

Barriers to Nutritious Food Production and Consumption:

Insights from Two Case Studies



Ang Raksmei, Ananya Cumming-Bruce, Chhaing Marong,
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List of abbreviations

ADB	Asian Development Bank
CARD	Council for Agricultural and Rural Development
CASIC	Conservation Agriculture and Sustainable Intensification Consortium
CDRI	Cambodia Development Resource Institute
CFR	Community Fish Refuge
FAO	Food and Agriculture Organisation of the United Nations
FGD	Focus Group Discussion
FWUC	Farmer Water User Community
FSN	Food Security and Nutrition
GIZ	German International Cooperation
ID-Poor	Identification of Poor
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
KII	Key Informant Interview
MAFF	Ministry of Agriculture, Forestry and Fisheries
NGO	Non-Governmental Organisation
NSFSN	National Strategy for Food and Nutrition Security
TWG-SP&FSN	Technical Working Group for Social Protection, Food Security and Nutrition
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization

Executive summary

Cambodia has made notable paces in reducing poverty and advancing human development. However, a significant portion of the population remains susceptible to poverty, food insecurity, malnutrition, and various shocks. The coronavirus disease 2019 pandemic, coupled with the global food and fuel crisis and recent climate-related events, has exacerbated the already fragile conditions for many, especially marginalised communities.

The Tonle Sap Lake and Cambodia's Mekong Delta are crucial for sustaining a rich diversity of fish species, rice cultivation, and local livelihoods, while also preserving biodiversity. However, these vital ecosystems face significant threats from human activities, such as agricultural expansion and water infrastructure developments, as well as the impacts of climate change. The region's rapid economic growth is exerting immense pressure on its resources, leading to a strain on the socio-ecological balance. In Cambodia, the challenge of achieving food and nutrition security is becoming increasingly complex: despite a diverse diet, malnutrition is prevalent due to widespread food insecurity and a lack of nutritional knowledge. Rice and fish are the primary dietary staples.

The Second National Strategy for Food Security and Nutrition (NSFSN) 2019-2023 forms the basis of the Cambodian government's current approach to tackling this issue, with an objective of ensuring equitable access to nutritious foods while strengthening community and governance mechanisms to address immediate and long-term nutritional needs and challenges. It is a comprehensive and ambitious strategy, and a high-priority issue for the government, however this study finds that this does not translate to similar levels of attention at the local scale, and that a major obstacle to its success is the lack of effective coordination between institutions, both horizontally and vertically.

This study explored intricate dynamics of food production and consumption in the Tonle Sap Lake floodplain and Cambodia's Mekong Delta areas, focusing on barriers to nutrition awareness, food production and consumption patterns and their drivers. Employing a qualitative methodology, the study gathered data through focus group discussions (FGD) and key informant interviews (KII). The discussions and interviews involved a diverse range of individuals residing in two distinct locations: Boeung Ream Community Fish Refuge in Kampong Thom province and Ta Soung Irrigation Scheme in Takeo province. The findings of the study are multifaceted, revealing that food consumption patterns are not merely a matter of personal choice but instead are influenced by a complex interplay of factors including food preferences, the availability and affordability of food, access to reliable information on nutrition, institutional capacities to deliver nutrition responsive planning, gender roles, and socio-economic status. A notable finding of the study is the identified gaps in nutrition knowledge and awareness among the respondents. This lack of information is further compounded by challenges in food production, which are attributed to agroecological changes, inadequate extension services, and issues related to water resource management. Despite the government's commitment to tackling food and nutrition insecurity at the national level, this study reveals a fragmented and uncoordinated approach at local and provincial levels.

In light of these findings, the study puts forth several recommendations. These include interventions aimed at improving access to nutrition information, addressing the constraints to food production, and providing support to households. The study underscores the importance of a holistic approach that integrates nutrition education into broader development planning. This approach, it argues, is crucial for building resilience, improving food security, and enhancing the well-being of the Cambodian population in the long term. It emphasises the need for a

multi-sectoral approach, involving stakeholders from various sectors, to address the complex challenges of food security and nutrition in Cambodia. This is vital for ensuring sustainable development and enhancing the overall quality of life of the population.

The policy recommendations include:

- Promoting community engagement in designing and managing nutrition and information services, and strengthening the Commune Development Plan and the three-year rolling Commune Investment Plan for food security and nutrition.
- Expanding social assistance programs to reduce barriers to health services and nutritious food, especially for vulnerable groups like women and children, to enhance nutritious food intake.
- Raising public awareness about affordable nutritious foods and promoting healthier dietary habits. Recognising and supporting women's role in household nutrition and including men in nutrition education to balance domestic responsibilities.
- Building climate resilience in food production and distribution systems to mitigate the impacts of climate change and natural disasters, ensuring stable food production and consumption.

1. Introduction

Over the two decades before the coronavirus disease 2019 pandemic, Cambodia's economy grew rapidly, leading to its anticipated graduation from least-developed country status by 2027 (United Nations, Department of Economic and Social Affairs 2021). Cambodia aims to achieve upper-middle-income status by 2030 and high-income status by 2050 (RGC 2023). However, 15 percent of the population remains near-poor and vulnerable to economic shocks (Karamba et al. 2022). The pandemic, along with global crises and climate shocks, worsened conditions for many, especially marginalised groups (WFP 2023). Despite government efforts, including cash transfers to 17 percent of the population, the economy shrank by 3 percent in 2020, and the poverty rate increased by 2.8 percentage points for the first time (Karamba et al. 2022).

Concurrently, Cambodia's vulnerability to disasters and climate change threatens agricultural productivity, livelihoods, food security, and nutrition, worsening household poverty (Smith 2023). The country ranks 14 of the 180 countries on the Climate Risk Index for 2000–2019 (Eckstein, David, and Laura 2021). Rising heat stress and hydro-meteorological hazards, such as floods and droughts, occasionally lead to extreme events with loss of life and livelihoods. This vulnerability is compounded by demographic trends, socioeconomic characteristics, and limited adaptive capacity.

Agriculture's contribution to the gross domestic product fell to 22 percent in 2020, yet 57 percent of households remain engaged in agricultural activities. Out of nearly 3 million smallholder farmers, about one-third have less than 1 hectare of land. Due to limited market awareness, they mainly grow rice using traditional methods. This results in yields and quality being vulnerable to climate shocks, with limited internal control systems (NIS 2022; WFP 2023). Food systems can greatly improve resilience, reduce poverty, strengthen livelihoods, and ensure access to healthy diets. However, challenges like poor water management and limited access to inputs, credit, and knowledge persist at the farm level. Additionally, post-harvest challenges like low food processing capacity and poor food safety standards are common. High supply chain costs make nutritious food options less affordable (WFP 2023).

To enhance food security and nutrition, the Cambodian government implemented robust nutrition policies under the National Strategy for Food Security and Nutrition (NSFSN) 2014-2018 and the Second National Strategy for Food Security and Nutrition 2019-2023. This policy aims to eradicate all forms of malnutrition (i.e., undernutrition includes wasting, stunting, underweight and micronutrient deficiencies; and overnutrition) and to achieve the 2030 Sustainable Development Goal of “Ensuring no one is left deprived of food or suffering from malnutrition”. Specifically, it aligns with Goal 2, which aims to “End hunger, achieve food security, improve nutrition, and promote sustainable agriculture”. The nutrition strategy aims to strengthen the food environment (i.e., the places and ways in which food is sold to and accessed by people) and consumer behaviours to enable healthier food choices and promote diversified, nutritious, and sustainable food production. Additionally, according to USAID (2018), the policy includes food-based dietary guidelines, laws on mandatory salt iodisation, and measures to reduce salt/sodium consumption and diabetes. Besides, there are complementary instruments such as the National Fast Track Road Map for Improving Nutrition (2014-2020) and the Policy and Strategic Framework on Childhood Development and Protection in the Agriculture Sector (2016-2020). Cambodia's food systems roadmap for sustainable development outlines a vision to break the intergenerational cycle of malnutrition, enhance local production and trade opportunities, and build systems that are more resilient to climate change and other shocks (RGC 2021). Beyond these national policies, Cambodia has

also become part of a global movement that brings together national leaders, civil society, bilateral and multilateral organisations, donors, businesses, and researchers in a collective endeavour to enhance nutrition (USAID 2018).

Despite government efforts, malnutrition remains a pressing concern, with limited progress made in addressing it. The prevalence of vulnerability to food insecurity rose by 5 percentage points between 2019 and 2021, reaching 27.5 percent—its first increase in decades. Vulnerability is lowest in Phnom Penh (16.7 percent) and other urban areas (20.4 percent), but highest in rural regions (32.8 percent). In flood-prone areas like Tonle Sap, it reaches as high as 35.5 percent and is nearly 32 percent in the Plateau region (WFP 2023). The demand for and consumption of healthy, nutritious diets remain sub-optimal, with a particularly low intake of fruits and vegetables. Rice, which is low in micronutrients and not fortified, accounts for up to 65 percent of daily energy intake, leading to a lack of dietary diversity (NIS 2020). In particular, food-related consumer behaviours and decisions are multifaceted and may not always align with choices that prioritise nutrition and health. These decisions are shaped by a broad spectrum of factors including dietary habits, societal norms, market trends, and the availability of information; they may fluctuate with the seasons and are constrained by the level of awareness regarding nutritious food consumption. Only 51 percent of young children consume a minimally acceptable diet in terms of diversity (NIS 2023), and the proportion among women and girls of reproductive age has recently dropped to 23 percent. Additionally, the consumption of unhealthy foods and beverages is on the rise (WFP 2023).

Women face significant risks of being left behind due to gendered stereotypes, the normalisation of male superiority, and limited economic opportunities, particularly in rural areas. Within households, women experience unequal power dynamics, with husbands contributing only about one-tenth of domestic and care work. Additionally, women are more likely to marry early in life. These factors hinder their ability to contribute equally to society outside the home. Alarming, one in five Cambodian women report experiencing gender-based violence in their lifetimes (United Nations Cambodia 2021).

Given these contexts, it is crucial to understand how various socio-economic groups produce and consume food, particularly during crises, and the challenges they encounter in ensuring a sufficient and nutritious food supply. Recognising the socio-economic and gender dynamics involved is essential to enhance the effectiveness of interventions aimed at promoting healthier food production and consumption.

Having understood the above issues, this study delved into unexplored aspects of food production and consumption patterns among different socioeconomic groups. Its main objective is to understand dietary habits, food production practices and barriers to insufficient food production and nutritional intake and the role of especially local formal and informal governance structures in delivering national policies on nutrition at the grass roots level. Although research has previously been conducted on issues of food security and nutrition among different socioeconomic groups in Cambodia, this study is unique in its focus. It is the first to explore the links between formal and informal institutions and households' ability to access nutritious foods and nutrition information, while also considering the influences of class and gender. It aims to answer the following research questions.

1. What are the formal and informal barriers to the production and consumption of nutritious food?
2. How do these barriers challenge nutritious food intake among different socio-economic groups?

