDO-KT, 2020) (Table 5).

Table 5. Population of the Studied provinces.

Province	Total area (km²)	Total population	Farming population	% of farming population
Prey Veng	4,883	1,245,127	963,550	78
Takeo	3,563	1,026,201	769,651	75
Kampong Thom	13,814	708,398	517,072	73

The studied sites are home to about 19,205 households living in 72 villages. Most of the villagers are farming as their primary occupation. The poverty rate of households in the studied sites constitutes 15% of the total households, of which ID Poor 1 constitutes 5% of the total households and the ID Poor 2 constitutes 10% (Table 6). The CAS 2020 reports an estimated that 57% of all agricultural households are engaged in agricultural production (CAS, 2020).

The Beung Sneh is the largest area and it is home to about 10,911 households living in 44 villages around the lake. It provides water for fishery, agriculture, and livelihoods. Rice and agriculture are grown around the lake, using water from Beung Sneh to irrigate the rice fields. The Theay and Tuk Thla Communes have the highest percentage of the ID Poor households, accounting for 22% respectively, while the Prey Kandieng and Baray Communes have the lowest percentage of ID Poor households, accounting for 10% respectively.

The Ta Soung is the second largest area, home to about 3,731 households living in 15 villages. Rice is the main crop cultivated by all households, supplemented by fishing and livestock raising. The ID Poor 2 constitutes 9% of the total number of households, followed by the ID Poor 1 for 5%. The Kampong Reab Commune has the highest percentage of ID Poor households, accounting for 17%, in which the ID Poor 1 for 10% and the IR Poor 2 for 7%. The Kampong Reap Commune is a flooding commune, which is flooded by water from the Kampong Preah Stream for about 6 months in the year. The rest of the communes is located in the upper lands, which are not under the floods from the Kampong Preah Stream.

The Beung Ream is the third largest area surrounded by 10 villages, home to about 3,325 households. The percentage of ID Poor 1&2 accounts for 18% in the Kah Koh Commune, which is also high compared with other communes (Table 6).

Majority of the population is farmer. They supplement their foods and incomes by fishing, livestock raising and vegetable growing. Fishing constitutes about 24% of the total population. Many young people migrate to find employments in main cities and overseas (Table 7).

Table 6. The ID Poor 1& 2 in the Studied Areas.

Province	Site	Commune	Name village	No. of HHs	ID Poor 1 HH		ID Poor 2 HH		Total no. of ID Poor 1&2	
					No	%	No.	%	Total no.	%
Prey Veng	Beung Phlang	Ampil Krau	3	1238	121	10	103	8.3	224	18
	Sub-total	1	3	1238	121	10	103	8.3	224	18
	Beung Sneh	Theay	4	918	79	9	126	13.7	205	22
		Damrei Puon	10	1756	77	4	213	12.1	290	17
		Samraong	10	1772	110	6	213	12.0	323	18
		Tuek Thla	4	558	60	11	64	11.5	124	22
		Me Bon	3	641	25	4	64	10.0	89	14
		Baray	2	1655	61	4	99	6.0	160	10
		Ta Kao	6	1504	61	4	105	7.0	166	11
		Prey Kandieng	5	2107	31	1	174	8.3	205	10
	Sub-total	8	44	10911	504	5	1058	9.7	1562	14
Kg. Thom	Beung Ream	Kakoh	10	3325	208	6	391	11.8	599	18
	Sub-total	1	10	3325	208	6	391	11.8	599	18
Takeo	Ta Soung	Ban Kam	6	1607	77	5	154	9.6	231	14
		Kampong Reab	2	532	55	10	36	6.8	91	17
		Pou Rumchak	4	778	38	5	59	7.6	97	12
		Prey Lvea	3	814	45	6	78	9.6	123	15
	Sub-total	4	15	3731	215	6	327	8.8	542	15
Grand total		**14**	**72**	**19205**	**1048**	**5**	**1879**	**9.8**	**2927**	**15**

Source: *Commune Database 2021*

Table 7. Occupation of populations in the studied areas.

Row Labels	Rice farming area (ha)	No. of HHs	No. of households fishing	%
Kampong Thom	**5099**	**3325**	**998**	**30**
Kakoh	5099	3325	998	30
Prey Veng	**25915**	**12149**	**2341**	**19.3**
Ampil Krau	3016	1238	248	20
Baray	2430	1655	0	0
Damrei Puon	2919	1756	497	28.3
Me Bon	1962	641	0	0
Prey Kandieng	3111	2107	511	24.3
Samraong	3373	1772	634	35.8
Ta Kao	3511	1504	301	20
Theay	2510	918	151	16.4
Tuek Thla	3083	558	0	0
Takeo	**6349.5**	**3731**	**1227**	**32.9**
Ban Kam	1491.5	1607	336	20.9
Kampong Reab	1458	532	293	55.1
Pou Rumchak	1905	778	275	35.3
Prey Lvea	1495	814	323	39.7
Grand Total	**37363.5**	**19205**	**4566**	**23.8**

Source: *Commune Database 2021*

5.1.7. Food Production System

Farming System

Cambodia is an agrarian country. It is rich in river systems surrounded by floodplains and rice fields. Rice fields and floodplain produce rice, crops, vegetable and livestock. River provides water to irrigate the rice farming and fish for people foods. Rice cultivated in the area close to river body is called 'srekrom', in area that is dependent on rainfall is called 'sreleu'. Srekrom is categorized into two categories–(1) the upper Srekrom, and (2) lower Srekrom. People is also classified based on the rice production system–those farmers who cultivated in 'sreleu' is called 'neakleu' or high lander. The 'neakleu' called the people living in the river a 'neak tonle' or river people, whose livelihood is fishing. Traditionally, 'neakleu' and 'neak tonle' exchanges fish and rice for their living. Thus, farming and fishing are the backbone of Khmer society. Hence, rice farming is the food production engines, but it is small-scale and family-based, depending on rainfalls at large, only small portions of farmlands are irrigated with rehabilitated irrigation system, though it is small-scale.

In the studied areas, the total rice farming area is 37,364ha. About 66% of the rice farming area cultivates wet-season rice. Nonetheless, the dry season rice farming area constitutes 29% of the total rice farming areas. Due to the geography of the rice farming areas adjacent to the river systems, such as the Mekong River and Tonle Sap Lake, the wet season rice farming is partly influenced by rainfalls and the hydrological regimes of the Mekong River. Nonetheless, in the upper rice farming area or Sreleu, which is not flooded by the river hydrological regime, the farmer cultivates the wet season rice, dependent on the rainfalls, between May and November, and the area which is flooded partly by river water and partly by river water is called a "upper Srekrom" where farmers cultivate the floating rice. However, the lower rice farming area, or the "lower Srekrom" is heavily flooded by the river hydrology so farmers cannot farm during the wet season, they waited until river water recedes from the floodplain, and then, the farmer starts cultivating the recession rice. The rice farming in the Sreleu was transplanting, while the floating was broadcasting and the recession rice farming was transplanting. Farmers used local rice varieties to cultivate in these areas. These practices were done 20 years ago, but it has been changed in recent times.

The Beung Sneh is surrounded by 22,899ha of rice fields, which are cultivated by villagers from 44 villages. The wet season rice farming area constitutes 69% of the total rice farming area and the dry season rice accounts for 31%. From May to November, rainfalls and water from the Mekong River flow into Beung Sneh, rising the water level in the lake, flooding the lower Srekrom 1-2m deeply which is not suitable for rice cultivation, and then submerging the upper Srekrom with an estimated depth of less than 0.5m. However, the water from the Beung Sneh does not reach the Sreleu, but the rainfalls fill in, allowing farmers to cultivate rice in the Sreleu and upper Srekrom between May and October. In November, water recedes the Beung Sneh, flowing into the Mekong River. During this period, farmer starts cultivating the recession rice in the lower Srekrom, using the water remaining in the Beung Sneh to irrigate the recession. Many villagers around the Beung Sneh call this a dry season rice farming. However, rice farming varies from village to village in the Beung Sneh, depending on the distance from the village to the lake. Many communes around the Beung Sneh are

located within the Beung Sneh floodplain, such as Theay, Prey Kandieng, and Ta Kao whereby the wet season rice farming area constitutes 32-59% and the dry season rice farming area constitutes 41-68%, suggesting that about half of rice farming area is wet season rice and another half is dry season rice. Other communes around Beung Sneh such as Damrei Puon, Samraong**,** Tuek Thla, and Mekong are located in the Southeast of Beung Sheh, which is a distance from the Beung Sneh, whereby the wet season rice farming area accounts for 91-98% and the dry season ricer constitutes 2-9%, suggesting that the rice farming area is dominated by the Sreleu and upper Srekrom, while lower Srekrom is not farmed by villagers.

Also, in the Beung Phlang site, the wet season rice accounts for 100%, suggesting that there is no system of Sreleu and Srekrom, only one category of ricefield, which is the wet season rice farming area. From the field investigation, it is suggested that among three villages having rice fields around the Beung Phlang, only Svay Teap Village is cultivating the dry season rice farming, following the construction of the Vaiko Irrigation. Only 0.2% of the farmlands are cultivated the dry season rice. Villagers from other villages in Ampil Krav have not used water from the Vaiko Irrigation system that much. The same happens to communities around the Beung Reap where farming is dominated by the wet season rice, and the ricefield is categorized into mainly the Sreleu.

In the Ta Suong Irrigating Community, the dry season rice farming constitutes 60% of the total farming lands and the wet season rice farming areas account for 40%. These suggest that the rice farming area is dominated by the Srekrom. Ricefields in Ban Kam, Pou Rumchak, and Prey Lvea are located in the Srekroam, accounting for 40-58% of the total farmlands. Kampong Reap is a commune located deep in the Kampong Preah Stream, where it is submerged in water for six months (Table 8).

Table 8. The wet season and dry season rice farming areas.

Site	Commune	Rice farming area (ha)	Total wet-season rice farming area		Total dry-season rice farming area	
			Area (ha)	%	Area (ha)	%
Beung Phlang	Ampil Krau	3016	3016	100	5	0.2
Sub-total		3016	3016	100	5	0.2
Beung Sneh	Theay	2510	1472	59	1038	41.4
	Damrei Puon	2919	2743	94	176	6
	Samraong	3373	3223	96	150	4.4
	Tuek Thla	3083	3033	98	50	1.6
	Me Bon	1962	1794	91	168	9
	Ta Kao	5941	1918	32	4023	68
	Prey Kandieng	3111	1652	53	1459	47
	Sub-total	22899	15835	69	7064	31
Boeung Ream	Kakoh	5099	5099	100	0	0
Sub-total		5099	5099	100	0	0
Ta Soung	Ban Kam	1492	619	41	872	58
	Kampong Reab	1458	27	2	1431	98
	Pou Rumchak	1905	1123	59	782	41
	Prey Lvea	1495	740	49	755	50.5
Sub-total		6350	2509	40	3840	60
Total		**37364**	**26459**	**71**	**10909**	**29**

Source: *Commune Database 2021*

Agricultural Lands

Farming is depending on farmland, which is an important asset for rural households and rice farming is the main livelihood activity. Rice farming is organized seasonally into the wet and dry season rice farming, depending on water availability. Due to geographical locations of the studied areas in the close connection with river system, farmland is organized into the lower, middle and upper ricefields. The lower and middle rice fields are located to the river or water bodies, while upper rice field is in distance.

The average agricultural land holding per household is 1.8ha in 2019, while the 2013 Cambodia Agriculture Census estimated this average at 2.5 parcels per holding (CAS, 2020). In the study, an average, one household owns the land of about 1.3 ha, of which the wet season rice farmland is about one hectare and the dry season rice farming areas of 0.3 ha per household. About 98% of Cambodian agricultural households own farmlands, of which 99.3% are in Takeo, 99.1% in Prey Veng and 98.3% in Kampong Thom Provinces. About 72% of Cambodian agricultural households hold farmlands less than 2ha, of which in Takeo Province, it constitutes 87%, followed by 82% in Prey Veng and 61% in Kampong Thom.

About 20% of households own farmland between 2-5ha, of which Kampong Thom constitutes 25%, followed by Prey Veng for 16% and Takeo for 11%. About 9.3% hold 5 ha of farmland or more. Furthermore, about 5% of agricultural households in Cambodia rented farmlands from others for agriculture, perhaps, they are landless. In Prey Veng, about 4% of agricultural households rent their farmlands or landless, followed by 3.4% in Kampong Thom, and 2% in Takeo Provinces (Cambodia Agriculture Census (CAS), 2020). However, in the studied area, about 13% of households have farmland less than one hectare, and 10% of households are landless (Commune Database, 2021).

In the studied area, farming households grow vegetables and crops to feed their families. They could supply vegetables and crops to consume at the household levels. However, villagers grow them in small quantities. When they need vegetables or crops in large quantities, they often rely on markets to supply them. Thus, the study does not cover vegetables at large.

In Takeo Province, in Kampong Reap, the landholding size per household is about 3ha, most of which are used to cultivate the dry season rice. However, the percentage of landless in this area is high, accounting for 31%, as they fish to supplement their incomes. In addition, the Kampong Reap Commune is flooded for six months in the year and it is dry for another six months and fishing was their main livelihood activity. Thus, about 31% of households are landless, as fishing is the main occupation. In Pou Rumchak, the landholding size per household is 2.4ha, half of which is for the wet rice season rice farming and another half is for the dry season rice farming. In Ban Kam Commune, the population density is higher than in other communes, and thus, the landholding size is smaller, about one hectare per household, half of it is the wet season rice farming area, and another half is the dry season rice farming area. In the other communes in Prey Kobbas District, only 0.1% of households own farmland less than one hectare and only 4.6% of households are landless (Table 9).

Table 9. Farmland holdings in the studies areas.

Province	Site	Commune	No. of HHs	Rice farming area (ha)	The rice land per household (ha)
Prey Veng	Beung Phlang	Ampil Krau	1981	3016	1.5
	Beung Sneh	Theay	2964	2510	0.8
		Damrei Puon	2679	2919	1.1
		Samraong	2482	3373	1.4
		Tuek Thla	2820	3083	1.1
		Me Bon	2109	1962	0.9
		Ta Kao	3739	5941	1.6
		Prey Kandieng	2887	3111	1.1
	Sub-total		21661	25915	1.20
Kampong Thom	Boeung Ream	Kakoh	3325	5099	1.5
Takeo	Ta Soung	Ban Kam	1607	1491.5	0.9
		Kampong Reab	532	1458	2.7
		Pou Rumchak	778	1905	2.4
		Prey Lvea	814	1495	1.8
	Sub-total		3731	6350	1.7
Grand total			**28717**	**37364**	**1.3**

Source: *Commune Database 2021*

In the Beung Phlang area, the size of farming land per household is about 1.5ha, which is cultivated for the wet season rice. However, around the Beung Sneh area, the landholder size per household is around one hectare per household, smaller than other provinces, given the high population density in Prey Veng Province, compared with other provinces, and the degree of potential development in the areas. In Theay and Prey Kandieng Communes, as it is located close to the Beung Sneh, farmers are farming both the wet season rice as well as the dry season rice, using water from the Beung Sneh. However, in Ta Kao Commune, the farmer owns the dry-season rice farmland larger than the wet-season rice farmland. However, in Damrei Puon, Samraong, Tuek Thla, and Me Bon Communes, farmers are farming the wet season rice more than the dry season rice, given the geography of these communes in a distance from the Beung Sneh area.

Around the Beung Ream area in Kah Koh Commune, Santuk District/Kampong Thom Province, the landholding size is 1.5ha per household, most of them are cultivated the wet season rice, which is located close to the National Highway no.5, far away from the Tonle Sap Lake. The hydrology of the Tonle Sap also influences the farming practices in these areas. Fish is also migrated along the rising water level in the lake in the wet season.

In the Beung Sneh area, the Prey Kandieng is a commune where the percentage of landless accounts for 22%, followed by Damrei Puon at 21%, and Baray at 19%. In Tuek Thla, Prey Kandieng, and Ta Kao Communes, about 32%, 26%, and 23% respectively have their households owned farmland of less than one hectares. Land speculation is high around the Beung Sneh, as it is located in the provincial town of Prey Veng Province (Table 10).

In the Beung Ream area, the percentage of landlessness constitutes 16% of the total population of Kah Koh commune, and about 31% of the households have a farmland area of less than one hectare. The landless households report the sales of their farmlands to private individuals and companies. At present, some of landless households hire farmlands from rich individuals or companies to cultivate rice farming at the cost of USD100 per hectare per season (Table 10).

Table 10. Land holdings in the studied sites.

Province	Site	Commune	Name village	No. of HHs	No. of HHs with farmlands less than 1ha		# of families who do not own any rice land	
					No.	%	No.	%
Prey Veng	Beung Phlang	Ampil Krau	3	1238	0	0.0	0	0.0
	Sub-total	1	3	1238	0	0.0	0	0.0
	Beung Sneh	Theay	4	918	0	0.0	0	0.0
		Damrei Puon	10	1756	10	0.6	369	21.0
		Samraong	10	1772	0	0.0	0	0.0
		Tuek Thla	4	558	176	31.5	21	3.8
		Me Bon	3	641	108	16.8	18	2.8
		Baray	2	1655	180	10.9	318	19.2
		Ta Kao	6	1504	347	23.1	70	4.7
		Prey Kandieng	5	2107	546	25.9	470	22.3
	Sub-total	8	44	10911	1367	12.5	1266	11.6
Kg. Thom	Beung Ream	Kakoh	10	3325	1032	31.0	540	16.2
	Sub-total	1	10	3325	1032	31.0	540	16.2
Takeo	Ta Soung	Ban Kam	6	1607	0	0.0	0	0.0
		Kampong Reab	2	532	0	0.0	164	30.8
		Pou Rumchak	4	778	0	0.0	9	1.2
		Prey Lvea	3	814	2	0.2	0	0.0
	Sub-total	4	15	3731	2	0.1	173	4.6
Grand total		**14**	**72**	**19205**	**2401**	**12.5**	**1979**	**10.3**

Source: *Commune Database 2021*

Farming Seasonality

At present, rice farming in Cambodia has been transformed from one crop to three crops a year in different rice fields. They are moving from rice farming relying on rainfalls to irrigated water, from transplanting to broadcasting, from labor-intensive to mechanization, from farming for subsistence to farming for trading, and from low yield to high yield. These changes are due to the unpredicted market-driven. It is uncertain about the impacts of RGC's agricultural policy on these changes in rice farming.

Farmers cultivate a rice variety that the rice market demands, including IR 504, IR 5154, and others, which are imported from Vietnam. The rice market is influenced by rice traders from Vietnam who buy rice from farmers who cultivate these rice varieties. These rice varieties yield 5-6 tons per ha and it grows for 95 days.

Given the increased demand for rice trade, farmers grow rice crops three times a year on their respective farmland. Thus, the rice field is organized into two categories: (1) Sreleu, and (2) Srekrom. The Srekrom is usually is categorized into the upper Srekrom and lower Srekrom.

The Sreleu has cultivated three rice crops a year. The first rice farming season starts in May/June and it will be harvested around August/September, and it is called wet rice farming as it is dependent on rainfall. After the first harvest, farmers start their second rice farming season in Sreleu in October/November and it will last around December/January. During the second rice farming season, farmers rely on water from the irrigation schemes to irrigate their rice lands for at least three months as it is a dry season, which has no rain, only water from the irrigation schemes. In some areas, farmers continue their third rice farming season in the Sreleu from February to April/May, depending on water availability. In many cases, farmers

face water shortages and the yield is not preferable to the level of the investment. Many farmers experience drought spells that damage rice farming in the dry season.

In upper Srekrom, farmers practice rice farming three times a year the same as in Sreleu–(1) wet rice farming season from May/June to August/September; (2) dry rice farming from October/November to January; and (3) dry rice farming from February to April/May. As upper Srekrom is located close to the river/stream, therefore, farmers could take water from the lake, river, and stream easier than the Sreleu (Table 11).

Moreover, the lower Srekrom is under deep water during the wet season from May to October due to heavy floods from the Mekong River and Tonle Sap Lake and also the rainfalls, which are not suitable for rice farming. From November onward, the water level in the Mekong River and Tonle Sap Lake receded, thus, allowing farmers to cultivate the recession rice in the old, but dry season rice farming at present. However, from February to April/May, farmers continue cultivating the dry-season rice farming in lower Srekrom, pumping water from the nearby irrigation schemes or lakes to irrigate their rice fields.

In the Beung Phlang area, farmers do not cultivate the dry season rice, except villagers in Svay Tep village, as they do not have secured water for dry season rice farming, although the Vailko Irrigation Schemes built by Chinese Companies in 2015, as the irrigation canals do not keep the water during the dry season. In the Beung Ream area, farmers own only Sreleu and they cultivate three rice crops in Sreleu a year; first, they start cultivating the wet rice farming season in May/June and they harvest it in September. After that farmers start dry-season rice farming for the second time in October/November which will last until January. The third rice farming season is also practiced by farmers around the Beung Ream, but they face extreme water shortage, leading to conflicts among farmers over water from the Taing Krasaing Irrigation Scheme. In the Beung Sneh area, Damrei Puon, Samraong, Tuek Thla, and Me Bon have high percentages of households (94-98%) relying on wet rice farming and small percentages on dry rice farming. These suggest that farmers in these communes are farming more in the Sreleu and upper Srekrom, and few in the lower Srekrom during the dry season.

Table 11. Wet and dry rice farming in Sreleu and Srekroam.

	February	March	April	May	June	July	August	September	October	November	December	January
Sreleu	Dry season rice farming/no farming due to shortage of water				Wet Season Rice farming depending on rainfalls				Dry season rice farming, pumping water from rivers & lakes			
Upper Srekrom	Dry-season rice farming depends on pumping water from rivers				Wet Season Rice farming depending on rainfalls				Dry-season rice farming			
Lower Srekrom	Dry-season rice farming				Flooding				Recession rice farming			

To grow these rice varieties, farmers need secured water supplies and high agricultural inputs, including pesticides, fertilizers, and other chemical inputs. Also, farming has been mechanized. To do so, farmers have relied on private sectors to supply agricultural inputs and mechanization at a high cost. Rice farming becomes less labor intensive, but a private sector dependency, where farmers are deeply involved in borrowing and paying for agricultural services provided by the private sector operators. Thus, farmers are indebted at a high rate.

5.2. Food Production

The main foods for people in the studied area are rice, fish, vegetable, and livestock. These foods are produced from lands, rivers, and natural ecosystems around their houses and communities. The studied sites are highly productive in food production, particularly rice, and fisheries.

5.2.1. Rice Production

The studied areas are productive in rice farming. Farmers cultivate both the wet and dry season rice at presence. Based on commune database, the average wet season rice yield per ha collected from the studied areas (Beung Phlang, Beung Ream, Beung Sneh and Ta Suong) is 2-3 tons. With the estimated total wet season rice farming area of 26,459ha, the total wet season rice production is estimated at about 60,624 tons per ha. In the dry season rice farming, the average rice yield collected from the field studies and commune database is 4-5 tons/ha. With the total dry season rice farming area of 13,409ha, the total dry season rice production is 53,320 tons. The total annual rice production in the studied area is 113,944 tons.

The Beung Sneh area is a rice producing engine of Prey Veng Province. It is surrounded by many rice fields, extended over 72 villages in 9 communes. In the wet season, some rice fields around the Beung Sneh lake are submerged by the rising water level and the rice field areas that could be cultivated in the wet season rice is estimated at about 15,835ha. In the dry season, water level in the lake recedes, and the area that could be cultivated the dry season rice reduce to around 7,064 ha. At the average rice yield of 4tons/ha for the dry season and 2 tons for the wet season, the Beung Sneh area could produce 70,359 tons (Table 12).

The Ta Suong Irrigating System is supporting the rice producing communities in Prey Kobbas District, Takeo province. About 10 villages from four communes in Prey

Kobbas District could double their rice productions in both the wet and dry season rice. The total rice production by 10 villages in Ta Suong Irrigation System is about 26,349 tons annually.

The Beung Ream is also surrounded by 10 villages in Kah Koh commune, where they form FWUC to manage the sub-canals of the Taing Krasaing Irrigation System to take water to irrigate their rice fields. With the irrigation system, farmers in Beung Ream could cultivate both the wet and dry season rice, which in total it could produce 12,089 tons annually to sustain livelihoods of farmers whose livelihoods is depending on rice farming (Table 12)

In the Beung Phlang area, farmers do most the wet season rice farming. The total wet season rice farming area covers 3,016 ha and the average rice field is estimated at about 2 tons/ha. Only 5ha is used to cultivated the dry season rice farming. Total rice production of the Beung Phlang area is estimated at abouy 5,147 tons annually (Table 12).

However, based on field studies shows that farmers in the studied sites could farm up to 2-3 times a year, depending on water availability, irrigation systems and access to water bodies. These include: (1) Beung Sneh, (2) Beung Phlang, (3) Beung Ream, and (4) Ta Suong. We examine rice production in each of these sites for more details.

Table 12. Rice productions in the studied area.

Site	Commune	Total dry-season rice land / Srekroam (ha)	Average dry season rice yield (ton/ha)	Rice Production (tons)	Total area of wet-season rice land/ Sreleu (ha)	Average wet season rice yeild (ton/ha)	Rice Production (tons)	Grand-Total of Rice Production (tons)
Beung Phlang	Ampil Krau	5	4	20	3016	2	5127	5147
	Sub-total	5	4	20	3016	2	5127	5,147
Beung Sneh	Theay	1038	3	2880	1472	3	4379	7,260
	Damrei Puon	176	3	601	2743	3	7818	8,419
	Samraong	150	3	489	3223	2	7252	7,741
	Tuek Thla	50	3	156	3033	2	6976	7,132
	Me Bon	168	4	700	1794	3	5083	5,783
	Baray	1123	4	4492	1307	4	4901	9,393
	Ta Kao	2900	4	12808	611	3	1680	14,489
	Prey Kandieng	1459	4	5252	1652	3	4890	10,142
	Sub-total	7,064	4	27,380	15,835	3	42,979	70,359
Boeung Ream	Kakoh	2500	3	7500	5099	1	4589	12089
	Sub-total	2500	3	7500	5099	1	4589	12,089
Ta Soung	Ban Kam	872	6	4854	619	4	2259	7113
	Kampong Reab	1431	5	7155	27	3	81	7236
	Pou Rumchak	782	4	3265	1123	3	3369	6634
	Prey Lvea	755	4	3146	740	3	2220	5366
	Sub-total	3840	5	18420	2509	3	7929	26,349
	Grand-total	**13,409**	**4**	**53,320**	**26,459**	**2**	**60,624**	**113,944**

Source: *Commune Database 2021*

Rice Production in Beung Sneh

In Beung Sneh, farmers cultivate rice three times a year on their respective rice fields. The waterer regime between the wet and dry seasons in Beung Sneh Lake shapes the rice fields into categories: (1) Sreleu, (2) Srekandal, and (3) Srekrom. Sreleu covers 15,835ha, which farmers cultivate the wet season rice. Srekrom covers 7064ha, which farmers cultivate the dry season rice. However, Srekrom is classified into two categories–(1) Lower Srekrom, and (2) Upper Srekrom.

In the wet season, between May and October, the water level in the Beung Sneh starts rising due to heavy rains around the lake and also the flow of water from the Mekong River into Beung Sneh. The Srekrom, particularly the lower Srekrom are submerged by the rising waters, which makes farmers unable to cultivate. Only Sreleu and the upper Srekrom are available for rice farming, in which farmers cultivate the wet season rice from May to October with rice varieties from Vietnam, namely IR504 and IR5154, depending on rainfalls, using heavy chemical agricultural inputs. The rice yield varies but is between 4-5 tons/ha a season.

Between November and January, there is less rainfall, and the water level in the lake goes down, but farmers could still farm the dry season rice in Sreleu, which they pump water from the Beung Sneh Lake via the built and rehabilitated irrigation canals around the Beung Sneh. In Srekrom, farmers start cultivating the recession rice traditionally in this area, but at present, they convert it to dry season rice, which partly relying water from water from the Beung Sneh Lake and partly on the irrigated water from the irrigation system. There are nine large irrigation systems and four medium size irrigation systems around Beung Senh Lake that have the potential to irrigate 6,780ha, benefiting 3,272 households. Farmers use the rice varieties taken from Vietnam and grow in the dry season as rice traders are willing to buy these rice varies from farmers. However, these varieties consume so much water for 95 days period and high agricultural chemical inputs to produce a yield of 4-5 tons/ha as average.

From February to April, farmers cultivate the dry season rice, but water availability in this period is critical, and therefore, the upper Sreleu is often left out from farming. However, Srekrom is fully cultivated during this period, using water from the lake and irrigated water. Competing for water for irrigating the Srekrom and lower Sreleu are high, and each farming households possess the water pumping generators to prepare for the dry season rice farming, which often lead to water conflicts. Also, some farmers encroach the lake areas to expand the lower Srekrom as it is located close to the water. However, farmers continue to use the same rice varieties from Vietnam and apply high agricultural chemical inputs to increase the rice field. Even though the rice yield per ha is not much increased due to the shortage of water, averaging 3-4 tons/ha. The destruction from pests and rats is also high, causing the yield lower than expected and it varies from year to year.

In Torp Sdach village in Theay Commune, about 105 ha is an upland ricefield, which is not flooded by the rising water level in Beung Sneh, and therefore, farmers cultivate 2-3 rice crops per year. However, about 200ha is located within the Beung Sneh floodplain and thus, the area is flooded during the wet season therefore, farmers could only cultivate one rice crop a year, particularly from March to May which is a dry season rice. About 250-300 HHs rely on water from the private pumping station. Among them, about 175 HHs are doing dry season rice farming, and all of them own pumping generators at least one.

Nonetheless, given the increasing number of rice cultivating times, from two to three times in respective rice fields, then, the rice production in the Beung Sneh areas would be double of the rice production estimated above.

Rice Production in Beung Phlang

Beung Phlang is surrounded by the rice field, most of which are classified as the wet season rice field. The rice field used to be flooded by the Mekong water, rising in the wet season from May to October annually. However, in the past 10 years, the Mekong water does not reach the areas around the Beung Phlang, and thus, farming is no longer depending on river, only on rainfalls. Thus, farmers cultivate the wet season rice in May-October, using the rice varieties of IR504 and IR5154 from Vietnam, with intensive uses of pesticide and chemical fertilizer and waters. The rice yield is ranged between 4-5 tons/ha

In 2015, RGC with funding supports from China built a Vaiko Irrigation system, irrigating the rice field in Svay Rieng, Prey Veng and Kampong Cham province, over 60,000 ha. Two main canals were developed to provide water to irrigating rice fields in these provinces. However, due to lower water levels in the Mekong River, the Vaiko irrigation canals still contain no water in the dry season. For these reasons, farmers around the Beung Phlang do not cultivate the dry seasons, only small number of households does.

Rice Production in Ta Suong Irrigation System

The Ta Suong Irrigation System supports 977 farming households in 15 villages in four communes in Prey Kobbas District. These are productive farming communities that produce tons of rice from Sreleu and Srekrom to support hundreds of agricultural households who live depending on rice farming. The Sreleu covers 2509 ha in these four communes which farmers cultivate the wet season rice. In addition, Srekrom is also highly productive for rice farming, covering 3,840ha. Both Sreleu and Srekrom are cultivated three times a year.

In May or June, water level in Kampong Preah Stream rising, which flood the lower Srekrom, brought tons of silts to fertilize the floodplain for about six months. At the same time, the monsoon produces the rainfalls over six months which make the area full of water. However, water does not submerge entirely the upper Srekrom and Sreleu and thus, allow farmers to cultivate the wet seasons, depending partly on river water in the upper Srekrom and fully rainfalls in the Sreleu. Farmers now cultivate the rice varieties from Vietnam (IR504, IR5154) which could yield 4-5 tons/ha, but farmers use highly agricultural chemical inputs to fertilize the rice farming (Table 13).

In November-January, water recedes the Srekrom, farmers start cultivating the recession rice which is traditionally called or the dry season rice farming at present. Farmers keep using the rice varieties from Vietnam as it yields higher than local varieties and market availability. However, farmers use high chemical inputs such as fertilizers and pesticide to keep its high yields. Also, they use huge water volume to irrigate the rice fields, and thus, rely on irrigation system to irrigate the rice fields, when water fee is charged to each farming households. Also, farmers cultivate the dry season rice in Sreleu as well, using irrigated waters to irrigate their dry season rice, using the same rice varieties and agricultural inputs to maintain a rice yield of 4-5 tons/ha (Table 13).

From February to April, farmers continue to cultivate the dry season rice in Srekrom and Sreleu, using water from the irrigation canals. The Ta Suong Irrigation System keeps pumping water from the Kampong Preah Stream to supply water to irrigate the dry season rice farming. As it is a dry season, therefore, water level in the Kampong Preah is low, affecting the CFis, and sometime, there is not enough water to pump out, affecting the dry season rice farming in the Ta Suong Irrigation Area. The water fee is not fully paid by farmers, as the rice yield is low, compared with other seasons.

Table 13. Farming Seasons in Sreleu and Srekrom.

Site/ Commune	Farming Season	Sreleu				Srekrom			
		No. of villages	No. of Farming (time/yea)	Rice variety	Yield	No. of villages	No. of Farming (time/yea)	Rice variety	Yield
Beung Phlang	May-October	3	Wet season rice farming	Local variety, IR 504, IR 5154	2 tons/ha local varieties. 4-5 tons/ha for IR504/IR5154	3	There is no Srekrom and the Vaiko irrigation system is built hugely by funding support by Chinese Government, taking water from the Mekong River in Kampong Cham Province to irrigate rice fields in Kampong Cham, Prey Veng and Svay Rieng Provinces		
	November-January		Dry season rice farming—This happens to few households	IR 504, IR5154	4-5 tons/ha				
	February-April		No farming, as no water						
Beung Sneh	May-October	44	Wet season rice farming—depending on rainfalls.	Local variety, IR 504, IR5154	4-5 tons/ha	44	The lower Srekrom is flooded from June to November. The upper Srekrom is not flooded, which is used for rice cultivation.	IR 504, IR5154	4-5 tons/ha
	November-January		Dry season rice farming—partly on rainfall and partly irrigated water	IR 504, IR5154	4-5 tons/ha		Recession rice farming	IR 504, IR5154	4-5 tons/ha
	February-April		Dry season rice farming—depends on irrigated water, some farmers cannot access water to dry season rice farming	IR 504, IR5154	4-5 tons/ha		Dry season rice farming season—depending on irrigated water.	IR 504, IR5154	4-5 tons/ha
Beung Ream	May-October	10	Wet season rice farming—depending on rainfalls.	Local variety, IR 504, IR5154	4-5 tons		No Srekrom—the Taing Krasaing Irrigation system drains water from Taing Krasaing River to irrigate rice fields in Kah Koh Commune, connecting with Beung Ream.		
	November-January		First dry season rice farming—partly on rainfall and partly irrigated water	IR 504, IR5154	4 to 5 tons				
	February-April		Dry season rice farming--pumping water from Kah Koh irrigation systems and Beung Ream--competing for water. Some farmers do not cultivate rice due to water availability	IR 504, IR5154	4 to 5 tons				
Ta Soung	May-October	15	Wet season rice farming—depending on rainfalls, no payment for water fees	IR 504, IR5154	4 to 5 tons	15	Wet season rice farming—depending on rainfalls, no payment for water fees	IR 504, IR5154	4 to 5 tons
	November-January		First dry season rice farming—depend on irrigation system and pump water from Ta Suong Irrigation scheme--payment for water fees	IR 504, IR5154	4 to 5 tons		First dry season rice farming—depend on irrigation system and pump water from Ta Suong Irrigation scheme--payment for water fees	IR 504, IR5154	4 to 5 tons
	February-April		Second dry season rice farming--pumping water from Ta Suong irrigation systems --competing for water, payment for water fee	IR 504, IR5154	4 to 5 tons		Second dry season rice farming--pumping water from Ta Suong irrigation systems --competing for water, payment for water fee	IR 504, IR5154	4 to 5 tons

Rice Production in Beung Ream

Traditionally, rice farming around the Beung Ream area was one a year, which is a wet season rice. The total area of the wet season rice is 5,099ha, distributing across 10 villages in Kah Koh Commune, Santuk District. Since the Taing Krasaing Irrigation System has been developed, there are increasing water availability, allowing farmers in the Kah Koh Commune to cultivate three times a year. About 570 farming households have benefited from the irrigation system.

From May to October, farmers cultivate the wet season rice, using the rice varieties from Vietnam (IR504, IR5154) and agricultural chemical inputs such as pesticides and fertilizers. Also, farmers use other chemical inputs to kill pest, grasses and rats. Farming in this period is relying on rainfalls with an average rice yield of 4-5 tons/ha. Thus, farmers do not fully pay the water fees as plenty of rainfalls.

After the wet season rice farming, farmers start the dry season rice farming from November to January. Water is still plenty, remained from the wet season, and thus, allow farmer to cultivate dry season rice farming. However, water is usually running out in late December or January, forcing farmers to pump water out of the irrigation system, sometime causing the conflicts between upstream and downstream canals.

After the second rice harvest, some farmers whose farmlands located close to the irrigation canals start a second dry season rice farming in February and last in April, cultivating the rice varieties from Vietnam with high agricultural chemical inputs and water uses. Severe water shortage occurs in this period, leading to water conflicts between the upstream and downstream irrigation canals. These have affected the rice yields and often the rice fields are spoiled due to long drought and sever water shortage. Water fees are usually not paid, as the low rice yield and some get spoiled due to severe drought.

5.2.2. Cambodia Rice Policy

According to a review of the agricultural sector by the World Bank (2015), Cambodian agriculture has benefited from a market-oriented policy, including (1) an open trade policy, enabling farmers to benefit from improved access to the European Union (EU) market as well as cross-border trade with Thailand and Vietnam; (2) wider availability of machinery services such as threshers and combine harvesters; (3) better access to rural finance, especially micro-finance; and (4) investment in rice milling.

government's policy promoting rice exports, with a goal of exporting 1 million t of milled rice. the Ministry of Agriculture, Forestry and Fisheries (MAFF) promoted ten varieties, including three early-maturing IR varieties—Sen Pidor, IR66, and Chulsar—that have the potential to meet the quality standard for high-value rice exports. However, farmers continue to use more Vietnamese varieties. IR504 from Vietnam is widely used by farmers in irrigated and recession rice areas in the DS. Though this variety is not of good quality for the local market, the high yield and the demand from Vietnam has meant that farmers widely adopt it for commercial production.

The growth in rice production was due partly to an expansion of cultivated area (at a rate of 1.7% during 1990–2017) but more so to an increase in yields (at a rate of 3.5% in the same period). Moreover, the area expansion has levelled off while there is still potential for further yield growth. The national rice yield now averages 3.5 t/ha.

The growth in production has generated a rice surplus above estimated domestic requirements (World Bank, 2015). The notional surplus increased from 1.44 million t of milled rice in 2008 to 2.38 million t in 2013. With increasing liberalisation of trade and explicit government encouragement—especially with the 2010 *Policy Paper on the Promotion of Paddy Production and Rice Export*, in which rice was designated as "White Gold"—the export of rice has increased sharply (ADB 2014). In 2013, formal exports of rice were 378,850 t, exported to over 50 countries, 91% of which were in the EU or Asia; half of these official exports were of high-quality fragrant rice. This was well below the target enunciated in the 2010 Policy Paper of 1 million t of milled rice exports by 2015.[2] However, in 2013, informal cross-border trade of rice and paddy (unmilled rice) to Vietnam and Thailand was estimated to be 1.5 million t (in milled rice equivalent).[3] Thus total exports of rice and paddy increased nearly 20-fold from 200 they used more than three times the seeding rate of the other two villages (380 kg/ha). The practice of direct seeding with a high seed rate, as observed in Snao, can increase crop yield through a high density of plants and hence panicles per unit area, compared with the minimal tillering of short-duration varieties using the transplanting method. Many farmers in the Mekong Delta in Vietnam broadcast at up to 300 kg/ha to ensure crop establishment and minimise weed infestation, with yields of 4–6 t/ha (Nguyen and Vo-Tong 2002).

5.2.3. Rice Varieties

Three rice varieties dominate the rice farming industry in Cambodia in terms of selectivity, productivity, adaptability and market availability. These include the IR 504, IR54151 and the OM 5154. They are high yields, short period of cultivation and exportability.

IR 504

The IR504 is characterized by long grain white rice: bloated, hard texture, no aromatic rice. The IR504 variety was produced by IRRI International Rice Institute and it was cultivated on Mekong Delta fields since 1992 and then thrives in the following years. It has a high productivity, good adaptability to lots of farming terrain, especially the short-term harvest season, so it has pushed the output up and the price of rice down to be suitable for the user's pocket. It is high quality long grain rice and it is popular rice variety in Vietnam, which has been dubbed "poverty reduction". This is a short-term rice variety grown in the Mekong Delta region, which has good pest resistance and high yield. Rice grain is large, opaque white, the rate of silver belly is high. Dried, expanded, porous rice is suitable for use as raw materials for production, customers who prefer dry rice.

The IR504 was introduced to Cambodia's farmer around the 2010s, influenced by the rice traders and the rice export policy in Vietnam. In Cambodia, farmers grow the IR504 in the floodplains of the Mekong River such as Kampong Cham; the Mekong Delta such as Prey Veng, Takeo and Kandal and the Tonle Sap. The growing period is 95 days, and thus, they grow three times a year. However, to grows this variety, it consumes a lot of water and agricultural chemical inputs, but the market is available throughout the year.

OM 5451

OM 5451 is a high-yielding rice variety grown in the Mekong Delta too, with a relatively short growing time (90 - 95 days). OM 5451 rice is a long-grain variety of fragrant rice created by a crossbreed combination between Jasmine 85 and OM 2490 varieties. It has been booming in Vietnamese. OM 5451 is a high-yielding long-grain cultivar of fragrant rice mainly grown in the Mekong Delta, with averages 6.5 tons per hectare.

Rising demand for this rice variety was propelled chiefly by the Vietnamese market. Because of that farmers in Cambodia now grows OM 5451 rice due to its strong market. They are grown across Cambodia, particularly in the studied provinces, three times a year. To grow this variety, farmers use a lot of water and agricultural inputs such as pesticides and fertizers. Farmers do not grow this variety for consumption, but for rice trade. Its markets are in Vietnam and always available. Every time farmers grow and harvest this variety, rice traders come to buy it and export to Vietnam.

IR5154

IR 5154 has a longer growth duration and cultivated in both dry and wet seasons. The dry season attainable yield of IR 5154 is fluctuated between 6.5 and 7.0 tons/ha. The seasonal variability was primarily driven by the climatic conditions during the plant's growth and development. The same as previous variety, farmers in Cambodia grow this variety across the country. It is high yield, short period of cultivation, and local adaptability. Farmers in Cambodia grow this variety three times a year.

In summary, while it has a high yield and marketability, growing these rice varieties produce a social, economic and environmental implications. The growing of these varieties in Cambodia have been influenced by the Vietnamese influence, through which the Vietnamese rice traders intrude into Cambodia rice market, setting up the network of rice traders, taking over the Cambodian rice trader business. Also, Cambodian farmers turn to grow these varieties, giving up the local varieties due to Vietnamese market influences. The local rice varieties that have long historical co-existence in Cambodia rice industry have been gradually disappeared.

To produce these varieties, farmers have to be equipped with skill, practices and technology provided by the Vietnamese suppliers such as fertilizers and pesticides, which create a market space for Vietnamese products. However, farmers do not have full knowledge of these varieties, the fertilizers they used, and the pesticides they applied, and so, many of them use it blindly, affecting health and environment such as water quality and aquatic animals. Also, the applications of these varieties, agricultural inputs and technologies cost farmers a lot more, ending up in a high indebtedness environment. Even farmers keep producing more, three rice crops a year, the price is fluctuated and farmers still cannot make enough profits, but keep borrowing the finance from the MFIs.

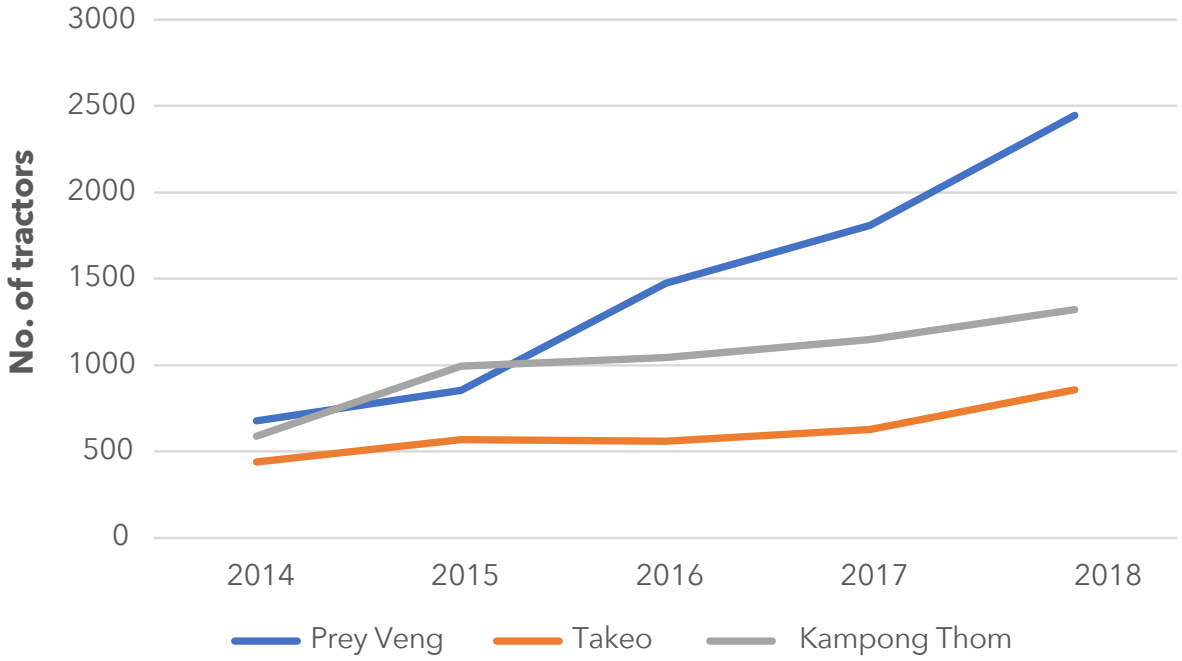
Farmers complained about the difficulty of finding technical assistance to control rice pests, especially in the DS. They applied many kinds of pesticides; some were banned and very dangerous to human health and the environment. Most of the pesticides sold in the market were imported from Vietnam or Thailand, with original language labels. Furthermore, there was a dearth of information from extension services to advise farmers on fertiliser application. Farmers applied at a rate they felt they could afford or merely followed the advice of the fertiliser merchants. Some fertilisers sold on the market also had low quality.

5.2.4. Mechanization in Rice Farming

Traditionally, farmers cultivate one crop a year, and they used draft animals to plow and harrow their rice fields. Farmers practiced rice farming by cooperating and reciprocating in which they join hands to cultivate rice farming. However, at present, to do rice farming for three rice crops a year, farmers are no longer using draft animals. Instead, they hire hand tractors to plow their rice fields. Increasingly, the hand tractors have been substituted by tracktors. In Prey Veng Province, the number of tractors has increased from 678 tractors in 2014 to 2,446 tractors in 2018, which is significantly increased, whereby draft animals are no longer used. In Kampong Thom, the number of tractors has also increased from 589 tractors in 2014 to 1,322 tractors in 2018. Farmers in Takeo Province have used tractors to plow their fields too. In the studied areas, about 95% of households hire tractors to plow their rice fields in three consecutive farming seasons. Tractors are owned by private individuals from the district/provincial centers.