By analysing these barriers, we aim to identify the specific difficulties that hinder access to and availability of healthy food options. Furthermore, the study delves into the dietary habits and food production practices prevalent among the communities, providing an examination of how cultural norms, societal expectations, economic conditions, and environmental factors shape these practices. This approach allows us to understand the challenges and behaviours influencing nutritional outcomes, ultimately contributing to the development of targeted strategies to enhance food security and nutrition in Cambodia.

2. Literature review

2.1. Understanding food security and nutrition

Food security, as defined in the State of Food Insecurity report, refers to as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 2001). This definition was further refined at the World Summit on Food Security in 2009, identifying four key pillars that must be fulfilled simultaneously in order for food security objectives to be achieved (availability, access, utilisation and stability) and underscoring the importance of “the nutritional dimension” within the concept of food security (FAO 2009).

Cambodia’s economy has experienced profound change and substantial growth in recent decades, with the poverty rate decreasing from 47.8 percent in 2007 to 17.8 percent in 2019–20 (WFP 2023). The country’s food security situation has reflected this: undernourishment figures dropped from 38 percent in 1992 to 25 percent in 2006, household consumption increased by nearly 40 percent between 2004 and 2011 and crop and food production quadrupled between 1990 and 2013 (Ecker and Diao 2011; Theng 2014; World Bank 2014). In 2017, the agricultural sector employed 37 of the Cambodian population and, in 2019, accounted for over one-fifth of the country’s gross domestic product; rice production dominates, contributing around half of its economic output (Alvar-Beltrán et al. 2022; Sok et al. 2021). Cambodia has achieved food security in terms of availability, producing quantities of rice that exceed domestic demand and is currently on track to becoming a major rice exporter (MAFF 2015; Thath 2014). Despite this, difficulties in accessing food, low dietary diversity, undernourishment and malnutrition remain widespread in Cambodia and are particularly pronounced in rural areas, where the majority of the country’s poor live. Approximately 14.2 percent of the population (or 2.3 million people) are severely food insecure, with 44 percent of women suffering from anemia and 32 percent of children under the age of 5 being stunted (FAO 2014; McDonald et al 2015; USAID 2021; WFP 2023).

Tackling food and nutrition security issues remains a top priority for the Cambodian government. Notably, it has established the Technical Working Group for Social Protection, Food Security and Nutrition (TWG-SP&FSN), chaired by the Council for Agriculture and Rural Development (CARD), serving as a mechanism to better coordinate and harmonise efforts among government ministries, NGOs, bilateral and multilateral donors and UN agencies to identify and address food and nutrition security issues. The National Strategy for Food Security and Nutrition (NSFSN) 2014–2018 and the Second National Strategy for Food Security and Nutrition 2019–2023 were developed by the CARD in collaboration with TWG-SP&FSN (CARD 2014; CARD 2019). The Second NSFSN is part of a broader effort to achieve the 2030 Cambodia Sustainable Development Goal (CSGD) of “Ensuring no one is left deprived of food or suffering from malnutrition”, more specifically, CSDG2 “End hunger,

achieve food security, improve nutrition and promote sustainable agriculture”. A number of other initiatives have been developed alongside these policies, such as the National Fast Track Road Map for Improving Nutrition (2014-2020) and the Policy and Strategic Framework on Childhood Development and Protection in the Agriculture Sector (2016-2020).

2.2. Socio-economic factors affecting food security and nutrition

The link between poverty and food security has been well established in the literature. The two are highly interrelated and feed into each other to form a vicious cycle (or “double burden”) whereby financial constraints prevent people’s access to safe, sufficient and nutritious food, limiting their physical and mental capacities to perform daily tasks and therefore their economic potential, consequently increasing their vulnerability to poverty (Ahmed, Ibrahim and Al-fel 2014; Siddiqui et al. 2020; Vorster 2010). On one hand, people with limited access to financial resources often find themselves unable to access safe, sufficient and nutritious food, instead compromising on the diversity and quality of food intake in favour of cheaper, less nutritionally dense products (Peña and Bacallao 2002). Poverty and low socioeconomic status are also associated with difficulties in accessing quality education, healthcare and infrastructure, while ownership of land, access to credit and employment are strongly correlated with higher income levels and therefore greater food security (Khudri and Chowdhury 2013; Mupaso et al. 2024; USAID 2011).

As mentioned previously, poverty rates in Cambodia have declined significantly, however income inequality is on the rise due to varying rates of economic growth in across different regions, with rural areas in particular failing to achieve as much progress (Ecker and Diao 2011; Hansen and Gjonbalaj 2019). Chhoun et al. (2016) found that disparities in employment status, particularly in relation to gender, increases the likelihood of income inequality, and therefore indirectly influences people’s nutritional status. Chen’s (2022) study on food consumption, household income and child nutrition in a district in Kampong Speu province highlights the fact that despite having knowledge about how to improve child nutrition, their capacity to do so was limited due to households facing financial hardships. The poor are also vulnerable to health shocks, exacerbated by involvement in physically high-risk jobs and inadequate access to clean water and healthcare services, increasing the risk of malnutrition (ADB 2011; Poirot et al. 2020).

Informal markets are a popular option for people to buy food, as items are typically less expensive than formal, regulated markets. However, water, sanitation and hygiene (WASH) practices and regulations tend to be weaker in informal markets, leading to high rates of foodborne pathogen contamination of vegetable and meat products (Schwan et al. 2021; Wiwanitkit and Kaewla 2015). The bacterial and viral infections caused by these pathogens as well as parasitic infections, such as diarrhea, weaken people’s immune systems while reducing their ability to absorb essential nutrients, therefore undermining the potentially high nutrition levels in certain foods (Vilain et al. 2016; Wallace et al. 2014). Indeed, Laillou et al. (2020) found that poor WASH indicators combined with a low child feeding score were equally predictive for 30 to 40 percent of stunting and wasting prevalence in Cambodia.

Dietary habits also undeniably affect nutrient intake. The malnutrition rate in Cambodia is among the highest in the ASEAN region, with children and childbearing women being particularly affected (World Bank 2019). This is mainly due to the fact that, across Cambodia, diets tend to lack variety and nutritional diversity. Rice and fish are the main staple foods, making up 60 percent of total energy intake and 37 percent of total protein intake respectively, with a noted lack of adequate vegetable and fruit intake which has been identified as an issue

of poverty rather than a lack of availability of these foods (Vilain 2016; Wallace et al. 2014). Formative research has shown that most Cambodians consider rice nutritious enough to prevent illness in children and support their development despite it being low in micronutrient content, suggesting gaps in nutrition-related knowledge (UNICEF, Helen Keller International and National Nutrition Program 2016 cited in Som et al. 2018). Additionally, rice contains substances that inhibit the absorption of zinc and iron, further undermining the micronutrient content of Cambodians' diet. Vilain et al. (2016) point out that the consumption of food items tends to be prioritised in relation to their cost, with a significant proportion of household income going towards securing rice.

Reinbott et al. (2016) found that a nutrition education programme delivered to rural Cambodians by government and village health volunteers led to significantly improved dietary quality and diversity in their children. The available literature suggests that the lack of an inter-sectoral, community-based approach to nutritional programming is a contributing factor. A survey conducted among women of reproductive age with young children in Kampot and Kampong Thom provinces found that nutrition and hygiene counselling was very limited, with nearly half of the surveyed villages lacking a nutrition counselling structure (Ok and Weingärtner 2016). Moreover, nearly half of the respondents across both provinces reported they would ask their mothers for feeding and nutrition-related advice, with over a third consulting friends or neighbours. Wallace et al.'s (2014) study also highlights the need for more comprehensive nutrition education campaigns, pointing out that nutritional programming in Cambodia is not well-integrated with the agriculture and public health sectors and lacks sufficiently community-focused initiatives, exacerbating the populations' overall poor nutritional status.

In the same vein, the prevalence of certain cultural beliefs and practices has also been identified as factors affecting Cambodians' nutritional intakes. Studies conducted in Lao PDR found that pregnant and post-partum women were disproportionately nutrient-deficient compared to the general population due to traditional local beliefs surrounding eating habits during pregnancy and lactation, which include avoiding or restricting the intake of certain foods such as fruit, raw vegetables, spicy foods and pork (Barennes et al. 2009; Ratsavong et al. 2020). Similarly, in Cambodia, it is common for childbearing women to avoid certain foods, such as fish paste and "hot" foods which are believed to affect the long-term health of both mother and child, often losing important nutrients in the process which in turn affects the growth and development of fetuses (Galvin et al. 2008; Vilain et al. 2016). Limiting food intake, so as to ensure easier deliveries by having smaller fetuses or to save money for childbirth expenses, is another contributing factor to maternal malnutrition (Som et al. 2018). Some traditional methods of food processing such as sun-drying, fermentation and oven-drying also significantly reduce the micronutrient content of the few nutrient-rich foods consumed by Cambodians (Vilain et al. 2016).

2.3. Food security and nutrition and gender equality

Despite playing a central role in processes of food production, preparation and distribution, women (particularly rural women) are disproportionately more likely to be food insecure, especially in low and middle-income countries (FAO 2022) - it is estimated that women account for over 40 percent of the agricultural workforce in developing countries (FAO 2012). Gender-based discrimination rooted in deeply entrenched socio-cultural norms and structures has meant that women often shoulder responsibility for food production and ensuring household food security while the extent of their contributions tends to be overlooked (Maffii 2015).

As mentioned previously, food insecurity and malnutrition frequently stem from poverty, which has also been found to amplify gender inequalities (Visser and Wangu 2021; Clement et al. 2019). Rural women feel the effects of poverty particularly acutely, as they are more likely to be underemployed or be engaged in unpaid work, especially domestic and caregiving work, while also allocating a larger proportion of their earnings towards household food supplies than their male counterparts (Kotzé 2003; Sinclair et al. 2019). Furthermore, lower educational attainment among women contributes significantly to gender disparities in income and food insecurity and increases the risk of inadequate nutritional intake (Broussard 2019; Ekbrand and Halleröd 2018; Miller and Rodgers 2009). This includes what Suri and Ashok (2022) refer to as ‘nutrition literacy’, which they explain is crucial to ensuring greater food security within households. Limited access to land and resources, capital and credit further exacerbates their vulnerability (Quisumbing et al. 1996). Unequal intra-household relations and power dynamics (including division of work and decision-making) have also been cited as contributing factors to higher rates of malnutrition in women, often dictating the degree of financial autonomy they enjoy (Botreau and Cohen 2020).

There is a substantial body of research documenting the benefits of mainstreaming gender perspectives in food production processes on food and nutrition security outcomes worldwide (Ayamga, Ayawine and Ayentimi 2023; Ghosh et al. 2021; Lufuke et al. 2022; Nnaji, Ratna and Renwick 2022; Suri and Ashok 2022). Although there has been a notable increase in attention given to the gendered aspects of food security policy debates in recent years, this has failed to translate to greater gender equality or food security outcomes (Clement et al. 2019). This has therefore highlighted the need for greater recognition of women’s central role in food systems in developing countries and how advocating for their empowerment can serve as a key strategy in advancing food security solutions (Visser and Wangu 2021).

The socio-cultural gender norms resulting from a hierarchical, patriarchal society, as is the case in Cambodia, typically assign women the roles of caregivers, with their responsibilities primarily focused on domestic tasks, household management and agricultural activities while men tend to work outside the home (Chhoun et al. 2016; Phuong 2018). Roughly two thirds of working Cambodian women are employed in agriculture (ADB 2019); in line with findings from global studies on gender and food security as explored previously, they are very much involved in food production, purchasing, storage and preparation processes and therefore play a key role in determining the health and nutrition security status of their households (GIZ 2023; Phuong 2018). It was found that in 2010, 18 percent of Cambodian women were malnourished (Windus et al. 2022), while Wallace et al. (2014) found in their study of women’s nutrient intake in Kandal province that 97 percent of women did not meet the daily recommended intake of iron. While this was in part due to a lack of knowledge and access to nutrition information, McDonald et al. (2015) found that women’s malnourishment also arises from intra-household gender dynamics that lead them to prioritise the consumption and nutritional needs of other members of the household over their own.

The Cambodian government has recognised the need for greater efforts to enhance inclusion and reduce inequalities and has identified women as a vulnerable group to be included in the Food Security and Nutrition (FSN) strategy (Smith 2023). This is also evident in the Second National Strategy for Food Security and Nutrition (2019-2023) which pays particular attention to the roles Cambodian women play in rural households as well as the importance of strengthening maternal and child health and nutrition (CARD

2019). To complement this, the strategy highlights the need to direct nutrition education programmes towards men, thereby encouraging greater gender equality by balancing the distribution of domestic responsibilities and improving the food and nutrition security status of the household. Windus et al. (2022) have however noted that the above strategies fail to specifically address nutritional adequacy of dietary intakes. Women, female-headed households and families with disabled members are recognised as vulnerable groups to be included in the Food Security and Nutrition (FSN) strategy (Smith 2023). The poorest households, which are often female-headed or include disabled members as well as those who are landless, from ethnic minority backgrounds or from remote or marginalised areas, are also vulnerable to nutritional deficiencies. Meanwhile, the ADB (2021) emphasised that localised or seasonal food deficits still occur and when they do, the poorest households suffer the most, pointing to the need to diversify national sources of nutrition and improve the overall food quality for the poor.

2.4. Food security and nutrition, climate change and resource governance

There is a substantial body of research on the adverse impacts of climate change and rapid economic development on food production and consumption. Climate change and variability has significant implications for global agricultural, livestock and fishery production, impacting both food quantity and food quality which in turn impacts food prices and safety (Ajilogba and Walker 2021; Mirzabaev et al. 2023; Visser and Wangu 2021; Wheeler and von Braun 2013). In the world's least developed countries, where people rely heavily on agriculture for food and income, poverty and food insecurity are compounded by the impending threat of climate change - Mugambiwa and Tirivangasi (2022) have concluded that climate change represents a barrier to the achievement of Sustainable Development Goal number two, “Zero hunger”, as it affects all the aforementioned dimensions of food security and the nutritional status of populations (El Bilali et al. 2020).

As a developing country highly dependent on agriculture, Cambodia is among the countries most vulnerable to the impacts of climate change and variability when it comes to food security. This is due to the increasing frequency and severity of climate-related natural hazards, including drought, flooding and tropical storms, combined with the population's weak adaptive capacity and lack of mechanisms providing farmers with ‘climate-smart’ adaptation options, which has significant implications for food production and agricultural productivity, and therefore the health and nutrition security of the population (Nong 2021; Touch et al. 2016; World Bank 2017). Rainfall variability, rising temperatures and the increasing frequency and severity of extreme weather events have significantly affected crop production over the last few decades – including rice, the central livelihood of rural populations accounting for over 60 percent of daily energy intake (Chhinh and Poch 2012; In et al. 2015; Sok et al. 2021).

In their study, Alvar-Beltrán et al. (2022) found that significant yield losses are projected for several vegetable crops commonly grown in Cambodia as a result of climate change and increased pressures on water resources. This will pose significant food and nutrition security risks for the Cambodian population, given the vital role of vegetables in maintaining a healthy diet but also, as mentioned in the study, as climate-induced increases in air temperature can negatively affect the nutrient quality of certain crops such as pak choi (Hwang et al. 2018 cited in Alvar-Beltrán et al. 2022). Chen (2022) explains that climate change further exacerbates household food insecurity and poor nutrient intake in rural areas as it can force people to transition from traditional (“legacy”) farming practices to new livelihood activities

such as livestock trading, potentially increasing vulnerability due to limited knowledge in these areas.

Messina et al. (2017) emphasise gender as a critical factor influencing the ways in which Cambodian men and women experience climate change and determining their capacity to adapt and respond to it, due to entrenched gender inequalities translating to disparities in roles and responsibilities as well as access to and control over resources. Nong (2021) also highlights the fact that climate change disproportionately impacts vulnerable groups, including women, who are more likely to live in poverty and thus feel its impacts more acutely than men.

Studies have outlined the benefits of hydropower infrastructure development and dam construction in promoting and sustaining economic growth in developing countries (Kondolf and Yi 2022; Shi et al. 2019). However, the social and environmental implications of such projects, including their impact on adjacent populations' food security, have also been extensively documented. For instance, in a study of the impact of two hydropower dam reservoirs in north-western Ethiopia, Jima et al. (2022) found that dam construction increased adjacent rural households' food insecurity by 14.6 percent and decreased dietary diversity by 24 percent. Cavallini Johansen et al.'s (2024) study of the challenges faced by a community in the Brazilian Amazon following the nearby construction of a hydropower dam yielded similar results. Cavallini Johansen et al. (2024) also identified a number of socioeconomic factors and characteristics, including young or female-led households, low education levels and unemployment, that are linked to higher levels of food insecurity.

Hydropower development in the Mekong River Basin is a very real threat to the food and livelihood security of riparian populations, including in Cambodia. On the one hand, upstream infrastructure development threatens aquatic biodiversity and the abundance of riverine fish species by altering water temperature, quality, nutrient and sediment supply, disrupting key migration routes as well as causing physical harm due to turbine blade strikes and changes in barometric pressure (Alghera et al. 2020; Baird and Hogan 2023; Bonnema et al. 2020; Ziv et al. 2012). The consequent reduction of fishery production threatens the livelihoods and food and nutrition security of riparian populations in Cambodia and the entire Lower Mekong Basin (Golden et al. 2019; Pearse-Smith 2012; Sor et al. 2023; Soukhaphon, Baird and Hogan 2021). Golden et al. (2019) estimate that by 2030, relative to 2010, millions of people will be at risk of protein and micronutrient deficiencies as a result of reductions in fish resources due to hydropower facilities.

It is also important to consider these developments within the broader context of climate change (Hoang et al. 2016). Literature examining the cumulative impacts of climate change and water infrastructure development on hydro-agro-ecological systems and conditions in the Mekong is limited (Pokhrel 2018). However, existing studies have shown that dam and reservoir operations have major implications for the hydrology and ecosystems of the river and Cambodia's Tonle Sap Lake but have little effect on the outcomes of extreme climate-induced events (flooding). Climate change remains the main driver of hydrological change but also amplifies uncertainty surrounding the impacts of these hydropower operations (Arias et al. 2012; Lauri et al. 2012; Ly, Sayama and Try 2023; Try et al. 2023). A study by Allison et al (2009) also highlights the difficulty in predicting the impacts of climate change and altered physical environments and ecosystems on fish and fishery production in developing countries, including in Cambodia (Allison et al. 2009). Given that Cambodia is highly vulnerable to the effects of climate change with limited capacity to adapt to it, the

uncertainty surrounding the future of its fish and fishery resources is a growing cause for concern.

Additionally, fragmented water and land management and their governance have led to ineffective cross-ministerial coordination, resulting in ineffective policies and reducing agricultural productivity (Ngin et al. 2024; Öjendal et al. 2023; Sithirith 2017). Sithirith (2017) highlights that, despite the benefits of Farmer Water User Community approaches, which prioritise community participation in water governance, they remain inefficient due to their dependence on government support and are unable to address wide-ranging agricultural production needs. A consequence of this lack of coordination across all levels of governance is the ongoing conflicts over water use between Farmer Water User Communities (FWUC) and community fisheries in Boeung Ream Community Fish Refuge and the Ta Soung Irrigation Scheme (Ngin et al. 2024). Furthermore, the strong focus on rice production in agriculture, which is especially vulnerable to climate variability, has had a number of adverse consequences on food security including water resource depletion, ecological disruption and diminished fish stocks, further exacerbating conflicts between water users and compromising nutrition security and livelihoods (Ngin et al. 2024). Moreover, the development of water infrastructure significantly impacts food security and nutrition in Tonle Sap Lake and Cambodia's Mekong Delta. Hydropower and infrastructure projects in the Mekong River Basin, particularly in upstream countries where Cambodia lacks control over water resources management, have altered the hydrological regime of the Mekong River and Tonle Sap Lake. This has affected fishery productivity and the food supply for rural populations (Sithirith 2024). The unpredictability of water availability due to upstream infrastructure development and climate change exacerbates these issues, making it difficult for farmers and fishing communities to sustain their livelihoods.

Cambodia's weak adaptive capacity to climate change combined with the high risks of farming has meant that its agricultural sector has become increasingly vulnerable to a number of factors, notably rising input prices, threatening food and livelihood security (Ham et al. 2023; Touch et al. 2023). The costs of machinery, new seed varieties, chemical fertilisers and pesticides, combined with household spending on daily food consumption, often exceed farmers' agricultural income, resulting in minimal profits as well as increased poverty in rural areas and deepened debt (Ham et al. 2023; Korn 2021). Limited access to high-quality, reliable and affordable fertilisers is a major factor behind low rice yields, exacerbated by the restrictive regulatory frameworks as well as distribution challenges (Theng 2020). Additionally, their lack of technical skills and knowledge due to inadequate support and practical training has meant that inputs are being used improperly and inefficiently, limiting productivity, crop yields and the overall growth of the agriculture sector (Korn 2021; MAFF 2020 cited in Nong 2021; Ros, Chhinh and Nang 2011). For instance, farmers' weak understanding of the proper handling, usage and application of pesticides has not only had adverse health and environmental impacts, but also locks farmers into "pesticide dependency" and in fact decreases their net income (Dunn et al. 2023; Ngin et al. 2017 cited in Dunn et al. 2023). As mentioned previously, yields are also decreasing due to climate change, while the high cost and limited availability of conservation agriculture inputs hinder efforts to boost productivity and enhance climate resilience (Alvar-Beltrán et al. 2022; FAO 2022).