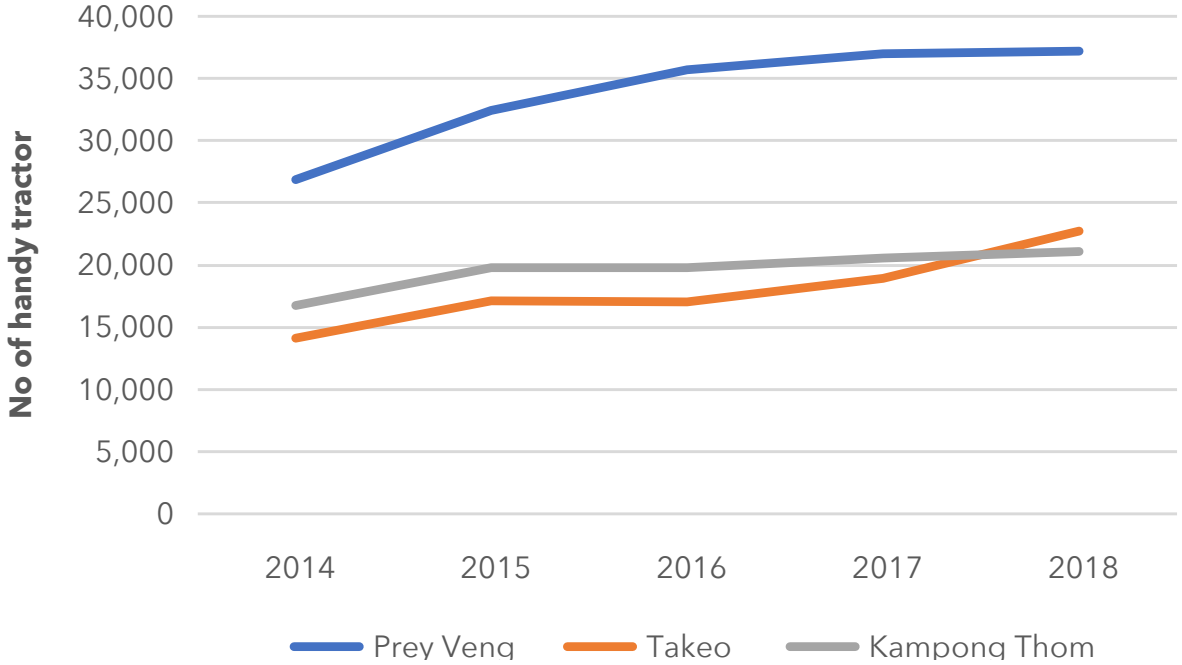
Farmer plows their rice fields two times per farming season before they broadcast their paddy rice. First, they plow their rice fields at the start of the rice farming season, at least to soften the soil. The second plowing is done when they broadcast the seeds in the rice fields, to make sure the rice seeds are covered by the soils. The cost for plowing is about 170,000-200,000 riel per hectare for one plowing. For two plowing, it costs 350,000 riels per hectare. The tractors are available at the village level and can be hired.

Figure 2. The increased number of tractors in the studied provinces.



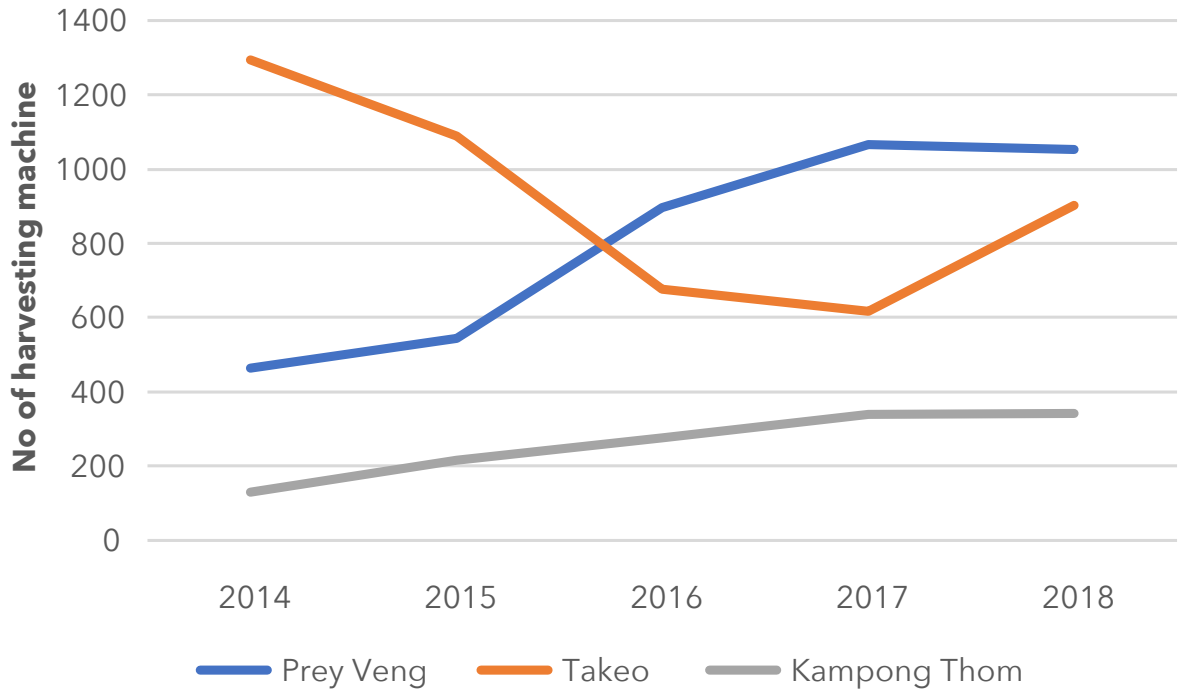
Hand tractors were by some farmers, especially those farmers with small rice farming areas. At present, farmers do not use the hand tractors for plowing the rice fields, but for plowing the field crops (chamcars). The Prey Veng Province has more hand tractors than Kampong Thom and Takeo Provinces. The Kampong Province has a number of handy tractors higher than in Takoe, but lower than Prey Veng Province. The number of hand-tractors in Takeo Province seems lower than other provinces.

Figure 3. The increased number of handy tractors by provinces between 2014 and 2018.



Also, farmers hire machines to harvest their rice during harvesting times. The harvesting machine is available at the village level. In Prey Veng Province, the number of the harvesting machine has been increased from 464 machined in 2014 to 1,053 machine. Also, the Kampong Thom Province has the harvesting machines, increasing from 130 machines in 2014 to 342 machines in 2018. Nevertheless, in Takeo Province, the number of harvesting machines have dropped. The cost to hire the harvesting machine is about 400,000 riels per hectare, including the packing. Farmers will collect their bags of paddy rice and transport them to homes at the cost of 2000 riel/bag.

Figure 4. The number of harvesting machines in the studied provinces.



The threshing machine is available at the village level for hiring after the rice harvest. In Prey Veng Province, the number of threshing machine has increased from 60,544 machines in 2014 to 78,552 machine in 2018. Kampong Thom has also high number of threshing machines, decreased from 1482 machines in 2014 machines, to 325 machines in 2018. However, in Takeo Province, the number of shreshing machines is decreased from 607 machines in 2014 to 581 machines in 2018.

Figure 5. The number of Threshing machines in the studied provinces.

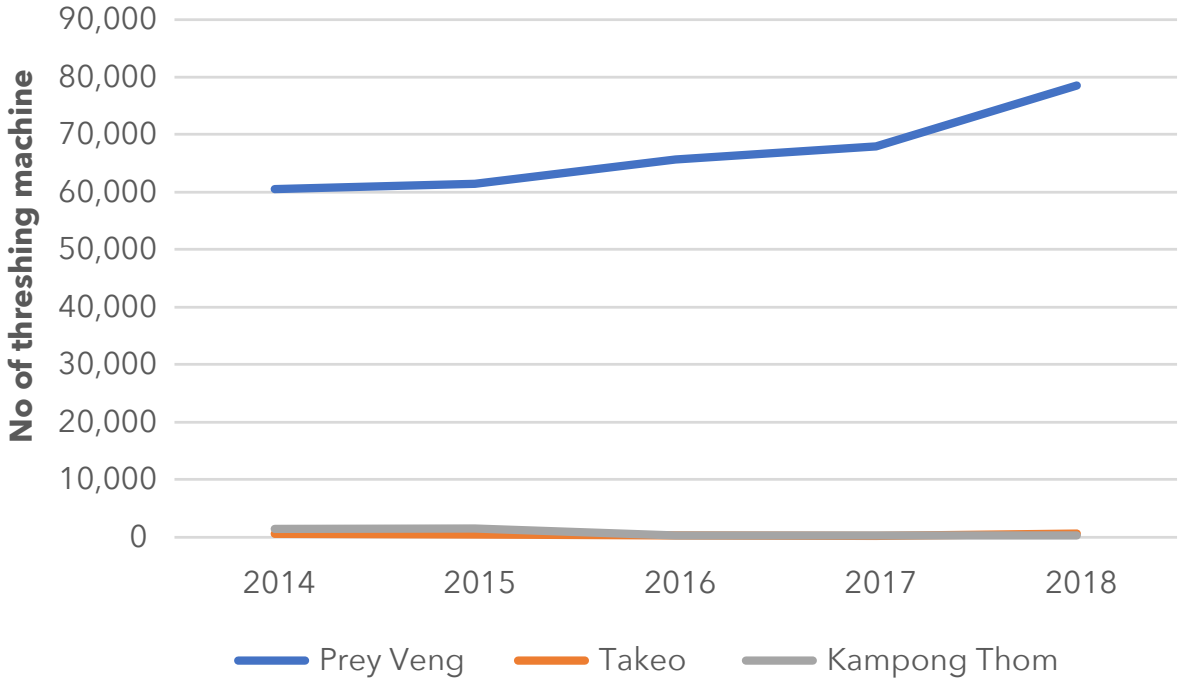
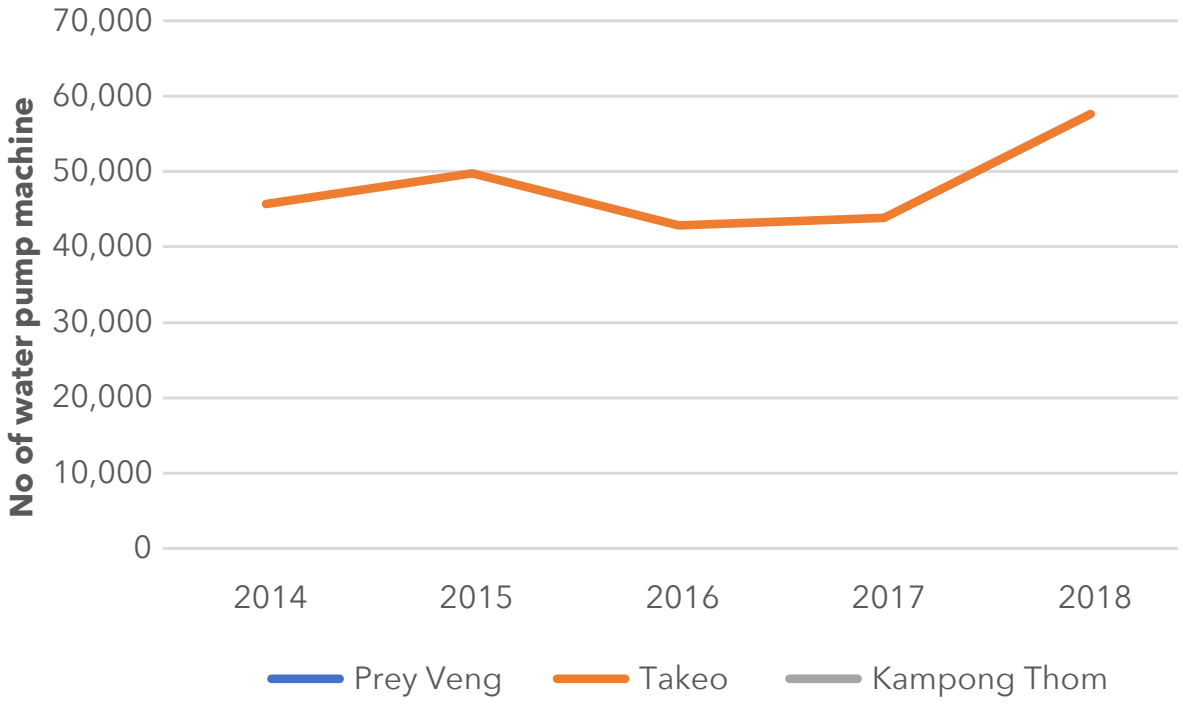


Figure 6. Mechanization of rice farming.

Farmers use the pumping machine to pump water to irrigate their rice fields, especially the dry season rice farming from November to January and from February to April or May. Without the pumping machines, farmers cannot get enough water to irrigate their rice fields, as water is scarce during the farming seasons, and also water is remote from their rice fields. Each farming household owns at least one or two pumping machines—one is small (generator) and another a large machine. Without the pumping machines, the farmer is like a soldier without machine guns in the war for water.

Figure 7. The number of water pump machine by province between 2014 and 2018.



5.2.5. Agriculture Inputs

The rapid uptake of high-yielding rice varieties has entailed greater use of fertilisers and pesticides. To cultivate these rice varieties three times a year, farmers apply heavy pesticides, fertilizers, and chemical inputs. About 73% of households in the studied area use fertilizers to fertilize their rice lands during the wet and dry rice farming periods. About 80% of households in Prey Veng applies fertilizers, compared with 67% in Takeo and 31% in Kampong Thom Provinces. In Prey Veng Province, Samraong, Tuek Thla and Damrei Puong communes have the highest percentage of farming households using fertilizers, constituting 88%, 87% & 85% respectively. In Takeo Province, about 82% and 85% of farming households in Kan Kam and Pou Rumchak Communes respectively apply fertilizers in rice farming (Table 14).

Farmer uses chemical fertilizer for 5-7 bags per ha for one farming season (3 months) starting from the time they broadcast the rice seeds till they harvest. The fertilizers they used include DAP, Urea, and other various types of fertilizer. One bag of fertilizer is about 50kg. However, farmers do not know these fertilizers, but they use them because their neighbor farmers also use them, and when they buy, they learn them from the sellers. The cost of fertilizer is 120,000 riel (USD30) per bag, and in total, it cost USD150-210 for fertilizer uses per ha. These fertilizers are imported mostly from Vietnam and they are sold publicly. The knowledge about fertilizers and how they should be used is limited based on the discussion with them during the interviews.

Apart from fertilizer, farmers apply pesticides to kill the pests that destroy their paddy rice. Farmers do not know the trademarks of pesticides, but they use because their farmer neighbors use them and the sellers instruct them how to use them. About 70% of households in the studied communes apply pesticides at all times during rice farming seasons. Farmers in Prey Veng Province use pesticides more than other provinces, accounting for 78%, followed by Takeo at 69%. In Prey Veng, farmers using pesticides in Damrei Puon, Samraong, Ampil Krav, and Prey Kandieng Communes constitute 90%, 83%, 81% and 80% respectively, which are the highest compared with other communes in the studied areas. These are the communes that are located in a distance from the Beung Sneh, which experience water shortages during the rainy season. In Takeo, Pou Rumchak and Ban Kam Communes have higher percentages of farmers using pesticides for rice farming, accounting for 83% and 80% respectively.

Figure 8. Pesticides used by farmers in Prey Veng Province.

The farmer informs us that they use 9 containers of pesticide per hectare. One container costs 15,000 riels (USD3.75) and then, the total cost of the pesticide used per hectare is USD33.75. The fee for pesticide spraying is 5,000 riel/ha (USD1.25). The sum of the total cost for pesticide use per hectare is USD35. However, the farmer sprays pesticide 3-4 times/ha until the rice is harvested, and then, the total cost is USD105-140. The uses of pesticides kill aquatic animals, including fish, and thus, not many fish are reported by farmers in the ricefields. Farmers also report about the uses of other chemical inputs to kill grasses and invasive snails. There is an increase in invasive snails in their rice fields, which destroy the paddy rice without proper protection. However, the percentage of households using organic pesticides and fertilizers is relatively low, 2% and 5% respectively. In some villages such as in Prey Kandieng Commune, farmers are no longer used organic fertilizers and pesticides.

The fertiliser market structure is evolving rapidly to meet farmers' demands and service the growing rice sector in Takeo. The market structure is well organised and led by the private sector operating a competitive marketing strategy, with prices set by market forces. There were six major fertiliser supply companies distributing agro-products in Takeo Province from their provincial wholesale outlets to one-stop retail shops in local village markets. imported different kinds of fertilisers

produced in Japan, the Philippines, the USA, China, and Vietnam through Vietnam traders who entered Cambodia through the Phnom Den checkpoint. This company supplied fertilisers not only in Takeo but in almost all provinces in Cambodia. The two largest suppliers were the HPC Company and the Yetak Group; their products were widely available in most wholesale and retail outlets, even in small village shops. Other suppliers were Chhun Sok Ann, Cheam Tech, Sayimex, and Lim Bun Heng. The Lim Bun Heng Company only imported and distributed specific fertilisers from Thailand, such as urea, 15-15-15, and 16-20-0. Other importers had different suppliers, from China, Japan, the USA, Vietnam, and the Philippines, but these products mostly came to Cambodia through Vietnam-based traders.

Many kinds of fertilisers, distributed by different importers and distributors, were available in the market. The single-nutrient products were urea and muriate of potash (KCl). Compound nitrogen-based fertilisers included di-ammonium phosphate (DAP) (18-46-0) and ammonium sulphate (16-20-0). Compound nitrogen, phosphorus, and potassium (NPK) products were available on the market in ratios of 15-15-15, 16-16-8-(13S), and 20-20-15. All fertilisers were sold in 50 kg bags, though farmers could buy products by the kilogramme. Most of the fertilisers sold in the market were labelled in Khmer, with the exceptions of 16-16-8-13 produced in the Philippines and urea from China and Vietnam, though these products were marked with small stickers in Khmer.

Neither traders nor the Provincial Department of Agriculture (PDA) had any records of the quantity of fertilisers imported or distributed in the province. It has been reported that there was large-scale smuggling of fertilisers from Vietnam into Cambodia, which were then sold on the market (Asian Development Bank 2002: 27). Smuggled goods were readily identified because the bags were not labelled in Khmer or marked with Khmer stickers. It was legal for farmers to come to Vietnam and buy up to 50 bags of fertilisers for use on their farms near the Cambodia-Vietnam border. However, some farmers came to Vietnam many times to buy fertilisers to sell to dealers in Cambodia for profit. Retailers' transactions with farmers were done in cash or on credit. Field interviews revealed that about half of retail sales were made on credit, with an added mark-up of KHR 15,000–20,000 per bag per planting season (three to six months). prices of fertilisers increased to about USD 40 per 50 kg bag, while DAP rose to about USD 60 per bag. the village price of urea was about USD 28 and that of DAP was USD 36 per 50 kg bag.

IFDC (2010) conducted nutrient analysis of sampled fertilisers from ten provinces and found that almost all compound NPK and NP (16-20-0 and DAP) fertilisers sold on the market were well below acceptable quality index values. Fake products were widely reported by customers, importers, dealers, and senior PDA officials during the field visits and interviews, confirming the findings of IFDC (2010). The most common practice was re-bagging less expensive fertilisers such as DAP and urea in sacks labelled with a high-quality brand, for instance, urea from Thailand and DAP produced in the USA, which are well-known high-quality products. Importers interviewed reported that some retailers had been brought to the authorities to get them to confess and promise not to buy and sell fake products using their brand name. Senior PDA officers, dealers, and retailers reported that, although there was a significant drop in the incidence of fake products, the problem persists, affecting about 5–10% of fertilisers in the market (compared with about 30% during the price spike in 2007–2008). the low quality of fertilisers sold on the market is a critical problem affecting crop yield and resulting in financial loss for farmers in the study area. Farmers reported that they suffered a yield loss of 40–60% if they applied poor-quality fertilisers.

In Takeo, there were about 179,800 rice farming households (CDB 2010) producing on average about 6.2 tons of paddy in 2011 (MAFF 2012). A yield loss of 20% would correspond to a loss of about 1.2 tons per household, worth USD 285.2 If 10% of farmers used poor-quality fertilisers and suffered a yield loss of 20%, the total annual crop loss for Takeo as a whole would be about USD 5.2 million. This loss would increase to about USD 13 million if farmers did not have the funds to then buy good-quality fertilisers after seeing the poor crop response (Table 14.3). If the same assumptions are extended to Cambodia as a whole, the losses would be of the order of USD 40 million and USD 106 million, respectively.

5.2.6. Water Uses

Cultivating three rice crops per year will require a lot of water. Farmer has used water intensively to irrigate their ricefields. From June to October, it is the rainy season, and thus, rice farming relies on rainfall. This is a wet season for rice farming. Usually, there is enough rainfall for rice cultivation and the rice yield is estimated at around 5-6 tons/ha. However, in some years, there is not enough rainfall, and in some years, there is a short drought during the rainy seasons. Some years, there are floods affecting rice production.

The second rice farming season starts in around November and ends in January. This is the start of the dry season; but lakes, ponds, and rivers still have plenty of water that could be used for the second rice farming season, which is considered as the dry season rice farming. Thus, farmers pump water from the lakes, ponds, and rivers to irrigate the second rice farming. The competition for water to irrigate has occurred which could result in water shortage in the late second rice farming season, around January. A small shortage of water occurs during this period, particularly at the later stage of cultivation, affecting the yield a little bit lower than 5-6 tons/ha.

The third rice farming season starts in February, which is a dry season when there is no rain; and lakes ponds, and rivers are getting dry. Thus, farmers choosing to do the rice farming season know that they face severe water shortages. To do rice farming in the third farming season, farmers know that they have to compete for water, otherwise, their paddy farms will be spoiled and damaged due to the drought. On the other hand, water competition would lead to conflicts among farmers over the use of water. Nonetheless, the third rice farming is suffering from water shortage and thus, the rice yield during this farming period is about 4 tons/ha.

Table 14. The Uses of Chemical Inputs in rice farming.

Site	Commune	No. of HHs	HHs using chemical fertilizers		HHs using organic fertilizers		HHs using pesticides		HHs using organic pesticides (nature) for killing pests and grass	
			No	%	No	%	No	%	No	%
Beung Phlang	Ampil Krau	1981	1610	81	77	4	1606	81	71	4
Beung Sneh	Theay	2964	2240	76	186	6	2170	73	157	5
	Damrei Puon	2679	2284	85	32	1	2402	90	16	1
	Samraong	2482	2179	88	43	2	2060	83	25	1
	Tuek Thla	2820	2457	87	23	1	2107	75	15	1
	Me Bon	2109	1531	73	67	3	1521	72	0	0
	Baray	1655	1256	76	27	2	1256	76	0	0
	Ta Kao	3739	2752	74	50	1	2754	74	4	0
	Prey Kandieng	2887	2308	80	60	2	2308	80	6	0
Sub-total	9	23316	18617	80	565	2	18184	78	294	1
Boeung Ream	Kakoh	3325	1023	31	536	16	609	18	81	2
Ta Soung	Ban Kam	1607	1320	82	111	7	1290	80	0	0
	Kampong Reab	532	220	41	100	19	220	41	100	19
	Pou Rumchak	778	662	85	25	3	648	83	55	7
	Prey Lvea	814	307	38	53	7	416	51	27	3
Sub-total	4	3731	2509	67	289	8	2574	69	182	5
Grant total	14	30372	22149	73	1390	5	21367	70	557	2

Source: *Commune Database 2021*

Floods and drought have occurred in the studied areas, and have affected the farming households who do the rice farming across these provinces. These happen because; first, the development in the upper Mekong River has degraded water resources flowing into the rivers, ponds, and lakes in Cambodia; second, local developments such as filling the wetlands, ponds, and lakes with concrete blocks jeopardize the hydrology of the Mekong and its tributaries in Cambodia; and third, the climate change has induced floods and droughts, damaging the rice farming production.

In Cambodia, about 50% of agricultural households face drought as the most severe shock. Pursat province had the highest percentage of households reporting drought as the most severe shock. In Kampong Thom, 53.1% of agricultural households report the drought as the most severe shock, followed by Prey Veng 40.5% and Takeo 15.8%. In the studied areas, drought has occurred in a few communes in the Beung Sneh area, particularly in Damrei Puon commune, affecting 10% of the households; and in Tuek Thla, affecting 6% of households. The drought does not much affect households in the studied communes as they could take water from the lake, ponds, and rivers. Also, the studied communes have located close to the provincial towns and the district centers, which have built good infrastructures such as roads, canals, dykes, reservoirs, and irrigation systems that could control floods and store water for use when there are droughts.

At the national level, about 20% of agricultural households face flood as the most severe shock. In Prey Veng, about 35.4% of agricultural households report floods as the most severe shock, followed by Kampong Thom, 17.2%. No data demonstrates the percentage of agricultural households facing the server floods in Takeo. In the studied area, floods have occurred only around the Beung Sneh, particularly in Damrei Puong, Samraong, and Tuek Thla Communes, accounting for 2%, 9%, and 0.3% of households. These floods occurred due to heavy rains, not the floods caused by the rivers (Table 15).

About 19% of farming households in the studied areas have their farmlands irrigated, of which 26% of farming households are located in the Ta Suong Irrigation Scheme, 18% of farming households in 8 communes located around the Beung Sneh in Prey Veng, and 17% of farming households in Kah Koh Commune who receive water from the Tain Krasaing Irrigation Scheme in Kampong Thom.

In Prey Lvea Commune in Prey Kobbas, Takeo Province, about 41% of farming households have their farmlands irrigated by the irrigation system namely Ta Suong, followed by 26% of farming households in Ban Kam, and 23% in Kampong Reab. In the Beung Sneh area, about 47% of farming households in Prey Kandieng Commune have their rice farmland irrigated by the irrigation schemes, followed by 23% of farming households in Damrei Poun Commune and 20% in Theay Commune. Also, in the Beung Ream area, about 17% of farming households in Kah Koh Commune have their rice farmland irrigated by the Taing Krasaing Irrigation Scheme built by funding support from ADB in 2015. On the other hand, in the Beung Phlang area, RGC received funding support from China to build the Vaiko Irrigation Schemes, taking water from the Mekong River in Kampong Cham Province to irrigate the rice farmland in Kampong Cham and Prey Veng, channelizing through the Ampil Krav Commune in Sithor Kandal District in Prey Veng Province; but only 3% of farming households in Ampil Krav commune have their rice farmlands irrigated (Table 16).

Table 15. Number of agricultural households affected flood and drought.

Site	Commune	No. of HHs	# of families affected by heavy floods	%	# of families affected by heavy droughts	%
Beung Phlang	Ampil Krau	1981	0	0.0	0	0.0
Beung Sneh	Theay	2964	0	0.0	0	0.0
	Damrei Puon	2679	40	1.5	262	9.8
	Samraong	2482	221	8.9	0	0.0
	Tuek Thla	2820	9	0.3	171	6.1
	Me Bon	2109	0	0.0	0	0.0
	Baray	1655	0	0.0	0	0.0
	Ta Kao	3739	0	0.0	0	0.0
	Prey Kandieng	2887	0		0	0.0
Sub-total	9	23316	270	1.2	433	1.9
Boeung Ream	1	3325	0	0.0	0	0.0
Ta Soung	Ban Kam	1607	0	0.0	0	0.0
	Kampong Reab	532	0	0.0	0	0.0
	Pou Rumchak	778	0	0.0	0	0.0
	Prey Lvea	814	0	0.0	0	0.0
Sub-total	4	3731	0	0.0	0	0.0
Grand-total	**14**	**30372**	**270**	**0.9**	**433**	**1.4**

Source: *Commune Database 2021*

Table 16. Number of families have rice farmlands irrigated.

Site	Commune	No. of HHs	# family who have some irrigated rice land		Rice farming area (ha)	Irrigated dry season rice area (ha)		Irrigated wet season rice area (ha)	
			No	%		No	%	No	%
Beung Phlang	Ampil Krau	1981	50	3	3016	2	0.1	2826	94
Beung Sneh	Theay	2964	606	20	2510	5900	235.1	791	32
	Damrei Puon	2679	629	23	2919	2100	71.9	500	17
	Samraong	2482	230	9	3373	200	5.9	150	4
	Tuek Thla	2820	309	11	3083	0	0.0	0	0
	Me Bon	2109	158	7	1962	0	0.0	0	0
	Ta Kao	3739	528	14	5941	1057	17.8	945	16
	Prey Kandieng	2887	1358	47	3111	611	19.6	0	0
Sub-total	8	21661	3868	18	25915	9870	38.1	5212	20
Beung Ream	1	3325	570	17	5099	2293	45.0	853	17
Ta Soung	Ban Kam	1607	421	26	1491.5	619.29	41.5	872.24	58
	Kampong Reab	532	120	23	1458	1351	92.7	27	2
	Pou Rumchak	778	104	13	1905	782	41.0	1123	59
	Prey Lvea	814	332	41	1495	755	50.5	740	49
Sub-total	4	3731	977	26	6350	3507.29	55.2	2762.24	44
Grand total	**13**	**28717**	**5415**	**19**	**37364**	**15670**	**41.9**	**8827.24**	**24**

Source: *Commune Database 2021*

In the studied communes, the irrigated dry season rice farming area constitutes 42% of the total farmlands. Also, only 24% of the wet rice farming area is irrigated in the wet season. In the Beung Phlang area, farmers are farming only the wet season rice, using water from the irrigation schemes of the Vaiko Irrigation Scheme, accounting for 94% of the total rice farming areas in Ampil Krav. In Prey Kobbas District, Takeo Province, the wet season rice farming relies on irrigation schemes to supply water to irrigate the rice farmland. In Ban Kam Commune, 58% of rice farmland is irrigated during the wet season rice farming, followed by Pou Rumchak for 59% and Prey Lvea for 49%. However, in Kampong Reab, it is flooded in the wet season, and thus, farmers do not farm the wet season rice, only the dry season rice, accounting for 93% of the total rice farmlands in the commune. For Ban Kam, Pou Rumchak, and Prey Lvea Communes, about 50% of respective commune farmlands cultivate the dry season rice, relying on the irrigated waters from the irrigation schemes of Ta Suong.

In the Beung Sneh area, the Damrei Puong Commune has most of its dry season rice farming land irrigated during the dry season, constituting 72% of the total rice farmland area, and only 17% of the wet season rice farmlands irrigated in the wet season. The rest of the rice farmlands around the Beung Sneh area largely are unirrigated in both wet and dry season rice farming. Thus, those farmers without irrigation canals have made efforts to pump the water from the water sources (lakes, ponds, canals, and reservoirs) to irrigate their rice farming areas.

The cost for water uses for the entire season is ranged between 270,000-300,000 rield/ha (USD67-75). The water fee by gravity is around 250,000 riel and 300,000-350,000 riel by pumping.

In some areas such as Prey Kabbas District, water distribution is operated by FWUCs and Private Operators. In Prey Leav Keut Commune, FWUC was established with support from CAVAC. The water fee was charged by FWUC. However, FWUC is not working well and so, water fee seems to be collected by Private Individuals at a high cost, around 350,000 riel/ha/season. In the Ta Sung Irrigation Scheme supported by CAVAC, FWCU was established to collect water fees. The water fee is charged based on the cost of electricity that is used to pump the water from the river into the irrigation. In this case, the water fee is ranged between 200,000-250,000 riel.

Figure 9. Competing water pumping for dry season rice farming in Beung Sneh Lake, Prey Veng.

5.2.7. Water Uses for River Farming

In Beung Sneh in Prey Veng, and Beung Ream in Kampong Thom; among the three rice-farming seasons, farmers pay the full water fees only for the second rice crop, between November-January, as they received enough water to irrigate their rice fields. However, farmers do not often pay the water fees for the first and third rice-farming seasons as the first rice-farming season is a wet season, and their rice fields are irrigated by rainfalls for the entire season, not the irrigated water. Nonetheless, the third rice-farming season is the season when water is never enough to irrigate their rice fields. Thus, it is likely that even if farmers cultivate three rice-farming seasons, they pay water fees only one time. Also, the percentage of water fee payments is account for less than 50% of the total population.

Farmers are now cultivating the rice varieties that are taken from Vietnam. These include the varieties of IR 504, IR 5154 and other species. These varieties could be cultivated within 95 days, and thus, they cultivate three crops a year, as long as rice traders buy them. Thus, the wet season rice has been replaced by 95-day rice varieties (IR504, IR5154), and Sreleu and Srekroam rice fields have been replaced by the dry season rice. First, farmer starts the first rice cultivation in June or July and harvest it in October; second, they start cultivating it in November and harvest in January; and third, they start in February and harvest in April or May.

As large rice field areas are located around the Beung Sneh areas and intensive rice farming for 3 rice crops per year, water use has reached critical levels. Farmers have pumped water from the Beung Sneh areas. There are more than 26 villages that use water from the Beung Sneh Area for rice farming. Each individual household owns a water pumping machine/generator.

There are two FWUCs, one in Theay Commune and another one in Damrey Poun Commune known as Kuy FWUC. They pump water to supply to FWUC members, and members pay the water fees based on the size of the ricefield per farming season. The water fee is based on the electricity cost, not the price of water, but the price of electricity.

However, farmers without the FWUC have used their water-pumping generators to pump water out of the Beung Sneh area and pay no fee for the water they use. There is competition among farmers over the uses of water from Beung Sneh areas. The water uses for rice farming has affected the fisheries. So far, CFis have not been active as most of their members are doing rice farming too.

5.2.8. Fish Production

The studied areas are selected given the roles of fisheries in food production. Fishery has been managed in four different regimes: (1) community fishery, (2) community fish refuge (CFR), (3) rice-fishery; and (4) open access. About 58% of villages have involved in CFis and only 4% of villages in the CFRs. Fishing has been small-scale and subsistent and it is varied between fishing areas in Beung Sneh, Beung Phlang, Beung Ream and Ta Suong. Fishing in Ta Suong is more or less river fishing, while in Beung Sneh, fishing is more a lake-fishing, and in Beung Phlang and Beung Ream are more like a rice-field fishing.

5.2.9. Fishery in the Food System

Fishing is supplementing foods to households, which provide protein intakes to rural households. Fishing is subsistent and small-scale, using small-fishing gears. About 27% of Cambodian households are engaged in fishing. One in 4 of agricultural household in Cambodia has engaged in capture fishing activities. Up to 60.4% of the agricultural households in Oddar Meanchey reported capture fishing activity, while only 9.4% of the holdings in Kampong Cham reported such activity. In Kampong Thom Province, about 43% of households are engaged in fishing given its geography close to Tonle Sap Lake, followed by 27% in Prey Veng and 11% in Takeo Provinces (CAS, 2020). In the Ta Suong area, about 33% of the population is engaged in fishing for their living, not for trade or sale. In Beung Ream, about 30% of the population is engaged in fishing to supplement the food for their families. In Beung Sneh and Beung Phlan sites, about 19-20% of the population is engaged in fishing for their food. The studied sites are key fish habitats that provide villagers with food (Table 17). Of the 542,000 holdings reporting catching fish, 39% reported a fish catch lower than the previous year, 47% reported a fish catch similar to the previous year, and 14% reported a fish catch greater than the previous year (CAS, 2020).

About 6.1% of households across Cambodia were engaged in aquaculture activity. Most provinces in the south part of Cambodia shows a higher percentage of households doing fish raising activity. Svay Rieng and Prey Veng are the provinces with the highest percentages (26.4% and 18.6% respectively). In Takeo Province, about 5% of households raise fish. Only less than 2% of the holdings in Kandal and Kampong Thom engaged in aquaculture activity. In the study areas, about 10% of households raise fish.

5.2.10. Fish Production

The Beung Sneh is the largest freshwater lake in Prey Veng, and it is a habitat for the fishery. The lake itself covers 3,924ha and it is connected to wetlands, streams, and water bodies, which form a large fishing area, covering around 85,236ha. It is estimated that about 3,140kg of fish is caught every day by fishing households around Beung Sneh Lake. Thus, the annual fish catch from the Beung Sneh will be 1,146 tons, which could provide food to many people around the Beung Snhe as well as in Prey Veng Province. In addition, in the Beung Sneh core area, about 86ha is a habitat for many bird species, with a total population of approximately 10,000 birds. Also, there are also other biodiversity species habituating in the Beung Sneh such as snakes, tortoises and reptiles. Wildlife is still a source of food living around the Beung Sneh area.

Table 17. Number of fishing households in the studied areas.

Sites	No. of HHs	No. of households fishing	%
Kampong Thom	**3325**	**998**	**30**
Boeung Ream	3325	998	30
Prey Veng	**12149**	**2341**	**19**
Beung Phlang	1238	248	20
Beung Sneh	10911	2093	19
Takeo	**3731**	**1227**	**33**
Ta Soung	3731	1227	33
Grand Total	**19205**	**4566**	**24**

Source: *Commune Database 2021*

The Ta Soung Irrigation System is taking water from the Kampong Preah Stream, which is a tributary of the Bassac River. The Kampong Preah Stream in Prey Kobbas District, Takeo Province, was a former fishing lot no.20 in Takeo and it was rich in fishery. Speaking to former fishing lot leasees, who are now members of community fisheries (CFis) in Prey Kobbas report that the fish production from the former fishing lot no.20 in Prey Kobbas was not less than 1,000 tons a year. Fishing Lot no.20 covered 6,673ha, which was leased out to the fishing lot owner at the cost of 46,000,000 riels, equivalent to USD 11,500. Based on the discussions with villagers in Ta Suong Community, the estimated household daily fish catch is about 2kg/day. It is estimated that the annual fish catch from the fishing households in Ta Suong is 864 tons/year.

The Beung Phlang used to be flooded by the rising water from the Mekong River where fish could reach out to an area of 1,864 ha surrounded by rice fields. It is now protected as the CFR, where fish could migrate from the CFR to rice fields surrounded and farmers could catch their food. The discussion with community members who fished in the area around Beung Phlang indicates that the daily fish catch would be around 2kg per household. With the estimated number of fishing households 248, the daily fish catch from the area around the Beung Phlang is estimated at around 500kg/day. The annual fish production of Beung Phlang would be around 183 tons.

Also, the Beung Ream is a CFR area where people protect the fishery for their fish. The same as Beung Phlang, Beung Ream is rich in the fishery and fisher migrates from the CFR site to the rice field around it. The daily fish catch by villagers around Beung Ream is about 2kg/day. The daily fish catch estimated from Beung Rean is about 1,596kg/day, which is equivalent 583 tons a year (Table 18).

Table 18. Fish production.

Row Labels	Fishery area (ha)	No. of households fishing	Fish Catch (kg/day)	Total Fish Catch (kg/day)
Beung Phlang	**1864**	**248**	**2**	**495**
Ampil Krau	1864	247.6	2	495
Beung Sneh	**85236**	**2093.4**	**1.5**	**3140**
Baray	0	0	1.5	0
Damrei Puon	15841	497	1.5	746
Me Bon	0	0	1.5	0
Prey Kandieng	655	511	1.5	767
Samraong	7266	634	1.5	951
Ta Kao	0	300.8	1.5	451
Theay	61474	150.6	1.5	226
Tuek Thla	0	0	1.5	0
Boeung Ream	**1059**	**997.5**	**1.6**	**1596**
Kakoh	1059	997.5	1.6	1596
Ta Soung	**7633**	**1227.05**	**1.93**	**2368**
Ban Kam	2000	336.15	1.75	588
Kampong Reab	1938	292.9	2	586
Pou Rumchak	840	275	2	550
Prey Lvea	2855	323	2	646
Grand Total	**95792**	**4565.55**	**1.75**	**7990**

Source: *FiA, 2023*

Apart from fish catch, these areas are rich in aquatic plants and animals such as lotus, water lily, hyacinth, snails, frogs, etc., which could provide foods to farmers who live close to the lakes. Snails have been reported abundantly, including the Golden Snail, which is an invasive species. The flooded forest has been a source of firewood for rural families living around the Beung Sneh.

Fishing is open access for small scale fishing in these areas. For CFis and CFRs, certain fishing gears prohibited as it could damage fishery resources and its habitats. Fishing for small-scale is allowed for year round. Fishing has been a source of livelihoods of households who are landless, accounting for 11.6% living in different villages in Beung Sneh (Table 18).

Fish catch has been reported dropping due to changing hydrological rimes of the rivers, the shallowness of the river, stream, lakes and ponds. The connectivity with rivers and lakes has been undermined due to infrastructure development, such as irrigation system and road development. Also, climate change has affected the hydrology of the river. The drought has occurred, affecting the water levels in the lake and river systems. The pumping water from the lakes, water bodies and rivers have affected the fisheries and biodiversity in the areas.

5.2.11. The Effects of Pesticide and Fertilizer Uses

The fish catch in the rice fields has been affected by rice farming three times a year, and thus, water from river, ponds and streams are pumped to irrigate the dry season rice farming, affecting fisheries in the canals, ponds and streams, as some ponds and canals are pumped emptily and driest. On the other hand, the uses of chemical fertilizers and pesticides jeopardize the aquatic environments, killing fish and aquatic organism. Farmers have reported about the decline in rice field fishery throughout the studied areas. Furthermore, irrigation management does not include fishery management and so, fish in the irrigation system is not well managed, leading to improper fishing, not in fishing practice outlined in the legal framework. Irrigation system has been criticized for its neglects and impacts on fishery at present.

5.2.12. Crop, Vegetable and Livestock

In addition, farmers grow crops in each household. Across Cambodia, 94% of agricultural household growing crops. Three main crops are grown by farmers including Mango, Banana and Coconut. This is up from the 88% of households engaged in growing crops reported by the CIAS 2019. Number of agricultural households keeping or raising livestock, poultry and/or insects at any time during the reference year (in thousands).

About 82% of agricultural households keep or raising livestock, poultry or insects at any time during the reference year. the CIAS 2019 estimated 75.3% of agricultural households keeping or raising livestock and/or poultry. About 4.4% of agricultural households raise cattle, whole 41% raise the poultry.

5.3. Food Consumption

5.3.1. Consumption

Rice and fish are the mainstays of food security for most inhabitants in Cambodia. Rice is the main crop consumed by all farming households. Also, all available farmlands for each household are cultivated with rice varieties from Vietnam (IR504, IR5154…). At present, rice is produced in large quantity per household seasonally and yearly. All rice productions are produced for sales. Only small portion of the rice produced is for household consumption, estimated 1,636kg of rice was consumed annually per farming households (Name, 2005). Some farming households sold all the rice produced, and they buy local rice varieties produced by farmers from other provinces to consume. On the other hand, some farming households cultivate local varieties of rice in the wet season such as Malis, Neangming and other varieties for household consumptions and in the dry seasons, they cultivate the Vietnamese rice varieties to sell to Vietnam.

In the mid-2005, about 25-40% of households sold their rice produces after their harvest (Nam, 2005). However, the Cambodia Agricultural Sensus (CAS) 2020 shows that about 61% of agricultural households in Cambodia conduct agricultural activity for household consumption, of which 6 in 10 agricultural households in Cambodia reported their agricultural production as mainly for home consumption. Provinces with the highest percentages are mostly located in the south part of the country, with over 90% in Kampong Speu,79.3% in Takeo, 61.3% in Kampong Thom and 58.1% in Prey Veng. However, about 39% of agricultural households have conducted agricultural activity for sale, of which Prey Veng constitutes 42.3%, followed by Kampong Thom 39%, and Takeo 21% (CAS, 2020). Markets for rice produced with the varieties from Vietnam are available. There is no concern on shortage of foods, but the main concern is about is cheap price of rice products. In the 2005s, the price of rice varied from 300 to Riel 600 per kg. At present, with the Vietnamese rice variety, the price is between 800 and 1200 riels per kg (Field Studies, 2023).

About 20.3% of the agricultural households report that agriculture contributes to 60-100% of the household total incomes. In Kampong Thom, 26.1% of agricultural households' report that 60-100% of household total incomes come from agriculture, fillowed by 21.3% in Takeo and 17% in Prey Veng (CAS, 2020).

Fish is consumed every day by rural households. It is estimated that each household consume fish an average of 0.47 kg per household day per in wet season and 0.44 kg in dry season (Nam, 2005). The annual fish consumption per capita is on average 52.4kg of fish per year (FiA, XXXX). Almost 85% of the fish catch in Cambodia was used for home consumption. In Prey Veng, about 88% of households consume their fish catch, followed by 83% in Kampong Thom and 77% in Takeo. On the other hand, about 14.6% of fish catch by the households in Cambodia was sold. The highest percentages of fish catch sold were in Kandal and Koh Kong provinces (69% and 66% respectively), while the

lowest percentages were in Kampong Speu. Overall, the households in northern provinces of Cambodia sold fish they caught less than southern provinces. About 22% of households in Takeo Province sold their fish catch, followed by 17% in Kampong Thom and 11% in Prey Veng (CAS, 2020).

This estimate is still relevant in the current situation, although wild fish is less abundant. Thus, rural households buy fish from local markets. Villagers report that local fish catch is not available for sale in local markets, and thus, they consume fish taken from outside their communities. Villagers also report that some of fish they consumed are raised fish, which probably imported from Vietnam. The media reports that tons fish are imported by traders into Cambodia from Thailand and Vietnam through the various border crossings, which are for the most part dried or fermented into pastes (Phnom Penh Post, 12 November 2021)[1]. In Prey Veng Province, it is estimated about 50-60 tons of fish a day are imported from Vietnam and sold in local market. In Kampong Thom Province, about 70-80 tons/day of fish are imported to sell in local market. The price of imported fish from Vietnam is about 4,000 riels/kg, cheaper than the Cambodian raised fish, but the taste is not that good compared with Cambodia's fish (Phnom Penh Post, 16 June 2021)[2]. In 2019, the Kingdom imported 130,000 tonnes of seafood (Phnom Penh Post, 05 April 2020)[3].

5.3.2. Rice Trade

Rice trade has been influenced on the one hand by: (1) one million tons policy of RGC; and (2) Vietnam rice export policy. In 2015, RGC adopted the One Million Tons Policy of rice export, which promote the rice production for export. Thus, RGC has embarked a program to rehabilitate the irrigation system to support rice farming around the country. However, the One Million Tons Policy was not reached, but the implication remains with rural farmers, and so, farmers experience lack of market for rice, leading to protests by farmers, particularly in Battamabg Province, for market for rice.

The rice export policy in Vietnam has spilled over to Cambodia. Vietnamese rice traders keep buying rice from Cambodia. To meet market demands for rice export in Vietnam, certain rice variety was introduced by rice traders to Cambodian farmers in the provinces bordered Vietnam, such as Takeo, Prey Veng and Kandal Provinces. These rice trades have expanded to other provinces across Cambodia, reaching Siem Reap and Battambang.

A rice trader has informally established their networks of rice traders across Cambodia. These rice traders have a close connection with the Vietnamese Rice Traders in Vietnam. Rice traders play influential roles in rice planting and trading. Those farmers who want to enter the rice trades with these trader networks, they need to plant rice varieties such as IR504, IR5154,… To do so, they end up in buying fertilizers, pesticides and other agricultural inputs from Vietnam markets. These trades and business in rice are informally organized through the rice traders and lack of intervention from government agencies or Ministry of Agriculture, Forestry and Fisheries (MAFF). Thus, the price of rice paddy is floated depending on the availability of rice produces. If there are more rice produced, then the price would drop and if the rice produces are less, then, the price would be high. The fluctuation of rice price has made farmers low profits, sometimes, losing. At the same time, farmers in order to keep up with the rice market, they often deal directly with rice traders and agricultural input sellers to advise them on how to use the pesticides and fertilizers, which at the end cost them highly and harm their health and rice fields.

Vietnam has a total paddy area of about 3.9 million ha and exported 4.8 million t of rice earning USD 2.2 billion in 2016, making it one of the top three rice exporters. Over half of rice production and over 90% of exports come from the provinces in the Mekong Delta. Yet in recent years, large quantities of paddy have been imported from Cambodia across its south-eastern border. Vietnam Food Association (VFA) estimated that, in 2008–2011, an annual average of 0.8–1.0 million t of paddy were imported from Cambodia through the border provinces (VFA 2011). Purcell (2010) reported an even higher figure of about 1.86 million t in 2010, of which 90% was for the domestic market. At the Tinh Bien border gate, about 1000 t of Cambodian paddy are imported into Vietnam each day.

An Giang Province has the largest rice area and output in the Mekong Delta, with a total cultivated area of 605,720 ha and production in 2011 of 3.86 million t (see Fig. 17.1 in Chap. 17). However, An Giang is also considered an ideal market for Cambodian rice, particularly from the adjacent Takeo Province (Chap. 12).

Vietnam and Cambodia have signed a number of important agreements to provide a legal basis for the development of cross-border trade. The Government of Vietnam issued Decision No. 254/2006/QD-TTg on 7 November 2006 on the management of cross-border trade, establishing preferential tax policies for imports from Cambodia to Vietnam, with rice exempt from any tax. With regard to paddy, though it is exempt from tax, import quotas are imposed by Vietnam on Cambodian paddy and rice, including general-purpose, aromatic, and sticky rice (MIT 2008). The combined quota was 250,000 t of milled rice-equivalent in 2010 and 2011, increasing to 300,000 t in 2012 and 2013. Despite this policy, it is estimated that between 0.8 and 1.0 million t of paddy (well over the quota) are s annually via the border gates in Dong Thap, Long An, and An Giang Provinces (VFA 2011). This phenomenon is partly because some Vietnamese farmers cultivate rice as share-croppers in Cambodia and bring their paddy to Vietnam to sell. Thus, the amount of paddy imported from Cambodia to Vietnam informally is large, consistent with the broader situation of unregulated cross-border trade between the two countries. There are three main channels by which paddy produced in Cambodia is imported into An Giang through the border gates: (1) paddy produced in Cambodia by Vietnamese farmers is taken across the border to sell to Vietnamese traders in An Giang (5%); (2) paddy produced in Cambodia

[1] Phnom Penh Post, Fish farmers in the Soup as Frozen inports take chilling toll. 12 November 2021. https://www.phnompenhpost.com/business/fish-farmers-soup-frozen-imports-take-chilling-toll.
[2] Phnom Penh Post, Export of freshwater fish see a slight dip. 16 June 2021. https://www.phnompenhpost.com/national/cambodias-fish-consumption-despite-supply-market-challenges.
3 Phnom Penh Post, 2020, Government bans fish exports. 05 April 2020. https://www.phnompenhpost.com/business/govt-bans-fish-exports.

is collected by Cambodian traders and sold to traders in An Giang Province at the border (55%); (3) Cambodian traders collect paddy and take it across the border to sell to paddy wholesalers with large granaries in An Giang (40%).