Agricultural extension services are a means for farmers to increase productivity and improve their livelihoods and food security by providing them with access to information, training and new technologies - crucial for developing countries, particularly in the context of climate change (Michigan State University 2017). Coverage of extension services in Cambodia is

uneven, with an estimated 70 percent of villages receiving extension input, although awareness of the availability of these services varies across provinces and is occasionally lower than 50 percent (Michigan State University 2017; ADB 2021). The public and private sectors, NGOs and donor organisations provide extension services, however weak coordination between service providers has meant that farmers often receive conflicting information, thereby reducing its effectiveness in adequately addressing farming communities' needs (Bicksler et al. cited in Nickens, Ader and Enriquez 2023; Ke and Babu 2018). Improved information access, according to Nickens, Ader and Enriquez (2023), would facilitate the more effective implementation of sustainable technologies which would, in turn, enhance the availability and variety of food sources, thereby increasing food and nutrition security.

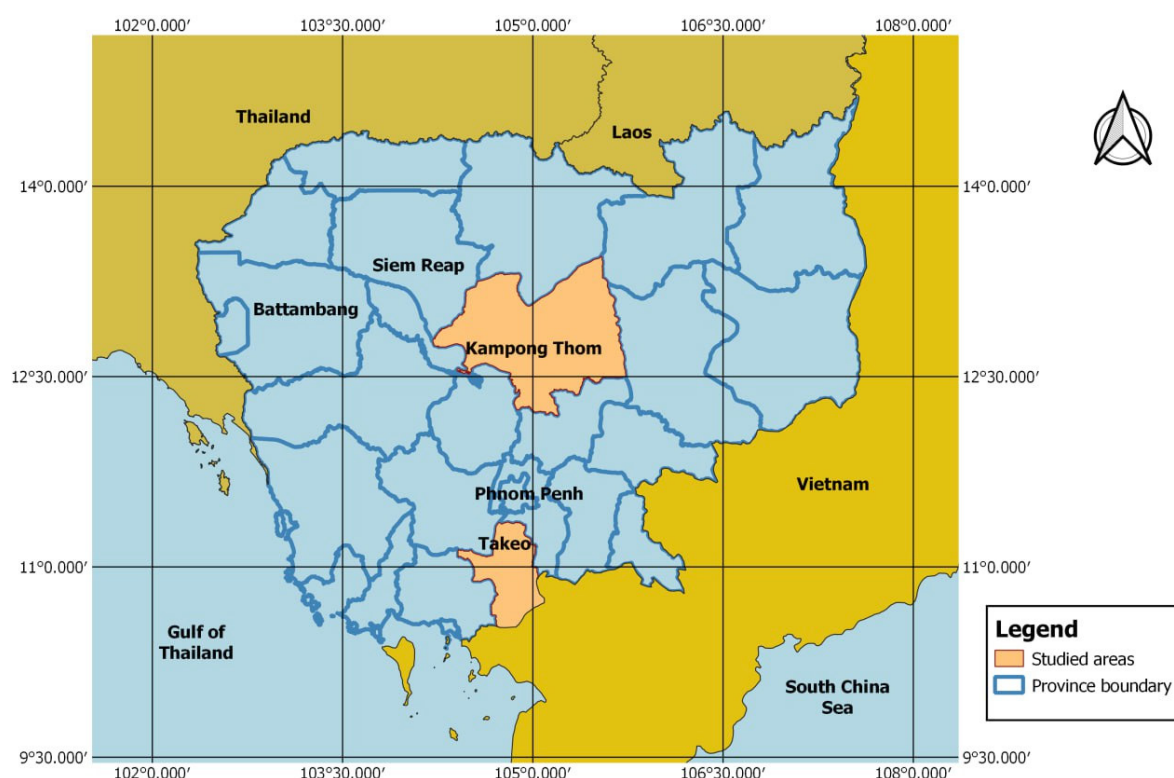
3. Methodology

3.1. Study areas

Kampong Thom and Takeo provinces were selected as study sites due to their locations within the Tonle Sap Lake floodplain and Cambodia's Mekong Delta, respectively (Figure 1). The seasonal flooding of Tonle Sap Lake brings in nutrients that support a rich diversity of fish species and rice cultivation, both of which are primary sources of protein for local communities (Sok et al. 2019). Similarly, the fertile soils and abundant water supply of Cambodia's Mekong Delta make it ideal for intensive rice farming, a staple food and a significant source of income for many Cambodian families (Sithirith et al. 2024). Both regions face challenges such as climate change, hydrological changes, and environmental degradation, which impact their productivity and sustainability. Despite these challenges, their contributions to food security and nutrition in Cambodia remain invaluable. However, the prevalence of food insecurity remains high in these areas. For instance, vulnerability in flood-prone areas like Tonle Sap reaches as high as 35.5 percent and in rural regions, it is 32.8 percent (WFP 2023).

Specifically, this research focused on Boeung Ream Community Fish Refuge (CFR) and Ta Soung Irrigation scheme. Boeung Ream CFR is a pristine freshwater reservoir situated in Chey Chumneah and Samnak villages, Kor Koh commune, Santuk district, Kampong Thom province. Boeung Ream, connected to the Tang Krasaing Irrigation scheme, has been officially designated as a CFR. It is located in Kor Koh Commune, a community that consists of 10 villages and houses an estimated 3,309 households (Sithirith et al. 2024). Villagers in Kanhchel and Kampong Reap villages in Kampong Reap commune, Prey Kabbas district, Takeo province, where Ta Soung Irrigation Scheme is located, were selected for interviews. The Ta Soung Irrigation Scheme is a vital component in the production of nutritious food in the region. It irrigates 1,511 hectares of land, benefiting 970 farming households across 15 villages in four communes (Sithirith et al. 2024). This area is a significant hub for rice cultivation, with farmers growing three rice crops annually using water from the Bassac River. This practice ensures a consistent supply of this staple food, contributing to a balanced diet for the local population. Additionally, the region includes a former fishing zone, which adds another layer to its food production capabilities. Both rice and fish are harvested here, offering a diverse array of nutritious food options for both consumption and commercial purposes. This highlights the importance of the Ta Soung Irrigation Scheme in promoting sustainable food production and consumption patterns in the region (Sithirith et al. 2024).

Figure 1: Location map of the study sites



3.2. Data collection

This study employs a qualitative method, in which the primary data were gathered through key informant interviews (KIIs) and focus group discussions (FGDs). Specifically, the KIIs were conducted with stakeholders, including the Village Chief, Commune Councillors, District Office of Agriculture, Water Resources, and Environment, Provincial Fisheries Administration, Community Fish Refuges, Farmer Water User Communities, Provincial Department of Water Resources and Meteorology, Provincial Department of Environment and Provincial Department of Agriculture to obtain their knowledge on sectors and gain a deep understanding of the local contexts of food production and consumption. In addition, the FGDs were held with various groups such as non-poor men, poor men (ID Poor 1 and 2), non-poor women, poor women (ID Poor 1 and 2), and women-headed families in each study site. The ID Poor is a government initiative, managed by the Ministry of Planning, that categorises households into four distinct groups based on their economic status: Poor 1 (very poor), Poor 2 (poor), At-Risk, and Non-Poor (RGC 2011). This system allows for targeted assistance and resource allocation. KII and FGD questions were designed to understand the barriers to food consumption within these communities, covering a range of topics including income sources, nutrition awareness, spending habits, food production, and coping strategies during periods of low income. Table 1 below shows the number of study participants. The details can be found in the appendix (see Table A1).

Table 1: Sampling and sample sizes

No.	Interviewees	Number of samples
1	Provincial government officers, local authorities, commune chiefs and commune councillors (Key Informant Interviews)	19 people
2	Non-poor, poor and female-head households (Focus Group Discussions)	20 groups or 120 people

The participants were selected according to the geographical location of their settlement, particularly villagers and local authorities residing and working along the irrigation schemes and the CFR. They are therefore mostly dependent on these areas for their livelihoods, while the local authorities have insightful knowledge concerning food production and consumption within these areas.

Table 2: Distribution of the total sample by site/commune

Province	District	Commune	Villages	KIIs	FGDs
Community Fish Refuge Boeung Ream					
Kampong Thom	Santuk	Kor Koh	<ul style="list-style-type: none"> • Chey Chumneah • Samnak 	10	10
Ta Soung Irrigation Scheme					
Takeo	Prey Kabbas	Kampong Reap	<ul style="list-style-type: none"> • Kanhchel • Kampong Reap 	9	10
Total				19 people	20 groups

The KII and FGD questions were designed to understand the factors influencing choices over and consumption of food within these communities and within differently situated households, covering a range of topics including income sources, nutrition awareness, spending habits, food production, and coping strategies during periods of low income. A session was held at CDRI in the second week of January 2024 to train four experienced enumerators on the study objectives and how to conduct KIIs and FGDs using the questions. A pilot test of the questions was conducted among the enumerators and the CDRI team, followed by revisions of the questions. Upon completion of the pilot test and the revisions, the data collection was conducted in the third week of January 2024. The KIIs and FGDs were audio-recorded with consent from participants. Audio recordings were transcribed and translated from Khmer into English for data analysis.

3.3. Data analysis

The information gathered from the KIIs and FGDs was compiled, summarised, and thematically analysed using an Excel spreadsheet. Primary deductive themes identified from the collected data include nutrition awareness, spending habits, food production, and coping strategies during periods of low income. We stratified the results by site and stakeholder characteristics to gain a nuanced understanding of how these themes vary and converge across different groups. In the final step, we developed thematic narratives to prepare for data interpretation and discussion of the findings. For each theme, we presented results from each site to facilitate comparison, highlighting similarities and differences across stakeholders and sites. Additionally, where applicable, we included direct quotations from various stakeholders and sites to support our findings and discussion.

4. Findings

This section presents the contexts of respondents living in the study sites and key findings about awareness of and access to nutrition information, spending on food, food production, managing food during lean times and production impacts, and formal and informal barriers to food production and nutrition consumption.

4.1. Contexts

Households in the study sites have varying socio-economic dynamics. For many, farming served as the primary income source, with land ownership varying in size. Education levels tended to be low overall, although non-poor households typically exhibited higher educational attainment.

In the Ta Soung Irrigation Scheme site, socio-economic conditions vary widely among households. Women-headed households rely on fishing, farming, and livestock rearing for income, with some members engaging in seasonal migration for additional work opportunities. ID-Poor women mainly depended on social protection programmes, fishing, and agricultural labour and generally had limited land ownership. ID-Poor men drew income from similar sources, with varying land ownership. Both women and men from non-poor households engaged in farming, stone sculpture and fishing, with some migrating for work. They generally possessed moderate to large land holdings.

In the Community Fish Refuge Boeung Ream site, women-headed households primarily earned income from farming, stone sculpture and livestock rearing, and tended to have low levels of education. Some reported that household members migrated overseas in search of employment. ID-Poor women depended on cash transfers, agricultural labour, and fishing and had limited land ownership. ID-Poor men had similar income sources, with varying land ownership. Non-poor women and men had income sources similar to those in the Takeo site, and typically owned moderate to large amounts of land.

4.2. Awareness and access to nutrition information

Participants demonstrated a basic understanding of nutrition but lacked detailed knowledge. Schools were identified as the primary source of nutrition information, followed by smartphones, radio and television. However, access to these sources was limited, particularly for those from poor households.