There are five main reasons for the substantial flow of paddy from Cambodia into the Mekong Delta. First, Vietnamese farmers in the Delta mostly cultivate high-yielding, low-quality varieties such as IR50404, IR3217, OM1490, and OM1723 to sell to exporters. However, when production of this type of rice exceeds export demand, unsold rice is difficult to sell domestically. The domestic market, especially in the large cities, prefers high-quality aromatic rice. This is the main reason why paddy from Cambodia is imported to Vietnam through the cross-border trade. Second, as noted above, farmers in the south-west region of Vietnam have rented land in Cambodia (in Takeo, Kandal, Prey Veng, and Svay Rieng Provinces) for rice cultivation. The cultivated area in Cambodia has expanded, and productivity has increased due to the application of intensive farming techniques from Vietnam. The cross-border trade is an essential outlet for rice cultivated by Vietnamese farmers in Cambodia. It is noteworthy that the rice produced by these farmers is not classified as either "Than Nong" or "Soc". Nevertheless, it consists of both IR50404 rice and aromatic rice varieties originating in Thailand. The seed of the standard IR and OM varieties has been brought from Vietnam to be planted in Cambodia. Although the quality of the paddy grown in Cambodia is lower (smaller grains, more cracked grains, and more chalkiness) due to poorer cultivation techniques, the price is also much cheaper than in Vietnam, hence Vietnamese traders and factories can benefit from dealing with this low-quality crop as well as the Soc paddy.

The paddy traded in the DS mostly comprised IR varieties of lower quality than the local varieties grown in the WS. Hence the farm-gate price was lower, at around USD 193/t (Table 12.3). As for WS paddy, the value added from the farm gate onwards was in part due to the costs of handling, materials, transportation, and informal fees incurred by each actor; these expenses were similar between seasons. However, the traders' mark-ups w were significantly lower for the DS crop and did not differ greatly from the village collectors' mark-up, ranging from USD 7 to 10/t (or 3.4 to 7.5% of the farm-gate price).

This indicates that the market was more competitive in the DS, squeezing the margins of all actors. The exporters, however, obtained a higher mark-up of USD 15/t, perhaps reflecting a degree of market power as the number of exporters was fewer and there was little domestic demand for the paddy. During the field interviews, it was not possible to obtain information on the transportation costs from the Cambodian port to Vietnam, only the handling cost of the Vietnamese traders at the border. Hence the remainder of the value chain and the final selling price in Vietnam was not captured (see Chap. 18 for the story from the Vietnamese side of the border).

In general, the market showed a high degree of competition, with many actors involved at each stage and prices set largely by market forces. Farmers could sell their paddy throughout the year into a highly competitive market. Paddy prices for different types and qualities were widely communicated on a daily basis (Gergely et al. 2010). However, there were obvious deficiencies in the market infrastructure, especially for export paddy. Takeo exported most of its rice surplus as paddy to Vietnam. Thus, the rice market in Takeo was highly dependent on the demand from Vietnam; if the border was closed or buying prices were reduced, there would be a major income crisis for value chain actors within Takeo. the farm-gate price of paddy in Cambodia was much lower than in Vietnam (and Thailand), stimulating the flow of exports from southern Cambodia to Vietnam, including both official and unofficial exports (hence there was no official record of the amount of paddy exported). This indicates that there was a lack of storage and milling capacity within Cambodia to process and export milled rice to Vietnam or the international market. The high cost of milling in Cambodia is reflected in the relatively high prices of milled and export white rice.

On the one hand, information about the availability of paddy in the villages is transferred along the chain from farmers to Vietnamese traders. On the other hand, information about prices and requirements for quality and quantities flows from Vietnamese traders back to farmers in the villages. This information flows through the intermediate actors in the value chain—exporters, regional traders, local traders, and village collectors. The price, quality, and quantity are set by the Vietnamese traders; the information is then passed on and manipulated by the different actors to cover their costs and obtain a margin, and finally farmers are faced with the farm-gate market price, quantity, and quality requirements. Mostly the Cambodian traders have little chance to negotiate the price and quality with the Vietnamese traders. When the demand is high, the Vietnamese traders seem not to take the quality problems so seriously, but they often take advantage of their position in the chain to downgrade the paddy and reduce the price.

There are no formal rules and regulations relating to setting the price of paddy in Takeo. Usually, the price is simply agreed between buyers and sellers, but it is ultimately limited by the price level set by the Vietnamese traders, otherwise the actors along the value chain will make a loss. Since rural roads have been markedly improved over the last decade, traders can now easily access most villages. Therefore, farmers have a degree of choice to sell their paddy to whomever can provide a better price.

There is also no formal or systematic mechanism in place to classify paddy quality at each link in the value chain; actors make judgements based on their own knowledge and experience before accepting paddy at agreed prices. The main quality criteria considered are moisture content and damaged or mouldy grain. Vietnamese traders particularly emphasise moisture content (a function of Cambodian traders buying paddy straight after harvest by combine harvesters when moisture content is still high). The Cambodian paddy exporters complain that the Vietnamese traders are too strict in setting quality standards as Cambodian farmers generally produce paddy that is not as good as the benchmark sample.

Vietnamese traders can downgrade the paddy and hence lower the export price. Measures are needed to formally grade paddy and encourage better quality so the trade is fair and beneficial to value chain actors on both sides of the border.

Most of the production in this village was for household consumption. In Snao and Ta Daeng Thmei, IR504 was the most widely cultivated, with a smaller number of farmers planting IR66 in Snao, and Senpidao in Ta Daeng Thmei. The cultivation of IR504 indicates that the harvest was all sold to the Vietnamese rice traders.

5.4. Indebtedness

To keep up with the rice trades and its markets, farmers increase the rice production with the increased production cost. At present, it is recognized that farmers pay the high prices for the rice production, including plowing, harvesting, pumping water, fertilizing and transporting it. To do so, farmers keep borrowing money from formal and informal money lenders. There are two types of money lenders—formal and informal. The informal money lenders have long been an important part of rural livelihoods. Informal credit draws on a culture of reciprocity and risk-sharing within kinship groups and the residential community or village and is still widely practiced. Some forms of village banks, savings-based microfinance, and self-help groups are vibrant forms of economic exchange, often initiated by NGO-sponsored community development programmes. These sources of finance are limited in coverage and provide relatively little capital. In most cases they cannot meet the demand for investment. Many of these community-based organizations (CBOs) simply dissolved after the project was completed. The limited capacity of informal credit systems has led to efforts to improve access to capital from formal credit institutions.

Since the 2000s, the formal money lenders in the form of micro-finance in Cambodia have emerged from non-profit microfinance projects initiated to fill the void left by the virtually non-existent rural banking sector. The high number of MFIs was associated with agricultural and economic growth. The increased rice trade to Vietnam has contributed to increased MFIs providing more loans to farmers, particularly the large scale rice farmers to produce more rice for exports to Vietnam. The one-million-ton policy for rice experience in 2025 has also attracted more loans from MFIs to provide to commercial rice farmers. The Asian Development Bank (ADB) estimated that the demand for rural finance in Cambodia was around USD 120–130 million per annum in 2000 (ADB 2001). By 2011 there were 29 MFIs and 1 commercial bank providing financial services in 24 provinces, covering 59,458 villages and 1.1 million borrowers with outstanding loans of USD 572.7 million, more than four times the ADB's estimate. By the first quarter of 2017, CMA reported 61 MFIs with 1.9 million borrowers and outstanding loans of USD 3,328 million (CMA 2017), a further six-fold increase. The highest numbers of borrowers in 2011 were in the provinces with the fastest rates of agricultural growth, such as Battambang, Kampong Cham, and Takeo.

Three categories of farmers are concerned with the loaning for agriculture: small-scale, medium-scale, and large-scale farmers:

a. *Small-scale farmers*—Many farmers own farmlands less than 2ha per household. The main source of finance for small, subsistence-oriented farmers was the local moneylender. Loans were usually small, ranging from USD 250 to USD 1000, and the interest rate was around 10% per month, which was more than three times higher than the rate charged by MFIs. Interestingly, these loans were mostly not used for agriculture, but for consumption expenditure and house construction. However, agricultural inputs (fertilizers, pesticides) were bought on credit from local input suppliers, to be repaid after harvest. Subsistence farmers preferred to use labor-intensive production methods which required less use of purchased or hired inputs, thus minimizing their demand for formal loans. These informal sources of credit required no collateral, were flexible, and could easily be accessed by farmers.

b. *Medium-scale farmers*— This type of farmer owns farmland between 2-5ha and produce rice for both household consumption and sale, and to do so, they cultivate both wet and dry season rice, with the wet season rice harvest mainly for household consumption, and the dry season (DS) rice exclusively for the market. Farmers used family labor for most activities. The rice was poorly irrigated, and little machinery was used as the farms wer mostly not accessible to tractors. The rice varieties were planted, and chemical fertilizer application averaged about 100 kg/ha. Farmers preferred to access inputs such as fertilizer from local merchants on credit, claiming that this service was readily available and they could repay the credit after harvest. However, farmers sometimes sold part of the WS crop if the DS crop had been less profitable or if they needed to repay credit or loans. They often experienced a shortage of rice (and cash) for around two–three months before the WS harvest.

c. For the DS crop, expenditure on inputs was three times higher, especially due to higher use of fertilizers, mechanized land preparation, irrigation, pesticides, and threshing. The higher costs and returns meant that farmers sought both formal and informal credit for their production expenditure. Though total costs were about KHR 3 million/ha, loans were around KHR 1–2 million (USD 250–500). Given the excess demand for credit, some moneylenders took loans from MFIs at 3% interest and re-lent this to farmers (without collateral but with other ties) at 5–7% interest. As with WS rice, farmers also bought inputs on credit in the DS, incurring up to 5% per month in implicit interest to be paid along with the principal after harvest. However, DS gross margins were highly vulnerable to fluctuations in the price as farmers were mainly dependent on the Vietnam market. In these circumstances, some farmers borrowed additional money from the MFIs to repay the local input merchants, thus risking the loss of their land and other household assets to meet their production commitments. If production failure (e.g., due to a pest outbreak) coincided with falling prices, the farmers would have been plunged into a debt crisis.

d. *Large-scale farmers*– large-scale farmers own more than 5ha of farmerland and cultivate only DS rice for the market, using large areas of land that are flooded in the WS, adding to the fertility of the soil and reducing the fertilizer requirement for DS production. Farmers used IR varieties, given their high yield and market potential. The average yield was 6 t/ha, significantly more than semi-commercial DS rice. Production costs were much the same as for the semi-commercial farmers in the DS as the lower fertilizer costs were offset by higher pesticide use and mechanization. Land preparation and harvesting involved hiring mechanized services and irrigation costs. However, the larger scale of production meant that total profits were substantial. Commercial rice farmers took loans from MFIs to cover their entire production expenditure, though some of the large landholders used their own capital for some or all of their costs. Having large and fertile landholdings to offer as collateral plus a profitable enterprise gave commercial farmers ready access to agricultural credit. Loans of USD 1000–1500 were common among farmers with 5ha or more of DS paddy land, four–six times as much as the semi-commercial farmers. Given the urgency to repay their loans and avoid incurring further interest charges, farmers sold their paddy immediately after harvest, preventing them from obtaining a higher price during the wet season. Commercial rice production also faced price fluctuations, pest hazards, and rising input costs, which threatened to reduce gross margins and hence the ability of farmers to repay their loans to the MFIs. The costs of fertilizers, pesticides, and machinery use keep increasing year by year.

At the time of this study; subsistence, semi-commercial and commercial farmers are farming three times per year, using the Vietnamese IR rice varieties, which yield between 4-5 tons/ha, with high agricultural chemical inputs, and consuming a lot of water. To do farming, farming household hires labors, applies mechanization and borrow loans. Given the increased access to MFIs, the informal money lenders seem inactive in lending their money to farmers. According to CSA (2020), about 21.3% of agricultural households take loans to be used for agricultural purpose. In Preah Vihear province, the households with such loan accounts for almost 60%, which is the highest percentage. The lowest percentages were Kampong Speu and Phnom Penh (less than 10%). In Prey Veng, about 20% of agricultural households have taken loans to support agricultural activities, followed by Kampong Thom 19% and Takeo for 12% (CAS, 2020). However, Sothorn (2011) presented that about 70% of farmers in Takeo Province took small loans of USD 250-1500 (Sothorn, 2020).

However, based on the survey conducted with communities in the studied sites, about 50-70% of households are indebted to micro-finance institutions. This is common across the study sites from Prey Veng to Kampong Provinces. Farmers borrow the money from MFIs to finance their farming activities and purchasing their farming materials (Table 19).

Table 19. Indebtedness of agricultural households in the study areas.

Site	Province	Commune	No. of HHs	No. of HHs Indebtedness.	%
1. Beung Phlang	Prey Veng	Ampil Krau	1981	1387	70
2. Beung Sneh		Theay	2964	1778	60
		Damrei Puon	2679	1072	40
		Samraong	2482	1489.2	60
		Ta Kao	3739	2243	60
		Prey Kandieng	2887	1444	50
Sub-total			16732	9413	56
3. Boeung Ream	Kampong Thom	Kakoh	3325	1995	60
4. Ta Soung	Takeo	Prey Lvea	3731	2611.7	70
Total			**23788**	**14020**	**59**

5.5. Migration

While rice farming is triple in the study areas, in terms of rice farming season, the increased production cost, the increased agro-chemical inputs, and mechanismation, it happens at the increased rate of migration. This happens due to the fact that, first, those who have received education struggle to use their skills in agrarian environments. Agricultural land is often divided among children, causing individual plots of land to decrease below the threshold of agricultural productivity. Agricultural livelihoods have also been undermined by deteriorating land and water conditions. These push factors create for a pool of underproductive labour in rural areas, which might be drawn to the garment, construction, tourist, transportation and service industries in urban areas. The main migration destinations are Phnom Penh, which receives half of all Cambodia's rural migrants, followed by other economically active provinces such as Battambang, Kampong Cham and Siem Reap. Second, there are more jobs created in the service and industrial sectors in main cities with high pays, and second, the increased service providers for agriculture at the village levels, where agricultural households could hire to cultivate their farmlands. On average, rural areas are losing 4% of their population a year. This

depletes rural areas' labour pools and damages agricultural production, especially given low rates of rural mechanization (UNESCO, UNDP, IOM, and UN-Habitat, note date)[4].

Between 2013 and 2018, about 1.3 million new jobs were created, of which 894 thousand jobs were in the industrial sector and 1,005 thousand in the services sector, while the employment in the agricultural sector having lowest productivities decreased by 617 thousand people. Thus, more young people migrate to cities to find a job. As of 2018, there are 1.23 million Cambodian workers worked overseas (Ministry of Labor, 2018). In 2014, Rural to urban migration comprises about 57% of all migration (UNFPA Cambodia, 2014)[5]. The GPCC 2019 found that the percentage of migrants in Cambodia was 21.5 percent. As expected, most of the migrants were in their prime working ages between 20 and 39 years of age, constituting almost half of the migrants (48.7 percent), both among males (49.7 percent) and females (47.8 percent) (GPCC, 2019).

Migrants to Phnom Penh come from all corners of the country, but the majority (59%) come from the four provinces near the capital large populations: Kandal, Kampong Cham, Prey Veng and Takeo (Ministry of Planning 2012). Cambodia is especially susceptible to the effects of climate change: the Tonle Sap Basin's flooding patterns are particularly affected by changing weather patterns. The 2000, 2011 and 2013 floods and storms around the Tonle Sap Lake were the worst in recent history, resulting huge economic and humanitarian costs (CDRI 2014a). These areas are likely to see labour outflow as a result of climate change (ADB 2012).

Young population aged above 18 years olds have migrated to work in cities and overseas in the textile industries, construction, and service sectors, where they could earn more than in farming jobs. As a consequence, only old people remain in the village. There are not many young people stayed in the villagers and there lack of labors. Thus, farming is the work of old people. Hence, there is a lack of labor for agriculture in all studied villages. In all studied sites (Prey Veng, Takeo & Kampong Thom), during the FGDs, most of members report that their households have their members migrated to cities. Generally, the migration constitutes 24% of the total population aged above 18 years old. Female migration from the studied areas constitutes 19% of total female population aged above 18 years old. In total, about 2% of population aged above 18 years old migrates overseas. Among the studied areas, migration in Prey Veng Province constitutes 32%, higher than in Kampong Thom 20% and Takeo 13%. The female migration in Prey Veng Province is also high constituting 26%, comparing 11% in Takeo and 10% in Kampong Thom (Table 20).

In Ampil Krav Commune, it has 5 villages with a total population of 17,572 people from 2112 HHs. About 85% are doing farming and 20% are fishing. About 4879 people age above 18 years old and among them, about 1368 people migrate to work in cities, which constitute 28% of total population. Woman is also migrated, constituting 17% of total women population aged above 18 years old. The oversea migration constitutes 9% of the total population aged above 18 years old, the highest percentage. Also, the brick industry booms in this area due to the availability of the clay soils, and the mushrooming of Borey/housing industry in Phnom Penh. In Peanea village, there are 4 brick industries, and in Kbal Beung village, there are 4 brick industries. There are few other brick industries in other villages. The brick industries in the commune could employ 5,000 people. At present, many farmers turn to be laborers for the brick industries. About 75% of the population in the commune works in the brick industries. At present, each brick industry employs 100-200 workers with a daily wage of 30,000 Riel.

In the Theay Commune, the total population aged above 18 years old is 8,344 people, of which 95% are farming, 2-3% are fishing, and the rest is the petit traders. About 2,505 people are recorded as the migrants, constituting about 30% of the total population, most of them are young people, aged between 20-40 years old. In addition, female migration constitutes 20% of total female population aged above 18 years old. Migration has happened due to low agricultural investment and small handholds among rural farming households. Farming has been challenged by increased agricultural inputs and lack of water, with cheap prices of agricultural produces.

In Damrei Puon Commune in Prey Veng Province, the total population aged above 18 years old is 7372 people. Also, about 2138 people or 29% of total population migrates to work in cities and overseas. In addition, female migration constitutes 30% of total female population aged above 18 years old in the commune. Migration has taken place in all villages in the Commune. Almost every household has a member migrated to cities and overseas, most of them seek employments outside the province. Declining natural resource basis, including fishery, water and agriculture are part of the reasons of migration.

In Prey Kandieng Commune, another commune in Prey Veng Province, adjacent to the Beung Sneh area, the percentage of migration is relative higher than other communes in Prey Veng Province, constituting 51% of the total population aged above 18 years old. In addition, female migration constitutes 36% of total female population aged above 18 years olds in the commune. In total, about 4% of total population migrates to work in overseas.

On the other hand, in Ta Suong irrigating community, about 13% of the total population is migrating to find employment in cities, although farming three times a year, as farming is no longer profitable and indebtedness is relatively high. Female migration constitute 11% of the total female population aged above 18 years old.

4 UNESCO, UNDP, IOM, and UN-Habitat, note date. Overview of International Migration in Cambodia. Available online: https://bangkok.unesco.org/sites/default/files/assets/article/Social%20and%20Human%20Sciences/publications/Brief%202%20-%20Country%20Brief%20-%20Cambodia.pdf. Accessed on 29 July 2023.

5 UNFPA, 2014. Migration in Cambodia. Available online, https://cambodia.unfpa.org/sites/default/files/pub-pdf/FactsheetMigration%20%281%29.pdf. Accessed on 29 July 2023.

Table 20. Migration in the studied areas.

Site	Province	Commune	No. of village	No. of HHs	Population (> 18 yrs)	No. of migration	%	Female Population (> 18 yrs)	No. of Female migrantion	%	No. of Oversea migration	%
1. Beung Phlang	Prey Veng	Ampil Krau	5	1981	4879	1368	28	2544	441	17	441	9
2. Beung Sneh		Theay	18	2964	8344	2505	30	4222	853	20	96	1
		Damrei Puon	17	2679	7372	2138	29	4029	1224	30	n/a	
		Prey Kandieng	7	2887	6614	3353	51	4483	1606	36	238	4
		Ta Kao	8	3739	4791	591	12	2583	296	11	95	2
		Teuk Thla	18	2820	7503	2541	34	3971	1317	33	176	2
Sub-total			73	17070	39503	12496	32	21832	5737	26	1046	3
3. Boeung Ream	Kampong Thom	Kakoh	10	3325	7891	1616	20	7597	754	10	n/a	
4. Ta Soung	Takeo	Ban Kam	7	1887	6488	1318	20	3393	647	19	161	2
		Kampong Reab	8	2021	5253	122	2	2693	46	2	n/a	
		Pou Rumchak	11	1983	6261	1387	22	3304	470	14	20	0
		Prey Lvea	7	1862	5553	271	5	2979	143	5	n/a	
Sub-total			33	7753	23555	3098	13	12369	1306	11	181	1
Total	**3**	**11**	**116**	**28148**	**70949**	**17210**	**24**	**41798**	**7797**	**19**	**1227**	**2**

In response to a shortage of labor in rice farming, farmers hire tractors to flow their rice fields. Also, farmers hire laborers to do the rice broadcasting. They also hire laborers to apply fertilizers, pesticides, and other agricultural inputs. During the harvesting period, they also hire threshing machines. Given these, many people call this a 'sethei kasekor' or the 'tycoon farmer' where farmers do nothing about farming, only hiring laborers, services, and inputs to do the rice farming for them and get the profit margins from farming.

The trend shows that young people keep migrating to urban cities, and it is unlikely that they will return to farm their rice lands. In the long run, farmers will sell their farmlands to private owners/companies. Farmers would hire the farmlands from the companies if they continue to farm. This is happening in study sites. In Beung Phlang area, farmers sold their farmland to private individuals who turn these farmlands into the brick industries. At 20 private individuals bought land in Ampil Krau commune around Beung Phlang Site to excavate the soil to supply to the brick production. Farmers instead seek employments as laborers in the brick production industries for the wage of 30,000-40,000 riels a day.

In Samnak village in Kah Koh Commune, Santuk District/ Kampong Thom Province, among 312 households, 50% of households sold their Srekrom (lower ricefield), close to TSL, to private Company at USD2,000/ha. About 70ha of farmland in this village is considered by villagers as Srekrom. At present, about 20 households have no farmlands. At present, farmers rent the riceland back from the Company to cultivate their rice farming at USD100/ha per farming season. Some farmers have rented these ricelands since 2010. In the Santuk Krao village, neighboring village of Samnak, about 250ha of Srekrom is sold to private Company. These happen not only in these two villages, but also in other villages in Kah Koh Commune.

5.6. Governance of the Food Production

5.6.1. Water Management and Irrigation System

The studied areas have developed irrigation systems. The study identifies 16 main canals, 28 Sub-canals (secondary), and 18 tertiary canals. In these irrigation systems, the study identifies 38 water gates that could control the water flows between the main reservoirs and the rice fields (Table 21). Each system is equipped with water pumping stations. Totally in the studied areas, there are four pumping stations. The Beung Ream in Kampong Thom Province is connected to the Taing Krasaing Irrigation System, built by MOWRAM with funding from ADB in 2015. In Prey Kobbas District, Takeo Province, CAVAC supported the rehabilitation of the Ta Soung irrigation scheme, funded by DFAT. However, the Beung Phlang in Ampil Krav Commune in Prey Veng Province is surrounded by the Vaiko Irrigation System built by MOWRAM with funding support from China. The Beung Sneh area was developed with various irrigation systems during the Khmer Rouge, some of which are rehabilitated by MOWRAM recently with funding support from ADBs and other donors, and some are rehabilitated by local governments with participation from local communities.

Table 21. Irrigation System in the studied areas.

Row Labels	Sum of No. of main canals	Sum of No. of Sub-canal	Sum of Tetary canal	Sum of No. of Water gates	Sum of Pumping station
Kampong Thom	**1**	**5**	**16**	**2**	**1**
Kakoh	1	5	16	2	1
Prey Veng	**13**	**13**	**2**	**26**	**2**
Ampil Krau	2	6	0	5	1
Baray	0	0	0	0	0
Damrei Puon	1	1	2	21	1
Me Bon	0	0	0	0	0
Prey Kandieng	4	3	0	0	0
Samraong	1	1	0	0	
Ta Kao	2	0	0	0	0
Theay	3	2	0	0	0
Tuek Thla	0	0	0	0	0
Takeo	**2**	**10**	**0**	**10**	**1**
Ban Kam	2	10	0	10	1
Kampong Reab			0		
Pou Rumchak			0		
Prey Lvea			0		
Grand Total	**16**	**28**	**18**	**38**	**4**

Source: *MoWRAM, 2021*

In the studied sites, five Irrigation Management Communities have been established. These Communities are named after the Farmer Water Use Communities (FWUCs), which are legitimated by Sub-Decree on FWUC issued in 2016 by MOWRAM. There are one FWUC in Kah Koh Commune in Beung Sneh, three FWUCs in Prey Veng, and one FWUC in Prey Kobbas, established in 4 communes.

The total area under five FWUCs in three provinces is 8753ha. About 2,152ha of the FWUC areas is in Prey Veng, followed by 1500 ha in Ta Soung in Prey Kobbas Takeo Province and 5,099ha in Kah Koh Commune. About 15,481 families are participating in five FWUCs in three provinces (Table 22).

5.6.2. Irrigation System in Prey Veng

In Prey Veng Province, there are 177 irrigation systems. Some 38 FWUCs have been established. In the studied areas in Prey Veng Province, nine irrigation systems are identified in 5 communes in 4 districts—03 irrigation canals in Theay Commune, Ba Phnom District, 03 irrigation canals in Prey Kandieng Commune, Peam Ro District, one irrigation system in Ampil Krav, Sithor Kandal District, and 02 irrigation canals in Svay Anthor District. About eight irrigation canals take water from Beung Sneh lake and one canal take water from the Mekong River in Kampong Cham Province (Table 23).

Table 22. A number of FWUCs established in the studied area.

Province/ Commune	Count of Name village	No. of FWUC	Sum of Areas (ha)	No. of villages in FWUC	%	No. of members (HHs)
Kampong Thom	**10**	**1**	**5099**	**10**	**100**	**13058**
Kakoh	10	1	5099	10	100	13058
Prey Veng	**47**	**3**	**2152**	**13**	**28**	**1453**
Ampil Krau	3	1	107	3	100	93
Baray	2	0	0	0	0	0
Damrei Puon	10	1	1570	6	60	984
Me Bon	3	0	0	0	0	0
Prey Kandieng	5	0	0	0	0	0
Samraong	10	0	0	0	0	0
Ta Kao	6	0	0	0	0	0
Theay	4	1	475	4	100	376
Tuek Thla	4	0	0	0	0	0
Takeo	**15**	**1**	**1502**	**15**	**100**	**970**
Ban Kam	6	1	1502	6	100	970
Kampong Reab	2			2	100	
Pou Rumchak	4			4	100	
Prey Lvea	3			3	100	
Grand Total	**72**	**5**	**8753**	**38**	**53**	**15481**

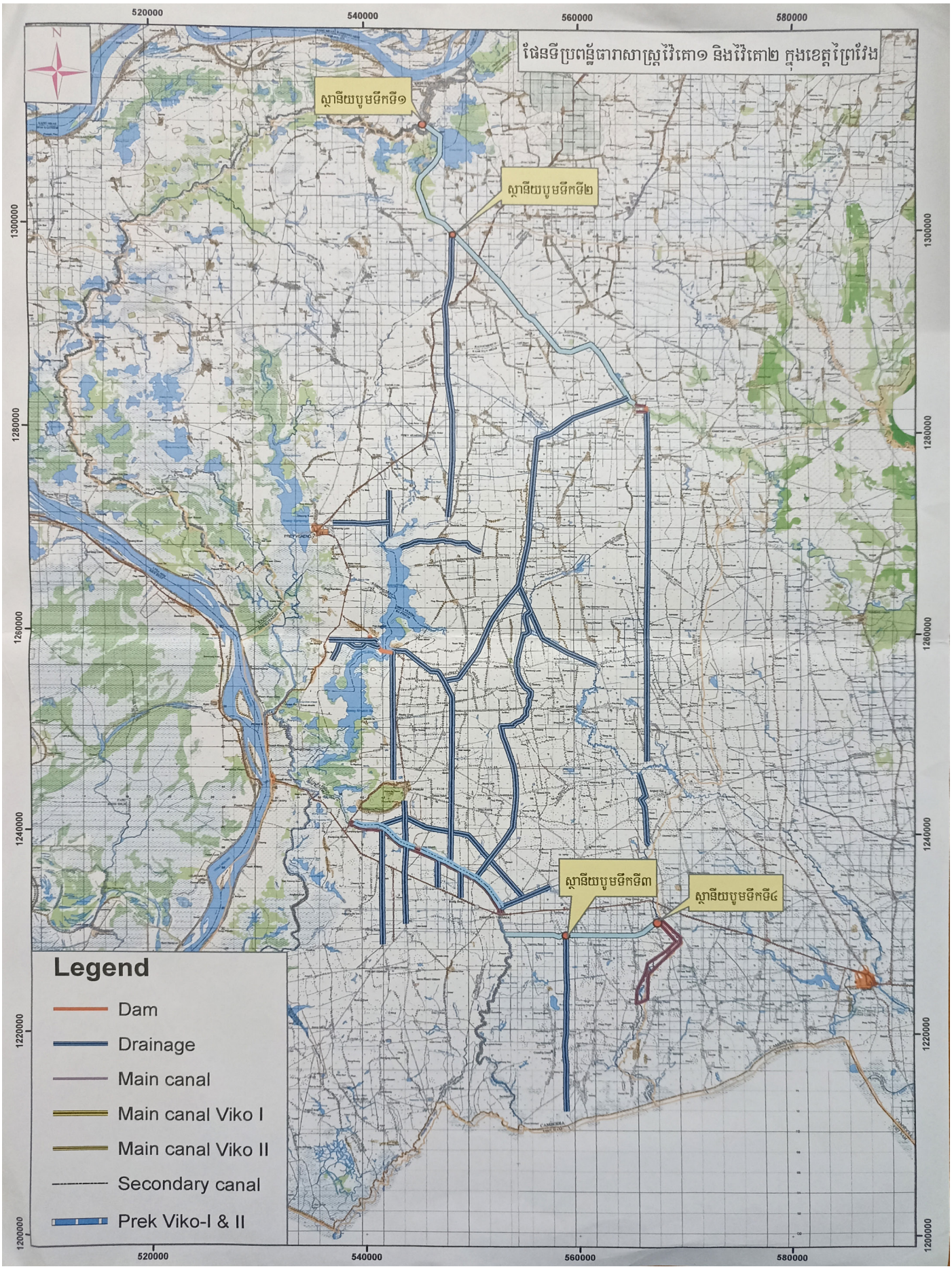
Source: *FWUC Database, 2021*

Table 23. Irrigation Systems in Studied areas in Beung Sneh and Beung Phlang Area.

District	Commune	Scheme Name (EN)	Infrastructure		Potential Area (ha)		River Basin	Water Sources	Distribution		
			Construction	Last Rehabilitation	DS	WS			Gravity	Pumping	Mixed
Ba Phnum	Theay	1. Po Louk Canal	1976	2008	170	4700	Mekong Delta	Sne reservoir	Y		
Ba Phnum	Theay	2. Khse Canal	n.a	1988	1300	1000	Mekong Delta	Sne reservoir	Y		
Ba Phnum	Theay	3. Top Sdach Canal	1990	2007	75	200	Mekong Delta	Sne reservoir		Y	
Peam Ro	Prey Kandieng	4. Phum Chan Canal	1977	2004	150	80	Mekong Delta	Sne Reservoir		Y	
Peam Ro	Prey Kandieng	5. Prey Kandieng Canal	1977	2005	100	600	Mekong Delta	Sne Reservoir		Y	
Peam Ro	Prey Kandieng	6. Russei Muoy Kom	1977	n.a	150	0	Mekong Delta	Touch Peam Ro river		Y	
Sithor Kandal	Ampil Krau	7. Svay Teab Canal	1976	2014	0	200	Mekong Delta	Vaiko canal			Y
Svay Antor	Samroung	8. Krochab Dam	1976	2006	0	200	Mekong Delta	Sne reservoir	Y		
Svay Antor	Damrey Puon	9.Chamcar Kuoy	1978	2014	0	2100	Mekong Delta	Sne canal	Y		
Total	5	9			1945	9080	Mekong Delta		4	4	1

Source: *FWUC Database, 2022*

Figure 10. Irrigation System in Boeung Sneh and around (Source: POWRAM Prey Veng, 2022).



5.6.3. Boeung Sneh

The total water volume of Beung Snea is about 85 million cubic meters in the wet season, and it decreases to around 40 million m^3 in the dry season. Large volume annually upstream watershed discharges into Beung Snea and maintains the functionality of the lake. Around Beung Snea, huge ricefield areas depends on water from the lake for agriculture and farming. They are home to many villages, most of them are farming. Given the increased farming seasonality, 2-3 crops per year, the demands for water for rice farming are increasing, causing water shortages in some years. Prey Veng Province has been ranked as number one in rice production, taking over Battambang:

Irrigation Canals in Beung Sneh–there are about 10-15 irrigation canals that take water to irrigate the rice field around Beung Sneh. Million of cubic metter are pumped out of the Beung Sneh every year to irrigate 3 rice crops a year. However, only two FWUCs are established to manage the water uses among farmers, one in Theay Commune and one Damrey Poun Commune.

FWUC Chamcar Kouy–In Damrey Poun commune, there is one FWUC namely the Chamcar Kouy, established in 2018 by 06 villages and it is financed by ADB:

- Year of establishment: 2018
- Irrigated area–2100 ha
- Main canal–01 with 8.8km
- Sub-canal–01
- Water gate–03
- Small water gates–18
- Tertiary–02
- Pumping station–01
- Committee–02 per villages. In total they have 15 people.
- Farming 2-3 times a year, but water fee is paid only once a year.

Private Water Pumping Operator–In Torp Sdach Village in Theay commune, the private water pumping station was operated by private individuals from Phnom Penh, granted by District Authority. The operator receives a 4-year contract, from 2016 to 2024, to pump water from Beung Sneh and sold to farmers for 270,000-300,000 riel per hectare per season. The pumping station could pump water to irrigate 305 ha in 5 villages. Thus, this operation allows farmers to cultivate 2-3 rice crops per year. About 105 ha is an upland ricefield, which is not flooded by the rising water level in Beung Sneh, and therefore, farmers cultivate 3 rice crops per year. However, about 200ha is located within the Beung Sneh floodplain and thus, the area is flooded during the wet season therefore, farmers could only cultivate one rice crop a year, particularly from March to May which is a dry season rice. About 250-300 HHs rely on water from the private pumping station. Among them, about 175 HHs are doing dry season rice farming, and all of them own pumping generators at least one.

Water Supply System–There are three water supply stations operated by Private Individuals that received the licenses from MOWRAM, pumping water from Beung Sneh, filtering it, and cleaning and selling it to villages. These two stations are operational and one is still under construction–one station is in Theay Commune, one in Samrong Commune and the newly construction one is in Damrey Poun Commune. About 50-60% of the population living around Beung Sneh use water from the water supply system for the price of 1800-2000 riel per cubic meter. It is estimated that one household uses 10 m^3/month.

Figure 11. The map of Boeung Sneh in Prey Veng Province.

Farmers have used water from Boeung Sneh irrigates their ricefields in the dry season. There are irrigation canals around the lake, taking water from the lake to irrigate the dry season rice. The Boeung Sneh is linked with the Ampil Krau through a Vaiko-1 canal, bring water from the main Vaiko-1 main canal in Ampil Krau down to Boeung Sneh.

Around the Boeung Sneh, there five irrigation canals built to take water from Boeung Sneh to irrigate ricefield around the lake. The water gates are equipped around the Boeung Sneh to pump water from the lake to the surrounding canals (Figure 11).

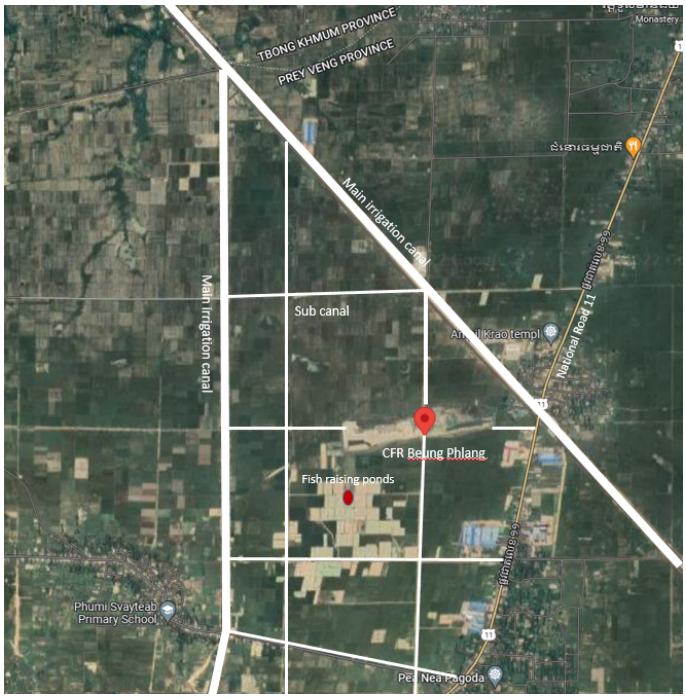
5.6.4. Beung Phlang Area

Beung Phlang is located in Ampil Krav Commune in Sithor Kandal District, Prey Veng Province. In Ampil Krav Commune, there is surrounded by the Vaiko Irrigation Schemes built by Chinese Firms in 2015–02 main canals and 10-12 sub-canals. In Ampil Krau Commune, the irrigation system is completely built in 2015, namely the Vaiko-1 Irrigation system (Vaiko-1), with the main canals and sub-canals. The source of water for the Vaiko-1 is the Tonle Touch, a tributary of the Mekong River, which originated Koh Sotin in Kampong Cham Province. There is a pumping station operated by electricity. The length of the Vaiko-1 is 88 km, covering a number of districts in Prey Veng Province. It could irrigate 150,000ha of ricefields (Figure 12).

There are water gates to release water from the main canals to sub-canals. There are two vertical sub-canals and four horizontal sub-canals. One vertical and one horizontal sub-canal link the CFR Beung Phlang to the main canals. The CFR Beung Phlang is situated in the center of the Ampil Krau irrigation system, and it is surrounded by ricefields. Fish from CFR Beung Phlang could migrate from the CFR areas to ricefields through these sub-canals and will make the ricefield abundant in fisheries.

However, the main canals and sub-canals are poorly managed and lacked maintenance. Some parts of the main canals are eroded which needs repairs. The sub-canals are shallowed which are unable to make the water from the main canals to the sub-canals. Due to poor maintenance, most of the sub-canals do not work and they are disconnected from the main canals and ricefields. As a result, farmers suffer from water shortages. The droughts and floods make further deterioration of the system, bringing about a greater disconnection between the irrigation system and ricefields. Villagers have not been using much water from the Vaiko Irrigation as there is not enough water and four out of five villages are doing only one rice crop a year, which is a wet season rice. Only one village, which is Svay Teap, is doing 3 rice crops a year. The canal system is getting shallow. At each village, there is a water gate and in each village, there is one person who is in charge of closing and opening up the water gate.

Figure 12. Irrigation system in Ampil Krau in Sithor Kandal District.



5.6.5. Beung Ream and Taing Krasaing Irrigation System in Kampong Thom Provine

In Kamong Thom Province, there are 259 Irrigation Schemes. Among them, 03 largest schemes: (1) Stung Chinit; (2) Taing Krasaing; and (3) 30-Kanha Irrigation schemes.

Stung Chinit Irrigation Scheme:

- irrigated area of 2802ha–01 main canal–7000m; 05 sub-canals; one main water gate and 5 sub-water gates.
- covering two districts–03 communes with 25 villages.
- FWUC was established in 2002.

Taing Krasaing Irrigation scheme:

- Irrigated area–4788ha–03 main canals with a total length of 10600m
- FWUC Taing Krasaing was established in 2018, led by 04 Committee members.

30-Kanha Scheme–1) irrigated area–32000ha, rehabilitated by Chinese funding and experts, 03 main canals, and 4-5 secondary canals; 2) No FWUC established.

- There are 19 water pumping stations operated by private individuals along the Stung Seng River Basin in Kampong Thom.
- FWUC–30 FWUCs in Kampong Thom, many FWUCs do not work, and only 10% are active.

Stung Chinit FWUC–established in 2002, led by 04 Committee members:

- District FWUC–01 (FWUC): Stung Chinit
- Commune FWUC–03 (one Commune as one Sub-FWUC)
- Village FWUC–25 (one village as one group-FWUC)
- 2800 households as members.

Taing Krasaing FWUC—established in 2018, led by 04 Committee members:

- District FWUC—01 (Taing Krasaing FWUC)
- Commune FWUC—03 Sub-FWUCs.
- Village FWUC—n/a
- Kakoh is one Commune FWUC (Sub-FWUC) with 09 villages as Village FWUC (Group FWUC). Beung Ream CFR is located in Kakoh Commune with 02 villages form the CFR.

There is a large FWUC established at the irrigation system level of Taing Krasaing Irrigation Schem, which covers many districts and communes. The irrigation system enters the Kor Koh Commune, and 09 villages have used water from the irrigation system to irrigate their rice field, particularly in the dry season. Three villages in Kor Koh Commune receive water for their rice farming from Svay Kantrum Sub-irrigation canals—(1) Kirivan, (2) Chey Chumneas, and (3) Samnak. The Svay Kantrum Sub-irrigation canal distributes water to rice fields around the CFR Beung Ream and to the Beung Ream. In each village, there is a sub-FWUC. Sub-FWUC is coordinating with CFR Committee to release water to the Beung Ream when there is a low level of water in the Beung Ream.

However, the other six villages in Kor Koh Commune receive water from the Sub-irrigation schemes: (1) Svay Roling Scheme, (2) Beung Takrom Scheme; (3) Beung Sour Ambeng Scheme, and (4) Beung Toul Taing Russey. Similarly, each village has set up a sub-FWUC. These villages and schemes do not have CFRs.

Farmers who used water from the sub-irrigation schemes pay the water fees. Actually, farmers pump water from the sub-irrigation canals using their water-pumping generators, which means that individual farming households own at least one pumping generator. The water fee is paid based on the size of the rice farming area and the distance from the rice field to the irrigation canals. The water fee is paid per crop. It cost 40,000 riel/ha/crop for a rice field located close to the irrigation and 20,000-30,000 riel/ha/crop for a rice field located close to the irrigation canals. The payments are made to the FWUC Committee. However, during the dry season, particularly from January to March or April, farmers pump water from the CFR area, but they do not pay water fees to CFR Committee, but to FWUCs.

Kah koh FWUC—covers Kakoh Commune with 10 villages, but only 9 village-FWUCs were established (Chey Chomneas and Kirivon villages are together as one village-FWUC):

- The total number of households (HHs) is 3,328 HHs. The majority is farming with 3 crops per year, and only 20-30 households per village are engaged in fishing.
- Kakoh FWUC has 01 sub-canal totaling 6km, crossing the ricefield of 10 villages. There are 16 tertiary canals with 6 water gates
- The agricultural land is 5099ha. The dry season rice farming is 2,000ha, which needs irrigation.
- One village is one Group-FWUC with 01 group leader and 02 deputy group leaders who will act to collect water fees. In total, there are 02 Sub-FWUC leaders and 17 Village-FUWC leaders across 10 villages.
- In Kakoh Commune, there is one river known as Stung Slap, and 09 large ponds. Three of these ponds were organized into CFRs. Beung Ream is one of three CFRs established by WorldFish.
- Water fee is 4000 riel/ha. However, only about 50-60% of households pay the water fees. The water fee is not collected for the entire 3 crops in the years, only one crop is paid for the uses of water, particularly from November/December to February. The Group leader will receive 15% of the water fee collected.

Water Uses:

- There is more water than before after the having irrigation. Farmers could do 3 rice crops per year, while it was only in the past.
- There is a competition or sometimes conflict over the access and sharing of water between the upstream and the downstream, affecting the water fee payment.
- In the Sub-FWUC, water is managed by the Sub-FWUC leader, covering the entire commune of Kakoh. When farmers need water, they need to inform the village-FWUC leaders, and then the leader will inform the Sub-FWUC leader. The Sub-FWUC leader will inform the water gate operators to release the water. Water through the sub-canal takes 3-4 days to reach the last villages in the Kakoh FWUC.
- In the sub-canal, there is fish, but the management is not by either FiA/FiAC/MOWRAM. In the ricefield, fish is available, but no record of fish catch. Estimated, farmers said about 25-50kg of fish they could catch from one hectare of ricefield a year. However, only 20-30 households in a village do fishing, while many are concerned more with farming.

5.6.6. Ta Suong Irrigation System

In Prey Kobbas District, we study the Ta Suong Irrigation System. There are three main canal systems that formed into one system of Ta Suong Farmer Water User Communities (Ta Suong FWUC). The Ta Soung is an FWUC organized by 4 communes (Ban Kam, Kampong Reap, Prey Lvea, and Por Romchak) to manage three irrigation schemes namely 1) Kampong Chaok, 2) Kouk Pring, and 3) Prey Lvea, irrigating 1511 ha supporting 970 households in 15 villages. The total length of the canal is about 5km long. The irrigation system comprises (1) two main canals, (2) 10 earth canals, (3) 08 concrete canals, and (4) 07 flooded-releasing canals. It is equipped with 01 pumping sstationwith 05 pumping machines (Table 24).

The entire irrigation system is organized into 10 blocks and each block has formed one sub-FWUC. Each block could cover around 200 ha and has set up a sub-canal with water gates that could take water to the remote rice fields. The release of water will be done by blocks, and FWUC has hired 2 farmers in each block to open and close the water gates. In total, it has hired 12 farmers to work in 10 blocks. It is overseen by 4 FWUC Committee members.

The irrigation system was built and financed by CAVAC in 2017 and it was phased out in 2021. After it ended, CAVAC formed the Mekong Water Solution (MWS) to take over and support FWUC to manage the irrigation system. Farmers who used water from the irrigation system to irrigate their rice fields pay the water fees to the FWUC.

Irrigation canals are connected to 4 CFis in Prey Kambas District, namely (1) CFi Kampong Reap; (2) CFi Pour Romchaok, (3) CFi Ban Kam, and (4) CFi Prey Lvea. These CFis were established in 2000 and 2002 by FiA/FiAC. It covers 844,793 ha with 1016 households as members.

5.6.7. Fisheries Resources Management

The studied irrigation canals take water from water bodies connected to the Mekong River, Bassac River, and Tonle Sap floodplain which there are rich in fisheries. There are irrigation canals connecting water sources to the rice fields. The pumping stations are built to pump water from water bodies, streams, and rivers to irrigate rice farming areas. The Ta Suong Irrigation System pumps water from the Prek Ambil river, a tributary of the Bassac River, to irrigate rice fields in 15 villages.

The Prek Ambil river was a former fishing lot no.20 in Take Province, where it was rice in the fishery and villagers from the Ta Suong Community catches for their food. The Beung Sneh is rich in fishery resources, and there are 44 villages surrounding the Beung Sneh, where villagers catch fish from the Beung Sneh. In Beung Ream, villagers from 10 villages in Kah Koh Commune go fishing around the Beung Ream area.

In summary, the fishing population in the studied areas constitutes 24% of the total population. In Prey Kobbas District, the fishing population constitutes 33% of the total population. In Beung Ream in Kampong Thom, about 30% of its population is still engaged in fishing. However, the fishing population in Prey Veng in general, and in Beug Sneh constitute 19%, which is low compared with other provinces (Table 25).

The fishing population has decreased in the studied area and thus, some of the fishing gear have been disappeared. Only 3% of fishing households still used the row boat for fishing. Also, the percentage of households that owned motor boats for fishing constitutes only 3%. It seems that people are not actively engaging in fishing and so, they do not own the fishing gear.

Table 24. The Ta Soung Irrigation System in Takeo Province.

Commune	Scheme Name (EN)	Infrastructure		Potential Area (ha)		Management		Water Sources
		Construction	Last Rehabilitation	DS	WS	FWUC	Date	
Kampong Reab	Kampong Chork Canal	1976	2007	747	0	Yes		Basak river
Ban Kam	Kouk Pring	1976	2004	764	0	Yes	2003	Basak river
Prey Lvea	Prey Lvea or Trapeang Chork Canal	1976	2007	0	1511	Yes		Basak river
				1,511	1,511			

Source: *FWUC Database, 2021*

Table 25. Fishing households in the studied areas.