Despite the diverse socio-economic backgrounds, men and women shared a common understanding of nutrition. This understanding, however, was often clouded by a lack of clarity. Nutrition was commonly associated with the consumption of a diverse diet which typically includes staples such as rice, protein sources like fish and meat, and a variety of vegetables. Interestingly, despite the recognised importance of grains in a balanced diet, they were not mentioned in the definition of a nutritious diet by both genders, pointing to gaps in nutritional knowledge. Among non-poor individuals, regardless of gender or location, there was a clear recognition of the importance of hygiene and clean eating aspects of nutrition. This perspective on the importance of cleanliness in dietary habits was also shared by some female heads of households in Takeo:

Nutrition is eating non-chemically treated vegetables and clean eating. Eating home-grown vegetables from our garden is better than buying them from the market. From my understanding, it prevents children and elderly people from contracting harmful diseases.

FGD, Women-Headed Household, Kanhchel Village, Kampong Reap Commune,
Prey Kabbas District, Takeo

Across all groups, nutrition was viewed as not just important, but central to well-being, with many expressing the belief that consuming the aforementioned foods boosts their physical strength and provides protection against diseases. This belief underscores the perceived direct link between diet, health, and well-being, and highlights the central role of nutrition in their lives. This expanded understanding of nutrition and its impact on health and well-being provides a comprehensive view of the socio-economic dynamics within these groups.

The sources and timing of nutrition education exhibited significant variation among respondents, influenced by factors such as gender and socioeconomic status. Common sources of information spanned both formal and informal channels, including social media, smartphones, television and radio (although limited access to these devices is common) as well as family, friends, school, and medical check-ups. Women, especially those who are married or pregnant, often acquire nutrition knowledge through medical check-ups during pregnancy. This trend was more pronounced among non-poor women, reflecting broader issues of access to healthcare and educational inequality across socioeconomic groups:

The district health centre explained to us what nutritious food was and what to eat during pregnancy in order to be healthy.

FGD, Women-Headed Household, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

I have received information about nutrition through the health centre and from NGOs, as well as Facebook.

FGD, Non-Poor Women, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

In contrast, some men from poor families, particularly in Takeo, became aware of nutrition as adults during visits to doctors or local healthcare centres. Others, especially in Kampong Thom, learned through conversations with family and friends. A small number of individuals, mainly from non-poor backgrounds and across genders, recalled learning about nutrition from their families during childhood. This trend was less reported among those from poor households, particularly women heads of households and those classified as ID-Poor. While some individuals gained nutrition knowledge from primary school (between the ages of 6 and 15), others missed out due to lack of schooling, indicating disparities in access to formal education:

I never knew about this when I was at school. I mostly heard about it from television advertisements.

FGD, Non-Poor Women, Kampong Reap Village, Kampong Reap Commune, Prey Kabbas District, Takeo

I am almost 50 years old now. I think I first started to hear about nutrition around 20 years ago. But I never had any in-depth knowledge nor did I ever learn about it at school.

FGD, Non-Poor Men, Kampong Reap Village, Kampong Reap Commune, Prey Kabbas District, Takeo

Medical check-ups, extension services, and awareness campaigns organised by local health centres and NGOs were frequently cited as primary sources of nutrition information for both poor and non-poor families in both locations:

Our District Health Centre organised training sessions for villagers. Last year, in 2022, Oxfam also provided training and awareness campaigns on nutrition and health. If I remember correctly, I joined four times. One of the sessions taught us about nutrition, hygiene, drinking clean water and consuming green vegetables to help build a strong body. Both my wife and my daughter joined me for that.

FGD, ID-Poor Men, Kampong Reap Village, Kampong Reap Commune, Prey Kabbas District, Takeo

Despite the availability of multiple sources of information, access to nutrition education remained uneven, with socioeconomic factors playing a significant role. Women, particularly mothers or wives, were highlighted as the primary participants in health and nutrition awareness events across both locations. This preference for women's attendance is deeply rooted in societal norms that associate them with household management and caregiving roles. The likelihood of women being available at home, compared to men who are often engaged in work outside the home, further facilitated their participation in these events, as suggested by this respondent:

I have small children at home who are taken care of by their mother while I go to work and earn money. Maybe my wife attended the meetings or received training on this.

FGD, ID-Poor Men, Kanchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

It was observed that some male participants were unaware of not only the timing and details of these events, but were also uncertain as to whether their wives or families attended these. This may further point to the common underlying assumption that issues related to food and nutrition are primarily the responsibility of women, given their role as homemakers and primary caregivers:

I am not sure if they're ongoing now, but if I remember correctly, a few years ago, I heard from the village chief, calling each household to join a meeting but I was busy and I am not sure whether my wife or anyone in my family attended.

FGD, ID-Poor Men, Kanhchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

My occupation is singing traditional songs during wedding ceremonies. Thus, I am not always home. I always go to different villages where I am asked to perform at ceremonies. Maybe there was a training session or meeting about [nutrition] and the village chief asked my wife, but I hadn't heard about it nor am I sure if my wife joined.

FGD, ID-Poor Men, Kanhchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

Despite this, there were instances where men, specifically husbands or fathers, participated when available, albeit infrequently. Participation in these events was often dictated by individual availability, with those who were free to attend doing so, as explained by the below respondent. This suggests that despite the expectation of women to attend such events in line with their domestic roles and responsibilities, men are not necessarily uninterested or unwilling to educate themselves about these issues.

If my husband comes back from the farm in time, he also joins. But most of the time, he is busy there.

FGD, Non-Poor Women, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

From a governance perspective, the approaches taken to provide people with nutrition information were markedly uneven in both studied sites. In both the Ta Soung Irrigation Scheme and Boeung Ream CFR, a variety of different institutions and actors operate, usually with very different agendas. In some cases, village and commune chiefs and councillors were proactive about mobilising people to attend information-sharing and training sessions on nutrition and in collaborating with schools, hospitals, NGOs and other institutional actors to facilitate the dissemination of this information:

An NGO came to work in the village which focuses on raising awareness and providing training on food and nutrition for children and pregnant women. The local hospital also teaches on this particular topic (...) If there are any partners coming to the village, the chief acts as a facilitator to gather people to attend the training or meetings.

Village Chief, Chey Chumneah Village, Kampong Thom

However, in other cases, it was clear that disseminating nutrition information was not considered a priority or integral to improving food security. When asked to describe the nature and focus of their work on nutrition, some respondents answered:

The commune collaborates with schools and school principals to raise awareness and educate students about food safety, health, sanitation and the environment. Moreover, raising awareness of these issues was also discussed and promoted during public forums, village meetings and training.

KII, Commune Chief, Kampong Reap Commune, Takeo

The village chief participates in work related to agriculture extension services, hosted and organised by NGOs. The main topics of discussion include agricultural techniques, rice growing and tolerant seeds.

KII, Sub-Village Chief, Samnak Village, Kampong Thom

Another respondent explained that nutrition is understood by the village as having sufficient food to eat, however having access to land is equally important as it ensures that food can be grown to meet nutritional needs while supporting families' livelihoods.

On a provincial level, there were marked differences in how institutions approached and prioritised nutrition within the wider scope of their activities. For instance, Kampong Thom's Provincial Department of Environment demonstrated a strong commitment to disseminating nutrition information and delivering nutrition-focused programmes, whereas the same department in Takeo did not integrate nutrition or nutrition planning into its work, as it primarily addresses issues related to ecosystem and environmental protection and conservation:

PDOE works on disseminating fundamental knowledge, including on nutrition, to the community. There is an Education Outreach Office that is responsible for disseminating knowledge and raising awareness for mothers and children to have an understanding of nutrition.

KII, Deputy Chief of Provincial Department of Environment, Kampong Thom

The department only works on issues related to the environment and protecting conservation areas. The department contributes to improving local livelihoods by helping grow food within the protected areas (...) The meetings or workshops are mainly related to the environment and food ecosystems.

KII, Deputy Director of Provincial Department of Environment, Takeo

Similarly, the Department of Agriculture's provincial offices in the studied locations take contrasting approaches to improving the food security situation in the respective provinces. In Kampong Thom, strengthening nutritional awareness is a key component of its provincial office's strategy to enhance food security whereas in Takeo's office, integrating nutrition planning into its work does not appear to be considered a priority for achieving similar goals, despite the evident need and opportunities for such work. This highlights inconsistencies in not only how local government structures address the issue of food security and nutrition information dissemination, but also between government policies and objectives (as outlined in the NSFSN) and the actions being taken at the provincial level:

The department works with development partners to enhance the understanding of local people on food security, children's nutrition and food sustainability. Partners include AFD, World Vision, WCF, World Fish and more.

KII, Deputy Director, Provincial Department of Agriculture, Kampong Thom

The department is working on a strategic policy that ensures food security and food safety for the province. The Office of Agriculture extension acts as a facilitator in creating an agriculture community (...) The only work on nutrition that the Department of Agriculture can do is to organise training sessions or workshops raising awareness of nutrition.

KII, Director of Fishery Administration, Provincial Department of Agriculture, Takeo

The respondent from Takeo did add, however, that the training sessions and workshops on nutrition organised by the Department of Agriculture regularly brought up issues of gender, women's rights, child labour and domestic violence. Although government institutions differ in their focus and priorities across provinces as has been shown above, a common thread in their approaches is the emphasis on the intersection of food security and promoting and enhancing the rights of vulnerable or marginalised groups.

4.3. Spending and food

In both Boeung Ream CFR and Ta Soung Irrigation Scheme, respondents' spending priorities were largely consistent, with food, children's education, and medical expenses taking precedence. Food was commonly ranked as the top priority, reflecting its fundamental role in daily life, with decisions on food purchases usually being made collectively by the household, driven by individual preferences as well as the availability of funds. Homemakers, particularly women, often independently made decisions regarding food purchases and meal preparation. In some households, the husband, being the primary earner, significantly influenced food purchasing decisions, thereby contributing to the family's economic power.

My family buys food depending on what my children like to eat and what my husband wants because he needs energy to work, so he needs to eat food that can support his strength.

FGD, ID-Poor Women Group, Kanhchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo Province.

My father, husband and children have different food preferences so mostly I cook food that everyone can eat. But when we don't have enough money, I cook based on what we have available and let them eat it even though they may not like it.

FGD, ID-Poor Women Group, Kanchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo Province.

Across both locations, all respondents reported that their primary food purchases for daily consumption included staples such as rice, fish, meats, vegetables, and cooking spices. A few respondents highlighted the importance of food variety, health considerations and the absence of harmful chemical substances in their food purchasing decisions. However, while family preferences and financial availability were the main factors influencing food purchases, considerations regarding food variety and health factors were less commonly mentioned.

When deciding what to cook, I have to think about how much money I can spend. If there is less money, I would only cook with whatever we had.

FGD, Non-Poor Women, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

My husband works hard. He prefers food like soup with meat and vegetables rather than dry food because it boosts his energy and gives him the strength to continue working. So, most of the time when I cook, I think of him first as he needs more energy from food to work and earn money.

FGD, Non-Poor Women, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

Children's education and medical expenses ranked as the second most important expenses after food. Additional spending priorities, such as transportation, agricultural expenses, water, and electricity bills were also mentioned, though they varied among respondents. Interestingly, bank loans emerged as a spending priority in some cases, shedding light on the financial obligations of these households. Overall, despite the differences in specific spending priorities, the key household concerns—food and education—remained consistent across both locations.

4.4. Food production

Most households engaged in subsistence farming, growing crops such as rice and vegetables. Constraints to food production included lack of access to land and water, climate changes, and lack of extension services. In both locations, the majority of respondents, particularly female heads of households and ID-Poor women, did not engage in paddy rice cultivation due to a lack of farming land. Instead, they focused on growing vegetables at home and raising domestic livestock, activities that require less space and fewer resources. A small number of individuals, including female heads of households and ID-Poor men who had access to small farming land areas near the village, did engage in paddy rice farming. Some individuals in both locations, particularly in Takeo and Kampong Thom, also engaged in paddy rice farming and cashew plantation, given their access to farming land areas near the village. Overall, while paddy rice farming was limited due to land constraints, vegetable gardening and livestock raising emerged as popular agricultural activities among respondents.

Both of the studied sites grappled with production constraints due to a variety of factors. The absence of adult males in the family, particularly elderly individuals, contributed to production challenges, especially for women who were heads of households.

Obstacles exist for women who are household heads because they have to do their own farms and excess labour which affects their health and drains their energy on top of their existing responsibilities in taking care of their family.

KII, Kor Koh Commune Council Member, Boeung Ream CFR committee, Tang Krosang FWUC Chief, Kampong Thom

Those women (i.e., female-headed households) have to be a mother and a father at the same time. They have to depend on themselves to feed their children. Sometimes, they can't have their children go to school because of their livelihood and the struggle for their earning income. Some women have to bring their children to work so they have to work and take care of their children at the same time.

KII, Koh Kor Commune Council Member, Kampong Thom

Furthermore, agricultural inputs such as fertiliser, seeds, and labour were noted as particularly expensive, creating significant financial constraints that disproportionately affected female heads of households and ID-Poor women. Despite these rising input costs, respondents reported declining agricultural yields and low market prices, exacerbating production challenges.

The vast majority of local people in the community depend on agriculture. Almost 70 percent of the population grows rice near the water resources... The challenge for CFR currently is that the farmers started to grow more rice during the dry season and they pump water from the lake. Meanwhile, the farmers have more expenses, especially women who need to take care of their families, housing, children, and food.

KII, Deputy Chief of CFR, Boeung Ream CFR committee, Kampong Thom

Despite facing these challenges, respondents emphasised women's high level of engagement in not only food production processes but also resource management and community affairs, highlighting their crucial contributions to food security and overall community well-being. This was illustrated in the following statements:

We have encouraged women's participation, and I have noticed increased participation among women, especially in awareness-raising activities, while men are involved in patrolling work. I believe that both women and men have equal access to fisheries resources since they can easily catch fish in their rice fields.

KII, Director, Provincial Fisheries Administration, Kampong Thom

(...) Women are very active in participating in water resource management, not only during difficult times but also in regular daily life.

KII, Director of District Office, Provincial Department of Water Resources and Meteorology, Takeo

Climate changes, including shifts in weather patterns, increased temperatures, and droughts create significant challenges to farming and raising domestic livestock across all groups, exacerbated by a lack of extension services and sufficient technical support. The location of the farming lands, distant from water infrastructure, further constrained food production for all farmers, regardless of their socio-economic status. This challenge was particularly felt by ID-Poor women in the Ta Soung Irrigation Scheme and non-poor men and women from both areas. The majority of the community surrounding the CFR depended on agriculture for their livelihoods: the increasing price of rice intensified competition for water. While many farmers benefitted from FWUCs, those living far from water sources resorted to pumping water out from the lake of the CFR, affecting the fisheries' resources. Additionally, residents far from the irrigation system incurred extra costs for gasoline to power-pumping machines for their rice fields.

People in Kor Koh and the community depend on growing rice for their livelihood. The main challenge for farmers in the community is pumping water for those whose fields are far away from the irrigation system. Currently, there is a concern about water availability for farmers growing rice during the dry season. When there is an obstacle for farmers, the community works with the local authority, commune, and village chief to solve the problem for farmers.

KII, Kor Koh Commune Council Member, Kampong Thom

The farmers whose rice fields or farms are far away from the water resources could struggle with irrigation expenses.

KII, Director of District Office, District Office of Agriculture, Water Resources, and Natural Resources, Kampong Thom

The constraints for farmers currently are the high input costs of fertilisers, chemical pesticides, labour, and materials used, the impact of climate change which causes crop disease, the lack of knowledge on technical agriculture, and fluctuating market prices. On the other hand, the farmers whose fields are far from the irrigation system encounter challenges in distributing water and spend more on inputs to irrigate their fields.

KII, Deputy Director, Provincial Department of Agriculture Forestry and Fisheries, Kampong Thom

The most common constraints for agricultural activities for farmers are the high prices of fertiliser and gasoline. Difficulty in accessing water sources is also considered a constraint for those farmers who are far away from the irrigation resources. Division of labour in the village also seemed to be difficult for the small families whose members were migrating.

KII, Village Chief, Ta Soung Irrigation Scheme, Takeo

Both locations were recipients of investments primarily focused on infrastructure development, such as roads, bridges, and irrigation systems. These investments, which were part of commune development plans, aimed to enhance connectivity and bolster food production capabilities, with a particular emphasis on paddy rice farming. The establishment of irrigation systems and the distribution of rice seeds were significant activities that contribute to increased food production capacity. However, it is noteworthy that there was a conspicuous lack of investments aimed at enhancing awareness or understanding of nutrition. Despite the focus on improving food production through infrastructure investments, there exists a gap in addressing the nutritional aspect of food security and well-being within the commune development planning processes.

The district office emphasises the critical importance of sharing information regarding project implementation from the pertinent provincial departments. This is particularly significant in light of the recent decentralisation of the office, which now falls under the jurisdiction of both the district administration and the Ministry of Interior. Since this restructuring, the office has observed a decrease in its activity and involvement in project development. Therefore, effective communication and information exchange are essential to ensure the office remains informed and can contribute effectively to project development.

KII, Director, District Office of Agriculture, Natural Resources and Environment, Takeo

The challenges faced by respondents, particularly women-headed households and ID-poor groups, in raising domestic livestock and growing home vegetables may indicate a limited of extension services, resulting in insufficient technical guidance.

We [the family] raise them [animals] based on what we know, without any technical support or knowledge. When they fall ill, I'm unsure how to treat them, so I often leave them be, and unfortunately, sometimes they die.

FGD, ID-Poor Women, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

There are challenges in raising domestic livestock due to the lack of proper land and shelter for them. The animals essentially fend for themselves, as I don't have the time to care for them while I need to earn money to support my family.

FGD, ID-Poor Men, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

At times, home-grown vegetables become diseased, and I'm unsure how to address it, so I tend to leave them be.

FGD, ID-Poor Women, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

4.5. Managing food during lean times and production impacts

In both study areas, households adopted a variety of strategies to navigate periods of low income. Economic solutions were common, with many individuals borrowing money from relatives, neighbours, and friends, and some even resorting to taking out bank loans. Food-based solutions were also prevalent, with all respondents reporting a reduction in both the quantity and quality of food consumed, relying on less nutritious foods high in unhealthy fats, sugar, and salt which, although relatively cheap, had a significant impact on the diets of all household members.

Livelihood-based solutions, such as cutting back on non-essential expenses and transitioning to different careers, were also reported in both locations. For instance, some individuals, mainly ID-Poor women, took up fishing, despite it not being their usual practice. A few ID-Poor men in the Ta Soung Irrigation Scheme also resorted to fishing, in some cases using illegal fishing tools, showcasing the lengths to which people would go to survive:

We didn't have enough money to buy food, so we had to fish and sometimes used fishing nets or illegal fish shocker tools.

FGD, ID-Poor Men, Kanhchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

Men from poor households in Takeo sought employment in garment and textile factories or as construction workers in urban areas or overseas as a coping strategy during low-income periods. In Kampong Thom, ID-Poor men and non-poor family members turned to construction work as an alternative source of income during difficult times:

Usually, my household relies on farming but during difficult times, I work on construction sites to earn more money.

FGD, Non-Poor Men, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

However, these coping strategies had serious impacts. Children's education was notably affected, with some having to leave school to engage in underage employment to support their families, particularly in garment and textile factories or as domestic workers. Interestingly, this was not mentioned by non-poor men or ID-Poor men. These differences were largely due to variations in the availability of resources and types of employment opportunities in each area.

My children quit school when they failed their exams and then started working at garment and textile factories in Phnom Penh. They send me money which I use to buy rice and spend on other things to support my household.

FGD, Women-Headed Household, Kanchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

In both study sites, all respondents confirmed that periods of low income significantly affected their food intake, with some respondents across both areas reporting reducing the number of daily meals from three to two and, in some cases, from two to one. This would, presumably, lead to higher rates of undernutrition but also increased risks of malnutrition as reduced meal

frequency lowers people's chances of obtaining the recommended amount of essential nutrients necessary for maintaining overall health and well-being:

We used to have a snack in the afternoon after lunch but during difficult times, we had to stop buying those. We even had to reduce the amount of food we ate from two meals to one.

FGD, Non-Poor Women, Samnak Village, Kor Koh Commune, Santuk District, Kampong Thom

We reduce the amount of food we eat for a few days until we have enough money to buy food. For example, we used to buy 0.5 kg of meat to cook for the household, but during periods of low income, we reduce this to 0.2 kg.

FGD, Women-Headed Household, Kampong Reap Commune, Prey Kabbas District, Takeo

Indeed, food-based solutions were also prevalent, with all respondents reporting a reduction in both the quantity and quality of food consumed, relying on less nutritious foods high in unhealthy fats, sugar, and salt due to their affordability, which had a significant impact on the diets of all household members. Affordable food items such as eggs, small fish, and fermented fish were often purchased in lieu of meat during these challenging times, with the latter being a popular choice due to its storability. Although not inherently unhealthy, fermented fish has a high sodium content which, when consumed in excess, can pose health risks. These foods were regularly consumed with home-grown vegetables, which were commonly harvested and cooked during periods of low income.

My wife cooks fewer meals. We collected green vegetables grown at home and eggs from our chickens or ducks to cook.

FGD, ID-Poor Men, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

We reduced our food intake a lot. For example, we used to eat fish and meat but due to financial constraints, we replaced those with eggs.

FGD, ID-Poor Men, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

A few respondents reported storing and preserving dried food at home for use during financially challenging periods, which helped minimise the impact on their eating habits or patterns. Overall, while there were similarities in coping strategies between the two locations, nuances existed in the specific food items purchased and additional measures taken to mitigate the impact of low income on food intake. Despite these changes, efforts were made to ensure that children maintained their diets, taking their youth and educational needs into account.