Province/Commune	No. of HHs	No. of households fishing	%
Kampong Thom	**3325**	**998**	**30**
Kakoh	3325	998	30
Prey Veng	**12149**	**2341**	**19**
Ampil Krau	1238	248	20
Baray	1655	n/a	n/a
Damrei Puon	1756	497	28
Me Bon	641	n/a	n/a
Prey Kandieng	2107	511	24
Samraong	1772	634	36
Ta Kao	1504	301	20
Theay	918	151	16
Tuek Thla	558	n/a	n/a
Takeo	**3731**	**1227**	**33**
Ban Kam	1607	336	21
Kampong Reab	532	293	55
Pou Rumchak	778	275	35
Prey Lvea	814	323	40
Grand Total	**19205**	**4566**	**24**

5.6.8. Community Fisheries (CFis)

After 2000, some commercial fishing lot areas were released for communities. The Community Fishery (CFi) was established since then. Until 2012, all fishing lots were abolished including fishing lots in Prey Kobbas District, Takeo Province, In Prey Veng and Kampong Thom Provinces. In the studied areas, we identifies 08 CFis established in Prey Kobbas District in Takeo Province and in the Beung Sneh area in Prey Veng Province, covering 92,869 ha, of which 39ha are managed as a conservation area inside the CFi areas. About 12,050 people from 42 villages are members of the CFis and they are managed by the Committee members of 87 people (Table 27).

Table 26. A number of fishing boats in the studied areas.

Row Labels	No. of households fishing	No. of HHs with row boats used for fishing	%	Sum of No. of HHs with motor boats used for fishing	%
Kampong Thom	**997.5**	**44**	**4**	**28**	**3**
Kakoh	997.5	44	4	28	3
Prey Veng	**11430**	**218**	**2**	**209**	**2**
Ampil Krau	247.6	0	0	0	0
Baray	0	12	n/a	15	n/a
Damrei Puon	4979	6	0	4	n/a
Me Bon	0	0	n/a	0	n/a
Prey Kandieng	5118	146	3	139	3
Samraong	634	19	3	19	3
Ta Kao	300.8	0	0	0	0
Theay	150.6	35	23	32	21
Tuek Thla	0	0	n/a	0	n/a
Takeo	**1227.05**	**188**	**15**	**152**	**12**
Ban Kam	336.15	19	6	3	1
Kampong Reab	292.9	0	0	0	0
Pou Rumchak	275	35	13	15	5
Prey Lvea	323	134	41	134	41
Grand Total	**13654.55**	**450**	**3**	**389**	**3**

Source: *Commune Database, 2021*

Table 27. A number of CFis, villages and members.

Province/ Commune	No. of CFIs	Area (ha)	Conservation area (ha)	No. of villages	No. of members	No. of CFi Committee
Kampong Thom	**0**	**0**	**0**	**0**	**0**	**0**
Kakoh	0	0	0	0	0	0
Prey Veng	**4**	**85236**	**37.93**	**25**	**11034**	**51**
Ampil Krau	0	0	0	0	0	0
Baray	0	n/a	n/a	n/a	n/a	n/a
Damrei Puon	1	15841	0.8	6	4979	9
Me Bon	0					
Prey Kandieng	1	655	4	5	5118	7
Samraong	1	7266	13	10	634	7
Ta Kao	0	0	0	0	0	0
Theay	1	61474	20.13	4	303	28
Tuek Thla	0	0	0	0	0	0
Takeo	**4**	**7633**	**1**	**17**	**1016**	**36**
Ban Kam	1	2000	0	3	219	9
Kampong Reab	1	1938	0	3	199	11
Pou Rumchak	1	840	1	3	275	7
Prey Lvea	1	2855	0	8	323	9
Grand Total	**8**	**92869**	**38.93**	**42**	**12050**	**87**

Source: *Commune Database, 2021*

In the Beung Sneh area in Prey Veng Province, four CFis were established in 2012, in 26 villages with 11034 households as members, covering 85,236ha. The Beung Sneh is also connected to 09 large irrigation schemes where water is pumped to irrigate 22,899 ha around the lake. In Svay Anthor District, there are two CFis established in 15 villages in two communes, covering 23,107 ha. In Prey Kandieng Commune, the CFi Mohachey Chumneas is established by seven villages in Peam Ro District. Another CFi is the Beung Sneh Theay, established in 2012 by 04 villages in Ba Phnom District. In conclusion, the CFi in Prey Veng Province is established by the commune. The CFi Committee (CFC) is elected from the villages in the communes. These CFIs are supposed to elect their CFi Committee members every 3 years, but since 2012, CFCs have not been re-elected, so the old elected CFCs continue to remain in the positions. In any case, CFIs are inactive since there are no supports (Table 28).

Beung Sneh area is rich in fishery. It is covered by water year-round, which is 12 m deep in the wet season and 05-07m in the dry season. The CFIs are established to manage and protect fisheries resources and sustain the livelihoods of fishing communities. It has been established that at least one ton of fish catch is taken out of the Beung Sneh water body within one day, supplying to a provincial town of Prey Veng.

However, for the CFi Beung Sneh Theay, only about 30 households from 4 villages are fishing. In the CFi Samay Thmey Techor has 08 villages as members, but only 20% of households are fishing in the Beung Sneh areas, and 80% are doing rice farming. The same happens to the CFi Damrey Poun, in which only 20% of households in six villages are fishing. The rest of the households in these CFis are farming 3 rice crops a year with a rice yield of 4-5 tons/ha.

The Ta Suong Irrigation System is connected to four CFis established in Prey Kobbas District, Takeo Province. These CFis were established in between 2000 and 2002, covering 844,793ha locating in 15 villages in four communes. About 1,016 people are involved in the CFis as members, of which about 550 people are female. The CFis are led by 36 CFC members (Community Fishery Committees (CFCs)), including 4 females (Table 29).

Oxfam Australia worked with these CFis between 2002 and 2015 to support communities to protect fishery resources for their livelihoods. Since the phase out of Oxfam works in the areas, CFis become inactive due to the lack of financial and technical supports. In 2022 and 2023, EU has provided the small grants to one CFi namely Kampong Reab for USD1000 per year. Despite that the small grant does not address issues that CFi faces, only the patrolling, the conservation and signboard for the CFi awareness.

CFis face many challenges including the encroachments into the conservation areas, illegal fishing inside the CFi core areas, the lack of participation of CFi members & non-members in the management of the CFi areas and the protection of fishery resources, the limited supports from FiA, FiAC and local government in managing the CFi areas, limited financial and technical supports from concerned agencies, the conflicts between CFis and FWUCs over the pumps of water from the CFi areas to irrigate the ricefields, the overlapped areas between the CFis and FWUCs, the lack of fishery management inside the FWUC areas, and the uses of pesticides & fertilizers in rice farming, killing aquatic animals and fish.

5.6.9. Community Fish Refuges (CFRs)

CFR is a form of community-based fishery management that is established to manage fishery in the natural lake, linking rice field fishery to the water bodies. The study focuses on two CFRs, one in Beung Ream in Kampong Thom and another one in Beung Phlang in Prey Veng Provinces. The Beung Phlang CFR was established in 2007 by 3 villages, while the Beung Ream was established in 2021 by 2 villages. The CFR is surrounded by large rice fields, and in the wet season, water from the Mekong River and Tonle Sap Lake floods the rice field around the CFRs, making fish migrate from the lake and the Mekong River into the CFRs and some fish species migrate from the CFRs into the rice fields, allowing farmers for catching more fish. The estimated fish catch in the rice field around the CFRs is 25kg/ha/season and 88kg/ha/season in Beung Phlang and Beung Ream CFRs respectively (Table 30).

5.6.10. CFR Beung Ream

WorldFish is implementing the Sustainable Aquaculture and Community Fish Refuge Project–Community Fish Refuge Component (SAFR-CFR) with 10 CFRs in Kampong Thom Province. The SAFR-CFR is financed by GIZ. On 15-16 February 2023, WorldFish organized the Annual Reflection Workshop to examine the progress and the improved performance of 10 CFRs in Kampong Thom supported financially by GIZ. Among the 10 CFRs, the CFR Beung Ream is selected as the site for the WP4.

For the above reason, I attended the SAFR-CFR Workshop to learn more about CFR performance and its challenges. It also provides the opportunity for us to communicate with the concerned stakeholders and the interactions with key stakeholders in Kampong Thom Province. It also provides a chance to meet with community leaders, the commune councilors, and the district authority. First, I attended the workshop and listened to the presentations made by 10 CFRs in Kampong Thom, including the CFR Beung Ream, and then, on the second day, I joined the field trip to Beung Ream and met with the CFR Committee, the Commune Councilors and Deputy Governor of Santuk District.

The CFR Boeung Ream was established in 2021 by four villages in Kor Koh Commune, Santuk District, Kampong Thom Province. The CFR Committee comprises of 07 members with two female members. They were officially elected on October 29, 2021, and recognized by the Commune, District, and FiAC-Kampong Thom (Table 30).

Table 28. CFis in Beung Sneh Prey Veng.

No.	Cfi	Location			Year of establishment	Area (ha)	No. of members		CFC		Registration date	Management Plan developed	No. of Conservation areas (ha)
		Commune	District	No. of village			Total	Female	Total	Female			
1	Damrey Poun	Damrey Poun	Svay Anthor	6	24.2.2012	15841	4979	2555	9	2	07.5.2013	2013	1(0.8)
2	Samay Thmey Techor	Samong	Svay Anthor	9	24.4.2012	7266	634	4283	7	0	07.5.2014	2013	2(13)
3	Beung Sneh Theay	Theay	Ba Phnom	4	24.3.2012	61474	303	106	5	0	07.5.2015	2013	5(20.13)
4	Mohachey Chumneas	Prey Kandien	Peam Ro	7	24.5.2012	655	5118	2.66	7	0	07.5.2016	2013	1(4)
	Total			**26**		**85236**	**11034**	**6946.66**	**28**	**2**			**37.00**

Source: *CFi Database, 2023*

Table 29. Number of CFis in Prey Kobbas District, Takeo Province.

No	Cfi Name	Location		Year	Area (ha)	No. of members		No. of CFC		Registration date	No. of Conservation areas (ha)
		Commune	District			Total	Female	Total	Female		
1	Kampong Reab	Kampong Reab	Prey Kobbas	2000	1,938	199	27	11	1	24.10.2017	1
2	Pou Rumchak	Pou Rumchak	Prey Kobbas	2002	840	275	170	7	1	Under process	0
3	Ban Kam	Ban Kam	Prey Kobbas	2002	n/a	219	102	9	2	n/a	0
4	Prey Lvea	Prey Lvea	Prey Kobbas	2002	2,855	323	251	9	0	n/a	0
Total	**4**	**4**	**1**		**844,793**	**1016**	**550**	**36**	**4**	**0**	**1**

Source: *CFi Database, 2023*

Table 30. CFRs in the studied Area.

Areas/CFR	Beung Phlang	Beung Ream
No. of CFRs	1	1
No. of villages	3	2
No. of HHs	561	392
Area (ha)	27	13
Conservation area (ha)	12	2
Size of CFR in the dry season (ha)	10	2
No. of membership	4981	572
Rice field areas around CFR (ha	1864	9000
Year of establishment	2007	2021
fish catch (kg/ha/season)	25	88
Funding (USD)	EU--USD1000 in 2022 and USD1000 in 2023	GIZ/WorldFish

The CFR area covers 13 ha, with the core areas of CFR covering 2ha for conservation. The water depth in the dry season is 2.5m. The Core area has been rehabilitated by CFR members with funding support from WorldFish/ANKO financed by GIZ in 2021. The CFR has been equipped with a water level monitoring system that could inform the CFR Committee about the level of water that could stop people from pumping water out of the CFR area. It has been demarcated with pillars for boundary demarcation, a security guard post, and a signed board demonstrating the prohibition of illegal fishing inside the CFR area (Figure 14).

There are 3 canals entering the CFR area: (1) O' Praing, (2) Beung Karav, another natural pond, connecting with Beung Ream; and (3) Irrigation canals built by MoWRAM. The O' Praing has been rehabilitated by a Private Company that took the soil/earth to build the roads. Since it has been rehabilitated, it provides water to the CFR Beung Ream which keeps the water in Beung Ream year-round. The irrigation canal enters the CFR Beung Ream and supplies water based on the requests from CFR Committee. The irrigational canal is part of the Stung Chinit Irrigation Scheme built by MoWRAM, and financed by ABD.

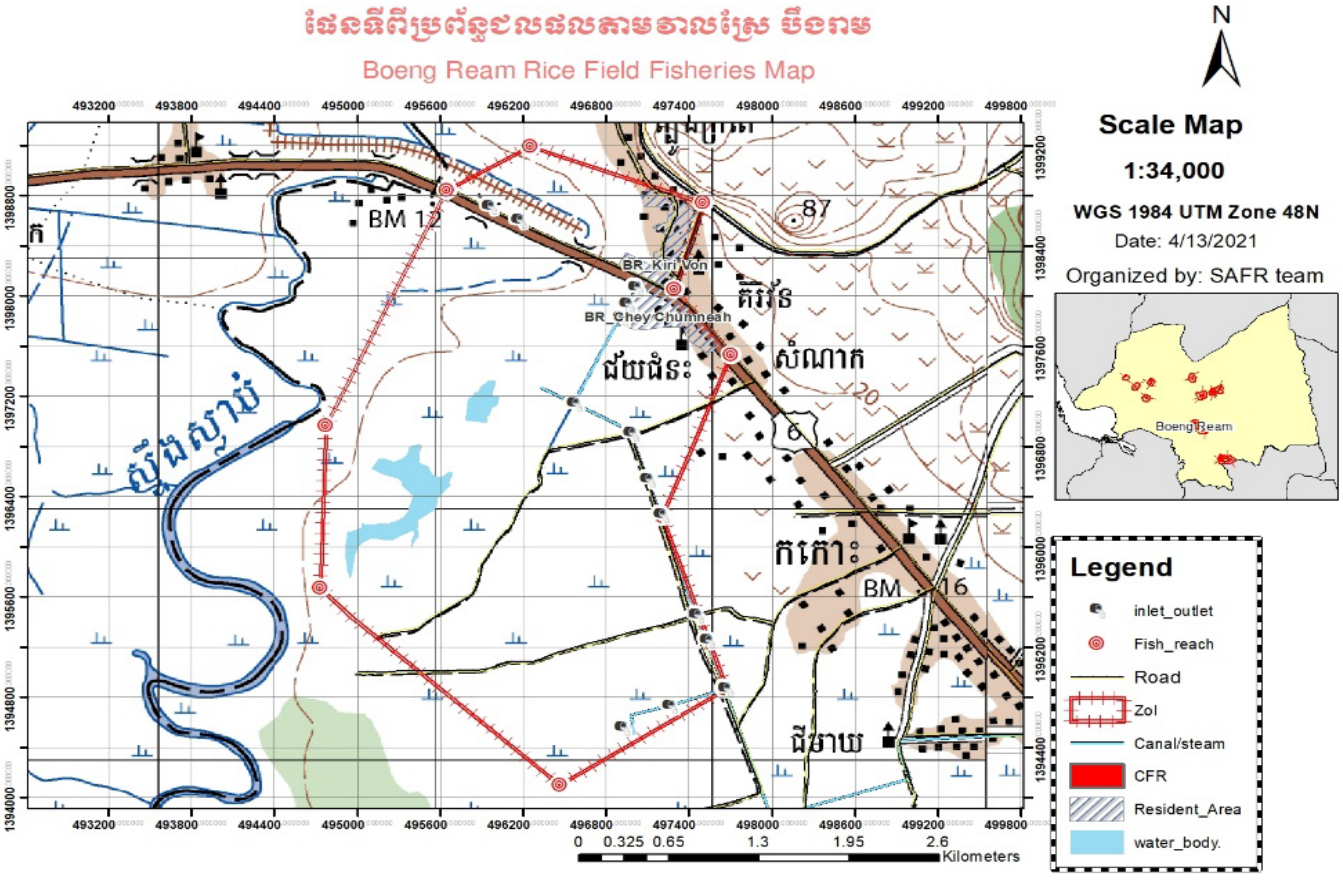
About 995ha of rice fields surround the CFR Beung Ream. Farmers have used water from the irrigation canals and Beung Ream to irrigate rice farming, particularly in the dry season. Farmers having rice fields around the Beung Ream cultivates 2-3 rice crops per year. First, from May to July/August, farmers cultivate rice, based on rainfall; second, from September to November/December, farmers cultivate rice using water from irrigation; third, from January to March, farmers use the water from the irrigation canals to cultivate the rice farming, but usually not enough, and therefore, they pump water from the CFR Beung Ream to supplement their rice farming.

There are about 572 households that do regular fishing, harvesting fish and aquatic animals, usually in the catchment area, which is flooded by the field fisheries system during the rainy season. Among them, 294 households do fishing in the CFR area. They fish for about 5 months a year. However, fish products from the field fisheries system benefit 716 families, about 20 percent of whom are poor farmers. The annual estimated fish catch from the rice field fishery is about 88kg/household/year. In addition, the annual estimated catch of other aquatic animals (OAAs) is about 48kg/household/year.

CFR Committee has collected the membership fees from villagers of about 3000 riel/household/year. About 63 households only paid the membership fees in 2022. The CFR Committee has also raised funds during Buddhist ceremonies such as Khmer New Year and other religious ceremonies. There is a record of financial management by the Cashier.

The CFR Committee and its members have developed the annual plan 2023 to implement the activities to protect the CFR. This plan covers several activities including: (1) Digging the ponds in CFR, (2) Building the guarding post for the patrolling team to keep watching the CFR area; (3) Install the Solar panels in the CFR areas; (4) Digging the canals around the CFR area; (5) putting the signed boards.

Figure 13. Map of the CFR Beung Ream and the Streams and Canals entering into the CFR Area.



5.6.11. CFR Beung Phlang

The CFR Beung Phlang is situated in the center of the Ampil Krau irrigation system, and it is surrounded by ricefields. Fish from CFR Beung Phlang could migrate from the CFR areas to ricefields through these sub-canals and will make the ricefield abundant in fisheries. Next to the private's dug pond is the Community Fish Refuge (CFR). Some areas on the western side of the CFR were excavated to supply soil to the brick industries, and it later was established by three villages in Ampil Krau Commune—(1) Peanea; (2) Kbal Beung, and (3) Svay Teap—to be the CFR to protect the land, fish and biodiversity in the CFRs for communities to use. It is only fishing areas remaining in Ampil Krau for villagers to fish apart from rice farming.

Ampil Krav Commune has 5 villages with a total population of 17,572 people from 2112 HHs. About 85% are doing farming and 20% are fishing. There are 8 brick industries in the commune that could employ 5,000 people from within the commune. About 70% of them are working as laborers in the textile industry. In Ampil Krav Commune, there is surrounded by the Vaiko Irrigation Schemes built by Chinese Firms in 2015—02 main canals and 10-12 sub-canals. However, villagers have not been using much water from the Vaiko Irrigation as there is not enough water and four out of five villages are doing only one rice crop a year, which is a wet season rice. Only one village, which is Svay Teap, is doing 3 rice crops a year. The canal system is getting shallow. At each village, there is a water gate and in each village, there is one person who is in charge of closing and opening up the water gate.

The CFR Beung Khlan covers about 27 ha with about 1,800m in length and 200m in width, and it is about 6 m in depth. The CFR holds water year round with a 6m water level in the wet season and 2m in the dry season. The deepest area covers 12ha, managing as the conservation area. It has been demarcated with poles plotted around the CFR areas. Communities have released fish fingerlings 2-3times in the past, and the fish stocks in the CFR have been rich, which sometimes migrate to ricefield around the CFR (Figure 2).

There is a CFR Committee of nine members, elected from the three villages mentioned above, and it is chaired by Mr. Chheang Mao from Peanea Village. Villagers from these villages are allowed to fish inside the CFR, but not in the conservation areas.

The CFR Beung Phlang is located within the Vaiko-1 irrigation system, which was built in 2015 by a Chinese Company, with a total length of 28km that could irrigation 60,000ha in Prey Veng Province. In this system, there are two main irrigation canals with one pumping station to pump water to supply these two canals. There are several water gates along the main canals to release water from the main canals to sub-canals. There are two vertical sub-canals and four horizontal sub-canals. One vertical and one horizontal sub-canal link the CFR Beung Phlang to the main canals.

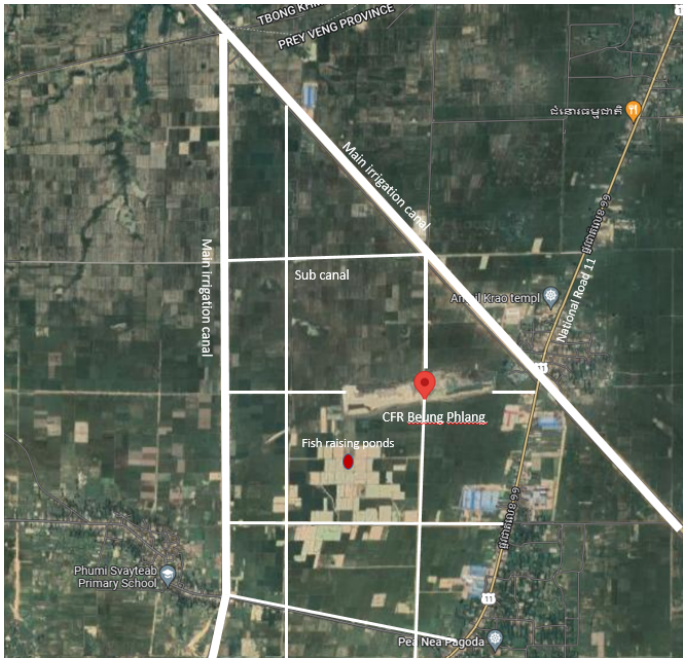
CFR Beung Phlang is established by 3 villages in the commune—Svay Tep, Penea, and Kbal Beung. The Beung Phlang is still rich in the fishery and it is surrounded by ricefield.

The fish catch is estimated at about 25kg/ha. About 10% of villagers are doing fish raising. People consume more fish in their daily foods. Around the Beung Phlang, there are about 20 ponds, which raise fish by the pond owners. Farming is a main source of income. The rice yield is 3 tons/ha—wet season rice, which is done by many households. The dry season rice yield is about 4 tons/ha.

However, the main canals and sub-canals are poorly managed and lack maintenance. Some parts of the main canals are eroded which needs repairs. They are now shallowed and are unable to convey water from the main canals to the sub-canals. Due to poor maintenance, most of the sub-canals do not work and they are disconnected from the main canals and ricefields. As a result, farmers suffer from water shortages. The droughts and floods make further deterioration the system, bringing about a greater disconnection between the irrigation system and ricefields. As a consequence, some farmers give up farming and migrate to cities or overseas for wage employment, as they need quick returns, as cannot rely on farming. Some sold out their farmlands to private individuals, who dig the clay soils to supply the brick industries. About 75% of the population in the commune works in the brick industries, as they earn more income, and some migrate to work in the cities and overseas.

Some 20 private individuals bought land in Ampil Krau commune to excavate the clay soils to supply the brick industries. It later turns out to be a big pond or hole. Some owners release fingerlings into the ponds. Later these areas turn out to be aquaculture ponds. The depth of the pond is about 5-6m depth and the size is about one hectare for the smallest one. To do so, the private owners of the aquaculture ponds start keeping the water in the ponds for the aquaculture and sometimes during the dry season pump water in to keep their aquaculture productive. Thus, water becomes an essential and needed resource for aquaculture.

Figure 14. Irrigation system in Ampil Krau in Sithor Kandal District.



The CFR, ricefields, irrigation canals and sub-canals, and ponds form a closed system, which could produce a lot of food to support the livelihoods of local communities. However, the system is disconnected due to the design, weak coordination, lack of participation of local communities in managing and maintaining it, impacts of climate change on rice farming and water scarcity, and low yields. These have made farmers give up farming activities and move to other wage labor. The influence of the private sector over land speculation made some farmers sell out their farmland to provide for individuals and turned the farmlands into a deep hole, which cannot be used for rice farming. In the long run, it turns out negative without appropriate measures to support farmers.

5.6.12. NREM Communities

Apart from the CFis, CFRs and FWUCs, there are other natural resources management communities established in the studied areas. At least there are five forestry established, three in Kah Koh Commune in Kampong Thom Province and two in Svay Anthor District, Prey Veng Province. Also, three community based natural resource managements were established also in Prey Veng Province, one in Ampil Krav commune, one in Theay Commune and another one in Me Bon Commune. At least there is one community-based ecotourism established by Ministry of Environment in the Beung Sneh areas for tourist to visit the bird sanctuary.