When we reduce our food consumption, the children get much weaker and easily get sick.

FGD, Women-Headed Household, Kampong Reap Commune, Prey Kabbas District, Takeo

Some households, particularly in the Boeung Ream Community Fish Refuge, Kampong Thom, noted a decrease in food consumption due to meals not being tasty, highlighting the complexity of maintaining dietary standards during times of financial hardship:

If us men eat fewer or tasteless meals, we feel weaker and less energetic.

FGD, Non-Poor Men, Chey Chumneah Village, Kor Koh Commune, Santuk District, Kampong Thom

During periods of low income, all respondents in both locations observed changes in food consumption patterns and dietary habits of all family members, including men, women and children. Most respondents across all groups mentioned prioritising food consumption for working males in households who needed to earn money to support their families:

My husband needs to eat more than us. I keep more food for him than for myself because he needs the energy and strength to work.

FGD, Women-Headed Household, Kanhchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

When my family didn't earn enough money, we didn't buy food. I had to go fishing. So, my family depended on how I fish - sometimes we only had one or two fish to eat together but my wife would have me and my children eat more than her.

FGD, ID-Poor Men, Kanchel Village, Kampong Reap Commune, Prey Kabbas District, Takeo

Interestingly, while the majority noted changes in food consumption patterns, some did not observe any change in the dietary habits of all family members, including children, highlighting the resilience of these households, particularly those who are non-poor groups, and their ability to adapt to challenging economic circumstances.

The nature and frequency of assistance people received during difficult times varied widely within and across the studied locations. Although not a common phenomenon, local governance structures did not always have the capacity to provide financial aid to people during difficult periods, instead providing affected them with foodstuffs or relying on external organisations and institutions for aid, usually in the form of donations. When asked whether they provided advice or guidance on food choices and nutritional priorities during periods of hardship, most respondents answered that they did not provide such advice, nor did they explicitly address the issue of nutrition. Given the constraints on food quality and quantity people face during financially challenging times as previously outlined, it is crucial to offer guidance on how to maximise their nutritional intake under such conditions. A number of respondents also mentioned that more vulnerable groups' needs were taken into consideration:

There is no assistance. The commune also claims that it does not have the capacity to help if farmers lose the benefits from their farming, especially during the dry season when they struggle with water scarcity. The commune can only provide a little support, such as rice, canned fish and soy sauce for affected people. The village chief has never advised anyone about their eating habits or what to eat. It is their personal life which the village chief has little capacity to advise on.

KII, Sub-Village Chief, Samnak Village, Kampong Thom

During difficult times, either during floods or drought, the village receives support from the district office and commune. Moreover, the village has a limited budget to support elderly people, veterans, orphans and pregnant or poor women. The support includes foodstuffs such as rice, canned fish and water as well as some of the budget. The Red Cross also contributes some of its budget to support victims of such events. (...) The village chief advises people to exercise caution during floods or climate events and told them to eat healthy and drink enough water. The food recommended to villagers includes meat, fish, eggs and vegetables as those are foods that can energise their bodies.

KII, Village Chief, Chey Chumneah Village, Kampong Thom

For those who struggle with their livelihood and do not have enough food, the village chief requests philanthropists and the CPP to provide support and food. The Red Cross

also provides support to affected people (...) The village chief introduced the concept of family vegetable farming and advised locals to practice safe food and water consumption.

KII, Village Chief, Kanhchel Village, Takeo

5. Discussion

Food utilisation, one of the key pillars of food security, refers to the effective assimilation of nutrients by the human body. Feeding and preparation practices, intra-household food distribution, sanitation and water supply and dietary variety play a critical role in determining the biological utilisation of food and nutritional outcomes. The socioeconomic dimension of utilisation, often overlooked, encompasses factors such as dietary knowledge, habits and decision-making processes related to food purchasing and preparation, often tied to educational attainment, household gender composition and income levels (Placzek 2021). The KII and FGD data from this study provided valuable insights into dietary habits and food production practices in the Tonle Sap Lake floodplain and Cambodia's Mekong Delta areas, specifically the formal and informal barriers affecting the production and consumption of nutritious food faced by the respondents from the studied communities. As previously outlined, there are a number of complex, interrelated socioeconomic, institutional capacities and environmental factors that determine and influence food consumption and nutritional status at the individual and household level.

The significance of rice to Cambodia cannot be understated. It is the staple of its population's diet, is a major export and driver of economic growth and its production has contributed significantly to poverty alleviation (Ros, Nang and Chhim 2011). Most rural households rely heavily on agriculture, mainly paddy rice production and fisheries, for their nutrition and food security needs. In this sense, it appears that the chosen study sites are an exception to the broader trend in Cambodia: most households in both the Ta Soung Irrigation Scheme and the Boeung Ream CFR engaged in homegrown vegetable farming and livestock farming, which require less land and resources than paddy rice cultivation. Vegetable consumption and production in Cambodia is generally low, with Cambodians consuming less than 50 percent of the recommended daily intake of vegetables, which account for less than 10 percent of cultivated land (Vilain et al. 2016; Yu and Fan 2009). The low consumption and relative unaffordability of vegetables compared to less nutrient-dense foods are mainly due to the fact that most fruit and vegetables produced within Cambodia tend to be rainfed and therefore vulnerable to the effects of climate change; farmers' high dependence on rice production therefore limits agricultural and dietary diversity (GIZ 2023). On the one hand, promoting widespread agricultural diversification and the cultivation of climate-resilient crops such as kangkong, sweet potato, pumpkin and other root vegetables (where suitable) would enhance households' dietary diversity and nutrition intake (GIZ 2023). This approach has the potential to alleviate poverty by diversifying income sources, reducing single-crop dependency and improving resilience to economic shocks and climate change.

Pronounced disparities exist between socioeconomic groups when it comes to resource access, translating to substantial marked differences in food and nutrition security outcomes. Non-Poor respondents, who typically possessed larger land holdings, were less likely to report noticeable changes in their household dietary habits; they also had better access to extension services, higher levels of education and a more comprehensive understanding of nutrition and hygiene compared to those who were ID-Poor. This enabled the Non-Poor, overall, to enjoy more stable and nutritious diets. In contrast, smaller land holdings, limited access to extension services and lower educational attainment collectively contribute to increased vulnerability and reduced

ability to ensure food security within female-headed and ID-Poor households, underscoring the need for sustainable solutions to ensure food security and nutrition for all groups, particularly during times of financial hardship.

Gender and family dynamics emerged as key factors influencing food consumption patterns and nutrition security among households in rural Cambodia. As discussed in the literature review, Cambodian women undertake the majority of caregiving and household management duties and therefore play a significant role in determining the food security and nutrition intake of their households. In addition to this, this study found that women who are ID-Poor or heads of households were disproportionately impacted by economic stressors and food production challenges. Indeed, faced with the responsibilities of managing food and children's education expenses, rising production costs as well as difficulty accessing resources further exacerbate financial difficulties, compounding their challenges as primary providers for their families. This is to the detriment of their own health and nutritional status – most respondents across both locations reported reducing the quantity and quality of food intake during financially challenging times, however the nutritional needs of working males were prioritised over those of other household members, which seems to align with the findings of a study by McDonald et al. (2015) investigating correlates of maternal undernutrition in Cambodia. This points to a clear need for greater support for female-headed and vulnerable households to ensure all members are consuming nutritionally balanced diets.

Persisting inequalities in roles and responsibilities on the basis of gender have negative implications for the future of Cambodia's food and nutrition security. Despite their critical role in food production and involvement in community affairs as shown in this study, women's limited access to resources, land and extension and financial services has significant implications for the food and nutrition intake of their households, while undermining their ability to effectively contribute to and benefit from agricultural improvements. Social stereotypes also exclude them from decision-making processes (Messina et al. 2017). For instance, a factor behind women's limited access to extension services is the predominantly male composition of extension service staff (UNIFEM 2004). Male extension agents find it culturally difficult to communicate and engage with female farmers but are also unable to provide them with the information and support specific to the agricultural activities typically undertaken by women. Such disparities create additional vulnerability to climate change, diminishing women's adaptive capacity and productivity and inevitably exacerbating food insecurity as conditions become increasingly challenging due to climate change.

The Cambodian government has made efforts to integrate gender perspectives in agriculture, climate change adaptation and development planning at national and sub-national levels. Notably, the Climate Change Priorities Action Plan for Agriculture, Forestry and Fisheries Sector 2014-2018 and Gender Mainstreaming Policy and Strategic Framework in Agriculture 2016-2020 developed by MAFF (MAFF 2013; 2015), as well as the Master Plan for Gender and Climate Change 2018-2030 produced by the Ministry of Women's Affairs (MoWA 2017) seek to enhance women's empowerment by ensuring equitable access to resources and representation, recognising and supporting women's roles in food production processes and climate adaptation and improving institutional capacity. The role and power of women as determinants of nutritional outcomes within households.

The outmigration of rural populations, usually young people, in search of employment to increase income is prevalent in Cambodia and has a number of implications for household food security. High levels of migration have resulted in growing numbers of female-headed

households, a phenomenon acknowledged in the aforementioned Gender Mainstreaming Policy and Strategic Framework in Agriculture 2016-2020 (MAFF 2015). The observation that respondents from female-headed households frequently report having family members who had migrated supports this trend. However as shown in the data, households headed by women are among the most vulnerable, with a higher likelihood of experiencing food insecurity, facing severe difficulties in accessing human and financial resources and having reduced adaptive capacity to climate change. Meanwhile, Sithirith et al. (2024) found that increased rural-urban and overseas migration has led to an increase in the consumption of nutritionally deficient foods such as fast food, instant noodles and sugary beverages by exposing rural populations to urban consumption practices and culture. Such trends exacerbate food insecurity, reduce rural productivity and agricultural knowledge and worsen nutritional outcomes for vulnerable populations; addressing the socio-economic challenges of migration and the nutritional shifts it entails is worth consideration.

This study's findings indicate that uneven and limited access to information on nutrition is a critical barrier to achieving food and nutrition security in Cambodia. Respondents generally demonstrated a basic understanding of key nutrition concepts and their role in ensuring individual health and well-being, however access to formal, comprehensive nutrition education is hindered by socioeconomic and gender disparities, resulting in significant gaps in nutrition knowledge to the detriment of women from poorer households. The experiences of the respondents documented in this study suggest that this problem is common across Cambodia. It is consistent with the findings from Wallace et al.'s (2014) investigation into the nutrient intake of women in Kandal province. Although Wallace et al.'s (2014) work covered a different location and had a different research focus, it also explored rates of nutritional knowledge, concluding that health education is not sufficiently integrated and fails to account for differences in lived realities and practices of different social groups. Given the central role of women in ensuring the food security of their households, targeted interventions will be necessary to achieve equitable access to nutrition information.

Furthermore, this study found a prevailing inclination within development planning processes towards investment in infrastructure development to enhance food production capabilities, rather than prioritising initiatives aimed at raising awareness of the nutritional aspect of food production and consumption. Indeed, these efforts often overlook this essential factor - the focus tends to be on increasing the quantity of food produced (i.e., paddy production), rather than its quality in terms of nutritional value. There is also a noticeable gap in addressing the nutritional aspect of food security within commune development planning processes, suggesting that the importance of nutrition in ensuring food security and individual well-being is not being adequately recognised or incorporated into local development strategies. This points to the need for the integration of nutrition education into development planning processes in order to effectively address food security issues.

Formal barriers to food and nutrient intake in Cambodia are often tied to agricultural expenses and infrastructure. This study revealed that households face significant challenges when it comes to food production: respondents noted that the high costs of rice, gasoline and agricultural inputs like fertiliser, seeds and pesticides, coupled with increased competition for water, low market prices and low agricultural yields has intensified financial strain on farmers and threatened their food and livelihood security. The declining yields also reflect the numerous challenges Cambodia's agricultural sector faces due to climate-induced temperature increases and erratic weather patterns, as discussed in previous research (Alvar-Beltrán et al. 2022; Chhinh and Poch 2012; Korn 2021; Sok et al. 2021). This is exacerbated by a lack of adequate extension

services and technical support, the effects of which were universally felt among respondents of this study, regardless of socioeconomic background. This is particularly problematic due to farmers' lack of understanding as to how to properly and efficiently use agricultural inputs, as explained by Korn (2021). It is crucial to address these gaps in service provision to support the agricultural sector and ensure food security and nutrition.

Limited institutional capacity and weak coordination between government agencies and administrative layers pose further challenges for Cambodia when it comes to addressing food and nutrition insecurity. On one hand, commune leaders did not always have sufficient resources to assist populations or provide nutrition guidance, particularly during periods of economic strain and climate-related crises such as flooding or drought. This study identified inconsistencies in the approaches taken by commune authorities, within and across the studied provinces to tackle food and nutrition insecurity, more specifically, revealing the fragmented and uneven prioritisation of nutrition within food security frameworks and information dissemination schemes. This was mirrored at the provincial level, with government departments and resource management institutions treating nutrition information dissemination with varying degrees of urgency. The lack of a cohesive approach across different levels of governance points to the need for more clear, integrated strategies to effectively address food security and nutrition and to achieve the objectives outlined in the NSFSN.

The shift towards a less nutritious diet during periods of low income reported by the respondents of this study undeniably had a significant impact on the physical health and well-being of all household members, as was explained in the literature review (Peña and Bacallao, 2002). Indeed, compromising the quality of one's diet can lead to nutritional deficiencies and other physical health problems such as anaemia and diabetes, leading to productivity and income loss. However, the psychological impact of doing so should not be overlooked. Research has shown that not having enough to eat or being unable to afford sufficiently nutritionally dense food has significant implications for individual mental health and wellbeing (Ejiokhuo et al. 2024; Thompson 2021). A report produced by Royal Holloway, University of London found that the psychological stress associated with taking on debt, overworking and being excluded from social life in order to meet daily dietary needs has led to increased rates of anxiety and poor mental health among rural Cambodians, fuelling a vicious cycle of poverty and food and nutrition insecurity (Iskander et al. 2022). As the effects of climate change are projected to intensify financial precarity and food insecurity in coming years, this issue emerges as an increasingly urgent one, underscoring the need to establish social safety nets and support systems providing households with debt relief and financial assistance during challenging times.

6. Conclusion

The Tonle Sap Lake and Cambodia's Mekong Delta, a socio-ecological system, is facing significant challenges due to the dual threats of climate change and economic growth. These threats have far-reaching implications, affecting food security on both local and global scales. In Cambodia, food insecurity and malnutrition are widespread issues despite the availability of foods required for a nutritionally diverse diet. Addressing these challenges is crucial for the sustainability and well-being of the communities that depend on this system. This research highlights the complex interplay of formal and informal barriers that affect Cambodians' food and nutrition intake.

Informal barriers to a complete and nutritionally sound diet are rooted in deeply entrenched gender-based societal norms and family dynamics. Gender roles were found to significantly influence eating patterns, dietary habits and therefore nutritional intake. This was particularly true for female heads of households, who frequently bore the brunt of these challenges. Despite a having a basic understanding of nutrition, detailed knowledge is limited especially among poorer households, with gaps in nutritional awareness observed between genders. The study highlights stark disparities in access to formal nutrition education, with many lacking essential knowledge typically imparted during school years.

On the other hand, formal barriers are typically associated with the costs of agriculture and infrastructure and insufficient governance arrangements. The high costs of agricultural inputs and climate-induced changes in agroecology pose significant farming challenges which are predominantly faced by female heads of households and women who lack sufficient income. Furthermore, the geographical distance of farmlands from water sources, alongside the rising cost of gasoline for water pumping and the increasing trading price of rice has led to heightened competition for water. This was, naturally, particularly challenging for those located far from water sources. The study also revealed that households face significant difficulties in food production due to rising input costs, decreasing yields and low market prices. Despite investments in infrastructure, there is a noticeable lack of initiatives aimed at enhancing nutritional understanding, with a focus on increasing the quantity of food available rather than its nutritional quality.

These issues were prevalent across various locations and posed a significant threat to food security, livelihoods and overall well-being, necessitating a comprehensive approach that addresses these formal and informal barriers to enhance food and nutrient consumption. This requires a multi-dimensional strategy that takes the intricate socio-economic and environmental factors at play into account while promoting sustainable practices, improving nutrition knowledge and tackling the root causes of these barriers. Only then can we hope to ensure food security and improve livelihoods in the Mekong Delta and beyond.

7. Recommendations

In light of these findings, the study suggests several interventions aimed at enhancing nutrition information access, alleviating food production constraints, and supporting vulnerable groups or households, to address immediate challenges, building household resilience and improving long-term food security and nutrition.

- **Community Engagement:** Communities need to be involved in the design and management of services related to nutrition and information. They should have access to services (including health, WASH, agriculture, and social protection) that they need and desire to attain optimal nutrition and food security. Strengthening the Commune Development Plan and the three-year rolling Commune Investment Plan for food security and nutrition is essential.
- **Social Assistance:** Social assistance programs aimed at mitigating barriers to health services and nutritious food can significantly alleviate malnutrition. The expansion of social assistance programmes, especially for vulnerable groups such as women and children, marks a substantial stride towards realising an effective social protection system and food security and nutrition in Cambodia.
- **Nutrition Education and Gender Equality:** Promoting public awareness about the availability of affordable nutritious foods and advocating for healthier eating choices

is essential. It is important to recognise women's primary role in managing household nutrition and the importance of their education in this area. Men should also be included in nutrition education, promoting a balanced distribution of domestic tasks and enhancing overall household food security and nutrition.

- **Climate change adaptation and disaster risk management:** The impacts of climate change and natural disasters can exacerbate the constraints that vulnerable groups such as women and children face in achieving food security and nutrition. It's crucial to build resilience in food production and distribution systems, thereby providing stability in food production and consumption through resilient food systems.

8. Limitations and areas for further research

The present study has several limitations. Firstly, its findings are limited to the experiences of a group of respondents from two rural provinces and do not reflect the food and nutrition security situation across Cambodia more generally, especially in urban areas where residents grapple with a very different set of challenges (Boonyabancha et al. 2019). This is particularly significant considering that, as mentioned previously, the study areas seem to be anomalous in the context of Cambodia in that many households engaged in livestock rearing and homegrown vegetable farming, rather than more typical activities of paddy rice cultivation and fishing. Additionally, while this study did shed light on the experiences of individuals from various socioeconomic backgrounds and roles within their communities, perspectives from other stakeholders such as healthcare providers who regularly engage with these communities and address pertinent issues, were not included. It is also worth noting that these findings do not capture long-term trends in food and nutrition security in Cambodia.

With this in mind, this study makes the following suggestions for future research:

- Conduct a similarly comprehensive study on food consumption and nutritional intake in urban areas in order to gain a more well-rounded understanding of consumption practices and nutritional outcomes in Cambodia, given the unique socioeconomic conditions in rural areas that are not found in cities.
- Conduct a quantitative study using survey data to compare and assess the prevalence and severity of different factors affecting nutritional intake across different urban and rural settings in Cambodia.
- Conduct a study involving healthcare providers, practitioners or volunteers in order to gain their perspectives on current food and nutrition security issues and identify key challenges in health and social care that require attention in order to effectively address these.
- Conduct further research assessing the impacts of sustainable farming practices (such as climate-smart or conservation agriculture) on the food and nutrition security of rural Cambodians.

Appendix

Table A1. The details of target groups and study sites for the interviews

Province	District	Commune	Village	FGDs	KIIs
Beung Ream (Community Fish Refuge)					
• Kampong Thom	Santuk	Kakaoh	<ul style="list-style-type: none"> Chey Chumneah Samnak 	1. FGD with Women-headed households of Community Fish Refuge Boeng Ream (2 groups) 2. FGD with Poor Women of Community Fish Refuge Boeng Ream (2 groups) 3. FGD with poor men of Community Fish Refuge Boeng Ream (2 groups) 4. FGD with Non-poor women of Community Fish Refuge Boeng Ream (2 groups) 5. FGD with Non-poor men of Community Fish Refuge Boeng Ream (2 groups)	1. KII with the deputy village chief of Samnak 2. KII with the village chief of Chey Chumneah 3. KII with commune council member of Kakaoh commune 4. KII with Deputy Director of the District Office of Agriculture, Water Resources, and Environment 5. KII with the chief of Kampong Thom Province Fisheries Administration 6. KII with the deputy chief of Community Fish Refuge 7. KII with the chief of Tang Krosang Water Consumer Community 8. KII with the director Provincial Department of Water Resources and Meteorology (PDWRAM) 9. KII with the deputy chief of the Provincial Department of Environment (PDOE) 10. KII with the deputy director of the Provincial Department of Agriculture (PD AFF)
Ta Soung Irrigation Scheme					
• Takeo	Prey Kabbas	Kampong Reab	<ul style="list-style-type: none"> Kanhchel Kampong Reab 	1. FGD with Women Headed-House of Ta Soung Irrigation Scheme (2 groups) 2. FGD with Poor Women of Ta Soung Irrigation Scheme (2 groups) 3. FGD with poor men of Ta Soung Irrigation Scheme (2 groups) 4. FGD with Non-poor women of Ta Soung Irrigation Scheme (2 groups) 5. FGD with Non-poor men of Ta Soung Irrigation Scheme (2 groups)	1. KII with Kampong Reab village chief 2. KII with Kanhchel village chief 3. KII with the commune chief of Kampong Reap Commune 4. KII with Chief of Ta Soung Water Consumer Community 5. KII with the Chief of Kampong Reab Fishing Community 6. KII with Director of District Office of Agriculture, Water Resource and Environment 7. KII with Deputy Director of Fishery Administration 8. KII with the Provincial Department of Environment 9. KII with Director Office of Water Resources and Meteorology
Total				20 groups	19 respondents

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