5.6.13. Community-Based Eco-tourism (CBE)

In Boeun Sheh, it is potential for eco-tourism due to the presence of the birds and water ecosystem. Many tourists spent their vacations in Boeung Sneh. The Ministry of Environment works with the local communities to establish eco-tourism to improve the community's economic prospects. Two villages have joined the establishment of eco-tourism in Boeung Sneh—(1) Torp Sdach and (2) Kampong Sleng.

At present, the Community Based Eco-tourism provides services to tourism including boat touring to the bird sanctuary, food and beverage, and sitting platforms for tourists. The cost for a boat per trip is 40,000 riel, and they charge 2,000 riel community boxes for the community budget. The boat tour services are operated by 8 boats. The sitting platform costs around 10,000 riels. Since it was established, on weekdays around 70 to 100 people visited, on the weekend between 300 and 700 people, and during festivals or national holidays between 2,000 and 3,000 people.

5.6.14. Tuolporn Taley Boeung Sne Multiple Use Area

In Boeun Sneh, there is an area with many birds, known as Tuolporn Taley Boeung Sne. There are 50 bird species residing in this area. The presence of these birds prevails due to the abundant fish resources in Boeung Sneh. The bird nests have been over-harvested by collectors, resulting in grave destruction. Without efforts from government agencies, the bird habitats in Boeung Sneh would disappear.

The government has issued a sub-decree establishing the Tuolporn Taley Boeung Sne Multiple Use Area covering 3,557ha in one town and three districts of Prey Veng province. MoE has established the bird sanctuary in Tuolporn Taley Boeung Sneh, covering 86ha. It has employed 03 Rangers from the villages surrounding to protect the birds from illegal poaching.

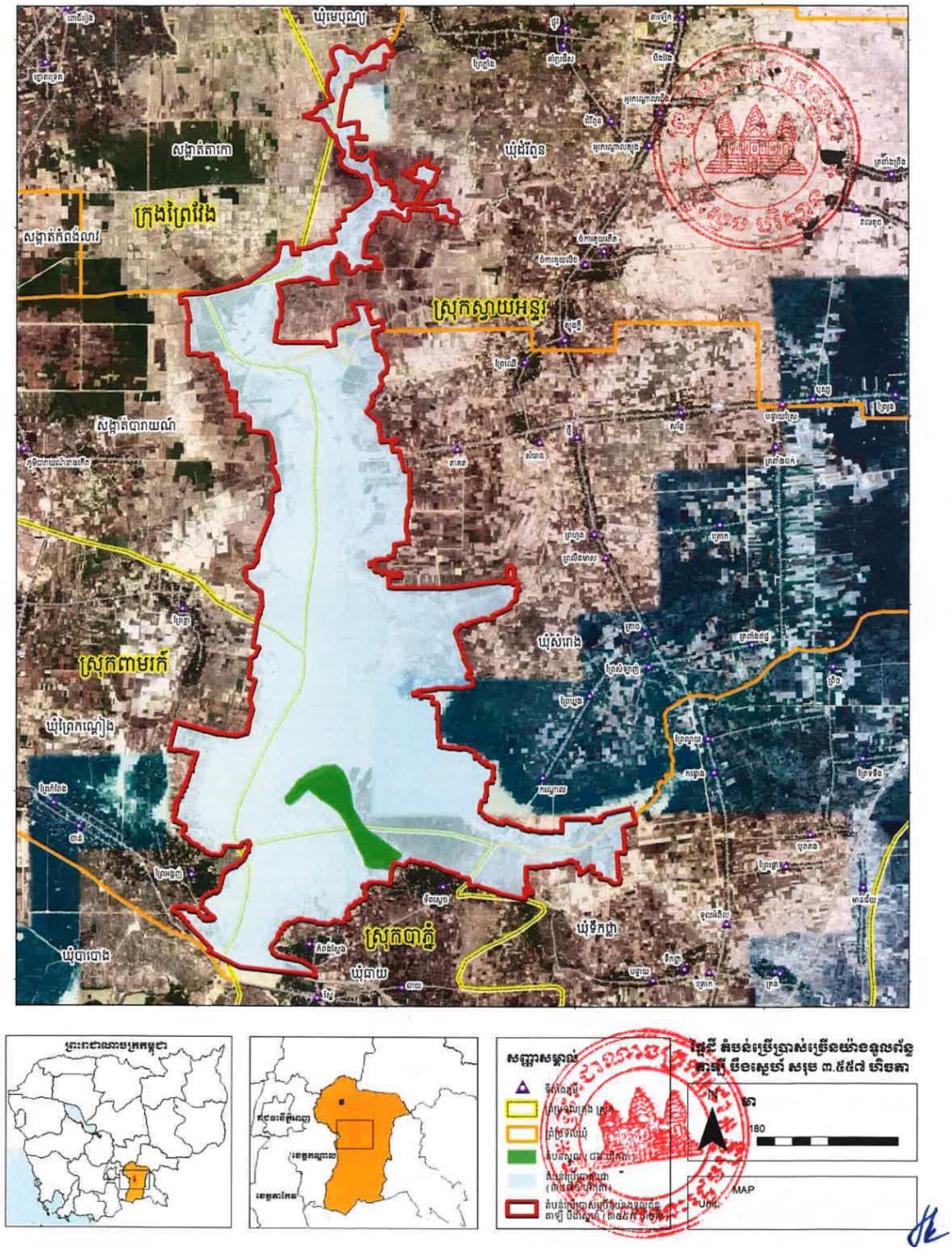
MoE has delegated the roles and responsibilities to the District Office of Agriculture, Natural Resources, and Environment. The District Office has played a key role in monitoring the activities inside the Tuolporn Taley Boeung Sne.

Table 31. The NREM Communities in the studied area.

Row Labels	No. of Forestry Communities	No. of NREM Communities	No. of Tourism communities
Kampong Thom	3	0	0
Kah Koh	3	0	0
Prey Veng	2	3	0
Ampil Krau	0	1	0
Baray	0	0	0
Damrei Puon	1	0	0
Me Bon	1	1	0
Prey Kandieng	0	0	0
Samraong	0	0	0
Ta Kao	0	0	0
Theay	0	1	0
Tuek Thla	0	0	1
Takeo	0	0	0
Ban Kam	0	0	0
Kampong Reab	0	0	0
Pou Rumchak	0	0	0
Prey Lvea	0	0	0
Grand Total	**5**	**3**	**1**

Source: *Commune Database, 2021*

Figure 15. The Biodiversity conservation areas in the Beung Sneh Lake.



6. Discusion

Farming and fishing are sources of foods for Cambodian people. Farming and fishing are subsistent and natural, connecting with river, water and lands. At present, farming and fishing have been growing following the economic growth and irrigation and water infrastructure developments. Farmers have increased the rice growing seasons from one rice crops to three crops per years. These developments have contributed to increase high demands for water for agriculture, the development of irrigation systems, the uses of high yield variety, the increased uses of agricultural inputs such as fertilizer and pesticides and the mechanization of agriculture. The increased rice farming across country has led to increased rice trade.

6.1. Water and Irrigation Development

The high demand of water for agriculture has led to water policy and irrigational development to support the increased rice farming. The Water Sector Strategic Development Plan 2019-2023 of MOWRAM promotes the irrigation rehabilitation and development to increase the irrigated area of rice farming of 30,000 ha annually from existing 1,802,359 ha in 2018 to 2 million ha in 2023 for both wet and dry season rice farming and 500 ha of other crops annually for the farmer to cultivate 2-3 crops a year to increase incomes and crease jobs for rural farmers. The RGC allocates USD471,790,000 from the National Budget to MOWRAM to implement the WSSP 2019-2023. MOWRAM needs additional USD2,671,014,000 from development partners in order for them to fully implement the WSSP 2019-2023. However, DPs have committed only USD2.41 million to finance the implementation of the WSSP 2019-2023. MOWRAM needs to find additional funds of USD256.15 million from other DPs. Nonetheless, the rehabilitated and built irrigation system that to support rice farming are suffered from lack of completeness to reach out the remote rice fields, given its focuses on building merely the primary canals. Many irrigation canals including those irrigation systems in the studied areas remain poorly operational such as the Vaiko Irrigation system and some in the Beung Sneh site. Many farmers remain inaccessible to irrigation canals and rely on water pumping generators to pump water from river and lakes.

Furthermore, MOWRAM has developed the National Irrigation and Water Resources Management Investment Program (NIWRMIP) 2019-2033 to improve irrigation system to get water to irrigate rice fields and improve rice farming. Indeed, since 2000, RGC has heavily invested in rehabilitating the irrigation schemes with a total budget of USD 1.3 billion, 80% of this fund came from the Development Partners (DPs) and 20% from a national budget. These investments cover 467,000 ha of irrigated land—327,000 ha of the wet season rice and 140,000ha of dry season rice. MOWRAM will 15 years to implement the IIPWM (2019-2033) program. The IIPWM will cost USD 2.64 billion. It will rely on loans and grants from DPs. ADB, WB, and European Banks have expressed in providing loans to finance this investment. MOWRAM has approached other DPs to explore funding support for this investment program.

6.2. Rice Export Policy

MAFF has the policy to expand the rice cultivated area to 3.30 million ha in 2023 and increases the rice production to 10.80 million in 2023. The rice yield per ha shall be increased to 3.34 tons/ha in 2023. In addition, RGC issued the Policy Paper on the Promotion of Paddy Production and One Million Tons Rice Export, and subsequently, milled rice export volume gradually increased to approximately 67% for 5 years from 2014 to 2018. The expansion and strengthening of the support services including research and dissemination of modern technology in all sub-sectors based on the potential geographical areas, the distribution of seed, fertilizers, agricultural materials, and the provision of rural credit, have been taken into serious consideration and set as a priority by the government in order to elevate agricultural productivity in the response to the market demand focusing on quantity, quality, safety, and international standard (NSDP, 2019). In addition, the RGC has promulgated the Industry Development Policy (IDP) 2015-2025, of which one of the main goals relevant to agriculture is to promote exports of agriculture processed products to 12% of the total exports in 2025. The study examines the One Million Tons Rice Export Policy and observes that farmers carry out the rice farming not in accordance with this policy as non-farmers we interviewed reported about selling paddy rice to government for exports. Instead, farmers in all studied sites report the sales of paddy rice to Vietnamese rice traders who cross the borders to buy rice from farmer, particularly in Takeo and Prey Veng Provinces, while in Kampong Thom, farmers sold paddy rice to local rice traders who export it to Vietnamese rice traders.

Also, farmers cultivate the Vietnamese rice variety, IR504 and OM5154 instead of local varieties. These rice varieties are cultivated because markets are available and it grows only for 3 months, with quick returns. However, these rice varieties consume more water and agricultural inputs—pesticides and fertilizer, which are environmentally hazard. The study questions the realization of one-million-ton rice export policy by the RGC whether RGC has not achieved its targets. The question was raised also how come farmers choose these rice varieties to cultivate on Cambodian farmlands, but take it to Vietnam—Growing in Cambodia and sale in Vietnam. Some anecdotal reports say these rice varieties were taken to Cambodia by Vietnamese farmers who rent the Cambodia's farmlands along the borders with Vietnam to grow these rice variety, particularly in Takeo and Prey Veng and later were taken up by Cambodian farmers to grow these rice to export to Vietnam too. These are powerful forces that make Cambodia's farmers to adopt this rice farming practice in a short period of time, compared with Cambodia Government who spent many years to introduce many local breeding rice varieties produced by CARDI to local farmers. At the same time, we did observe any intervention from agriculture experts from different levels to support farmers and advise them on practicing these cultivations. On the contrary, farmers tend to go further on their owns to produce more and sell more these varieties. If it goes further unchecked, farmers would give up local varieties which

are prevailed there for long time and farmers have knowledge of it. At the end, farmers would end up depending on these varieties to cultivate on their farmlands.

These varieties come with the packages of fertilizers, pesticides and networks of rice traders. These rice varieties work well with fertilizers and pesticides that produced in Vietnam by the Vietnamese sellers. They come with the knowledge and expertise in pesticides and fertilizers to advise Cambodian farmers how to use it. To make it simple, farmers interact directly with sellers and traders of pesticides and fertilizers, without asking agricultural extension officers in the areas. Farmers start depending on fertilizers and pesticides to be used with these rice varieties and expertise of pesticide and fertilizer sellers. However, farmers are not aware about the impacts of the uses of these agricultural inputs. Without the supports from local agricultural officers and the interventions of from relevant local government institutions, these will go unchecked and make tremendous impacts on agriculture sector in the long runs.

6.3. Mechanization of Agriculture

The RGC has recognized the importance of agriculture in economic development but has acknowledged that Cambodia's agricultural farming systems are subsistent/ family-based for household consumption and they have been adversely affected by natural disasters resulting from climate change. This is due to the fact that these small-scale farming are relying on rainwater and inefficient irrigation system, which leads to fluctuation of annual agricultural production. Rice is the main agricultural crop. The RGC has developed Five-Year Strategic Plan 2019-2023 for Agriculture Sector to accelerate economic growth and alleviate poverty. The strategic goal of the Royal Government is to strengthen the role of agriculture sector in generating jobs, ensuring food security, reducing poverty, and developing rural areas. One way of developing agriculture is to promoted mechanization of agriculture to produce for exports. The strategic plan on agricultural mechanization was developed by the Department of Agricultural Engineering in 2011. This strategic plan aims at enabling access to mechanization, skill development, strengthening of commodity chains, and improving policy, legal and regulatory environment. Indeed, agriculture sector account for around 41.5% of total employment. Cambodia produces more food than domestic demand and has also produced and exported many kinds of agricultural products, particularly Cambodia exported more than 600 thousand tons of rice in 2017 and Cambodian rice has also gained great reputation on international arena (Rectangular Strategies, 2018). The RGC has a policy to promote the production of all crops with around 5% growth per year and to increase the export of agricultural products by 7% per year through agricultural modernization, increased productivity, diversification of crops with high potential and strong competition in markets (Rectangular Strategy, 2019).

In the studied areas, agricultural mechanization is more or less farmers hire hand tractors and tractors to plow their rice fields, harvesting their paddy rice and threshing their harvest instead of using draft animals. About 95% of agricultural households in the studied areas have used machines to support agricultural activities. These happen since 2009, because of lack of labors given the high rates of migration, among young people aged above 18 years old, accounting for 24% across the studies areas and only old people remain in the villages, looking after children at homes. However, agricultural household owns a farmland of an average 1.38ha, which is not suitable for household to use agricultural machines to plow, and harvest and thresh their rice paddy. These have increased the cost of rice production. Since many young males migrate to find works in cities and overseas, the handling of agriculture machines remain in the hands of women and old people. Any failure in rice farming for season would double their cost—one cost for hiring the machines and another cost for losing the yields. In anyhow, these turn into the risk taking in rice farming business.

The increased uses of machines and tractors have made many farmers gave up the livestock raising activities. The culture of animal raising become less significant in the communities, particularly among young people as they are exposed to wage labors and city life, and so, they do not want to continue practicing the animal raising. Also, the culture of relying on cow dungs to fertilizing their ricelands have no longer practiced in their villages. Villagers turn to relying inputs from the markets for foods and agriculture.

6.4. Fishery and Rice Farming

Fish is also food for rural population, which they could catch naturally or raise it, and thus, it is important to manage fishery sustainably. To improve fisheries resource management to be more effective and sustainable, FiA aims at maintaining a natural fish catch of around 600,000 tons per year, increasing from 898,700 tons in 2019 to 1,219,400 tons in 2023, and increasing aquaculture yields by 20% per year from 97,800 tons in 2019 to 171,170 tons in 2023 (NSDP, 2019). To achieve this, the RGC will continue to implement its priority activities as follows: (i) strengthening sustainable fisheries resource management and community fishery (CFi) development in line with the Strategic Planning Framework for Fisheries 2015-2024 and the statements on national policy for fisheries; and (ii) increasing aquaculture to increase the supply to fish farms, including techniques, fish varieties, credit, markets and the implementation and enforcement of laws through the continued use of existing mechanisms which is the priority in fisheries protection. In the study areas, CFis and CFRs have been organized and strengthened to manage fisheries involving local communities and government agencies.

CFis and CFRs have faced challenges in terms of maintaining the water in the CFi and CFR areas to protect fish and its conservation. Given the increased rice farming, particularly in the dry seasons, farmers have encroached the CFis and CFRs to extract water to irrigate their rice fields, regardless the effects on fisheries and environments in the lakes and rivers. Thus, CFis and CFRs have conflicted with rice farmers in the same villages or communities. The pumping of water from CFi or CFR areas are common, affecting fish habitats, shallowing the CFis which could lead to more fishing activities, killing biodiversity

and also encroaching the wetlands when they are drying the lakes or rivers. The situations are getting worse when CFis and CFRs are weak, lack of supports, lack of participation of local community members. Many CFis and CFRs do not have financial and technical supports and so, they are dysfunctional, and more anarchies occurred inside the CFis and CFRs.

In addition, irrigation system in the studied areas take water from the CFis and CFRs. In many cases, irrigation systems cut across the aquatic floodplains and rice fields, block the river channels, streams, lakes and ponds and change the land and waterscapes. It also turns the fishery domains into the irrigated lands and ricefields, which are managed by MOWRAM/PDWORAM, in which their responsibilities are on irrigated water, not fishery and so, fish is not counted in the management of irrigation system. Also, coordination between MOWRAM, MAFF and FiA is somehow weak and unpredicted with no improvement so far. Even District Office of Water Resources and Meteorology is integrated with Agriculture and Environment; they still receive commands from PDOWRAM or MOWRAM.

The irrigation system aims at boosting rice farming. Given the cultivation of Vietnamese rice varieties, farmers use lots of pesticides and fertilizers. These have harmful effects on fish and aquatic animals. These practices continue to increase in the future and no action has been taken to address it. Fish production has been reduced in the fishery domains and rice fields. It needs immediate actions from the government agencies responsible for fishery and rice farming management. There is a need of immediate study of the impacts of pesticides and fertilizers on aquatic animals in the rice fields and water bodies.

6.5. Climate Change

Climate change has occurred in Cambodia in the forms of floods and drought. Cambodia is ranked as one of the most climate-vulnerable countries in the world, ranked 13th out of 181 countries (German Watch, 2016; [6] Yusuf, and Francisco, 2009).[7] These will put pressure on water supply and water for rice farming, especially in the dry season and increase demand for the management of flooded water in the wet season. Floods accounted for 70% of rice production losses between 1998 and 2002, while droughts accounted for 20% of losses, induced significant food security (RGC, 2006). In fishery, climate change has contributed to the reduction of reverse water flow the Mekong flow to Tonle Sap Lake by half, from 43km3 to 18.89 km,3 between 2019 and 2021, reducing inland fish production in Cambodia has from 535,005 tons in 2018 to 413,200 tons in 2020; and in Tonle Sap Lake by half from 291,260 tons in 2018 to 144635 tons in 2020, lower than the annual average fish in Tonle Sap Lake of 250,000 tons (EU Report, 2021). As a consequence, it is predicted that climate change in Cambodia could reduce Cambodia's GDP by 2.5 percent by 2030 and by almost 10 percent by 2050 (Department of Climate Change, 2018).[8] Cambodia lost $1.5 billion – 10 percent of its gross domestic product (GDP) – in 2015 from the negative effect of climate change (Vannak, 2016)[9]. Also, it is predicted by 2050 the climate change would put 61% of Cambodia's rural GDP per capita at risk. It is projected that the 2050 climate projections would affect around 7 million Cambodians employed in the agricultural sector and about 240,000 people in construction, causing a total economic impact of $1.5 billion (Talberth and Reytar, 2014; Department of Climate Change, 2018).[10]

The reduction in water from the Mekong River has affected the flows of natural waters from the Mekong River into the floodplain areas in the lower Mekong River Basin in Cambodia, especially the Cambodian Mekong Delta. The irrigation canals have been built in the studied areas such as Vaiko Irrigation Schemes, the Ta Soung irrigation and other schemes to take water from the Mekong River and its tributaries to get water to irrigate rice farming, particularly the dry season rice farming. On the one hand, these have disconnected these areas, lakes and rivers from the Mekong River and changed the lands and waterscapes. It has also affected fishery domains, fish habitats and fish migration. Fishery has not been integrated in the irrigation management, resulting decline in fish production.

Given the increased rice farming season from one time to three times per year, the demands of water for rice farming have been increased. Climate change has implicated the demands for water during the drought events, leading to a high competition for water among farmers and sometimes water conflicts between the upstream and the downstream farming communities. The Beung Sneh Lake is a source of livelihoods to villagers in 44 villages. The drought events in 2022-23 have led to more water pumped out of the lake, to save the dry season rice farming, making the lake lowest water level, reaching the emergency alarms in its history. As a consequence, some offenders encroach the lake areas to occupy the lands for farming and fill them up for rice cultivation.

[6] German Watch 2016. https://germanwatch.org/sites/germanwatch.org/files/publication/13503.pdf Accessed 20 July 2017.
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[9] Chean Vannak, 2016, "10% of GDP lost to climate change", *Khmer Times*, 4 July 2016
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7. Conclusion

River, lake, floodplains and farmland produce foods to sustain livelihoods of communities for many generations. Given the increased population and development needs, these food production land-waterscapes have been so-called developed and transformed into specialized and controlled landscapes, claiming at increasing the management and improved productivities. These have induced the disconnection between rivers, floodplains, lakes and farmlands. Policy and institutional frameworks have been attached to these land-waterscapes. Irrigation systems have been built, cutting across the rivers, floodplains and landscapes and claiming to provide water to irrigate and improve rice farming across countries. Fishery domain has been managed into CFis and CFRs, claiming to protect and conserve fish for foods for rural population who live dependent on these resources for generations. However, fishery resources have affected by the irrigation development and rice farming, leading to decline in fish production.

Rice farming has been increased to three rice crops per years. RGC claims this increased rice production contributes to the rice export policy of one million tons per year. However, the increased rice production among farmers do not necessarily contribute to the rice export of policy of Cambodia, but to rice export of Vietnam, as Cambodian farmers cultivate Vietnamese rice varieties introduced, serving Vietnamese rice export. However, Cambodia farmers are suffering from price fluctuation and price setting by the Vietnamese rice traders. Due to the increased global demands for rice in 2023, due to the failure of the grain deal in the Black Seas between Russia and Ukrain and the reduction of rice export by 40% from India to global market, the Vietnamese rice exports to global markets have increased in quantity and price to around USD800/ton, higher than the previous price of around USD550/tons. As a result, the rice price in Cambodia has increased from 800 Riel to around 1200-1300 Riels, making more farmers to grow more rice, resulting in more water is used, leading to water shortage and conflict.

The increased rice production should have helped reduce migration and indebtedness so that more labors from local villages are involved local rice production and more incomes generated. Nonetheless, more young people migrated to cities and overseas for wage labors, constituting 25% of young people aged above 18 years. As a consequence, there are labor shortages for rice farming, leading more farmers hire machinery to farm and harvest their rice fields, mostly by old peoples while young people earn wage labors to pay the farming costs and debts. To do so, farmers keep borrowing from formal and informal money lenders, including MFIs to cover the high cost of rice production, accounting for 50-70% of agricultural households.

The increased migration and indebtedness in farming communities have not gone down at present. If they are unchecked, it will go up and these would lead to young people giving farming and ending up working in the wage labor sectors. In doing so, they would end up selling their farmlands to private companies and individual, particularly to get cash to pay the debts and if they need to do rice farm, they may end up hiring farmlands from private companies or private individuals to do rice farming. These have happened in studied areas, particularly in Kampong Thom, Prey Veng and Takeo Provinces. More studies would be needed to understand these dimensions and to explore the possibility to curve these changes.

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Citation

This publication should be cited as: Sithirith M, Sao S, Silva SD, Kong H, Kongkroy C, Thavrin T and Sarun H. 2024. Governance of the Food System in the Mekong Delta, Cambodia: Rice, Fish, Water and NRM. Penang, Malaysia: WorldFish. Technical Report.

Acknowledgments

Funding support for this study was provided through CGIAR Initiative on Asian Mega-Deltas. This work was carried out with support from the CGIAR Asian Mega-Deltas (AMD) and Aquatic Foods (RAqFs) Initiatives. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund: *www.cgiar.org/funders*.

Design and production

Chua Seong Lee, Thavamaler Ramanathan and Sabrina Chong, WorldFish.

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