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Addressing occupational safety and health challenges linked to **CLIMATE CHANGE** in agricultural supply chains in Viet Nam

RESEARCH REPORT

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Central Highlands Viet Nam, ILO Vision Zero Fund 2024

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Abbreviations

ADB Asian Development Bank

CSPH Colorado School of Public Health

CU University of Colorado

GHG Greenhouse gas

HUPH Hanoi University Public Health

IFPRI International Food Policy Research Institute

IFPRI International Food Policy Resource Institute

ILO International Labor Organization

IMHEN Institute of Meteorology, Hydrology and Environment

IPCC Intergovernmental Panel on Climate Change

LMIC Low- and Middle-Income Countries

MARD Ministry of Agriculture and Rural Development

MOIT Ministry of Investment and Trade

MONRE Ministry of Natural Resources and Environment

MOT Ministry of Transport

MPI Ministry of Planning and Investment

MRC Mekong River Commission

NGO Non-Governmental Organization

NTP-RCC National Target Program to Respond to Climate Change

REDD United Nations Collaborative Program on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

SOE State Owned Enterprise

UNDP United Nations Development Program

UNFCCC United Nations Framework Convention on Climate Change

VCCI Viet Nam Chamber of Commerce and Industry

VHI Vietnamese Health Insurance Program

VN Viet Nam

VZF Vision Zero Fund

Executive Summary

Purpose

This study aimed to explore opportunities for occupational safety and health strategies to adapt to the impacts of climate change for small-scale farmers in Viet Nam. Viet Nam is ranked sixth among all countries in the world affected by climate variability and extreme weather. Given Viet Nam's substantial agricultural sector, understanding climate change-related hazards experienced by agricultural workers is essential to safeguarding safety, health and well-being of agricultural workers.

Objectives

The study had three primary objectives:

1. Identify the key climate change- related occupational safety and health hazards faced by agricultural workers.
2. Gain insights into agricultural workers' perspectives on climate, safety, health and their well-being.
3. Propose adaptive strategies to enhance the safety, health, and wellbeing of agricultural workers (key target groups for strategy implementation: policy makers, government agencies and research institutes, community organisations, health service providers, training providers, companies).

Approach

To achieve these objectives the methodological approach involved:

1. Conducting a comprehensive literature review.
2. Collecting and analysing qualitative data in three provinces in Viet Nam.
3. Synthesizing study findings and providing recommendations for adaptive strategies.
4. Holding a technical validation meeting with diverse stakeholders in Viet Nam.

Results

The study identified four primary climate change-related hazards impacting safety, health and well-being of agricultural workers:

1. Extreme weather events, such as drought and floods.
2. Rising temperatures.
3. Sea level rise and salinity intrusion.
4. Increase in biological hazards.

Synthesizing these results led to the development of a framework for prioritizing adaptive strategies, incorporating prevention and implementation through the hierarchy of controls. Four key opportunities emerged from the synthesis:

1. Adaptive strategies should address multiple climate change-related hazards, considering variations of hazard impact across agricultural sectors and regions.
2. Implementation and evaluation designs should prioritize scientific rigor to provide a representative evidence base.
3. Intervention designs should seek to reduce inequities in climate change-related hazard impacts among subpopulations of agricultural workers.
4. Adaptive strategies should address both the physical and mental health impacts of climate change-related hazards, recognizing the increasing psychosocial challenges and the potential co-benefits of an integrated physical and mental health approach.

Future Directions

In designing pilot studies to test adaptive strategies, active involvement of agriculture workers throughout the process is recommended. A community based participatory research approach can enhance the uptake of recommendations and facilitate learning about the feasibility, effectiveness, sustainability, and scalability of interventions.



INTRODUCTION

Climate Change and Occupational Safety and Health

The Global Climate Risk Index 2020 ranked Viet Nam sixth among all countries in the world most affected by climate variability with 3260 km of coastline, 3000 islands, and over 70% of the population living in low lying coastal plains.¹ A rise in the sea level, temperatures, extreme weather events and biological hazards are projected to become even more severe in the coming decades.² The majority of the 2.5 million households living under the poverty line are mostly small-scale farmers.¹ Consequently, the Vietnamese government recently developed the [National Climate Change Adaptation Plan](#). The main goal of this plan is to reduce vulnerability and risk to the impacts of climate change through strengthening the resilience and adaptive capacity of communities, economic sectors, and ecosystems and to promote the integration of climate change adaptation into the strategic and planning system.

Agriculture is highly dependent on weather, including high and low temperatures, rainfall, wind intensity, and many other variables, which can place the sustainability of farmers' livelihoods under threat. Research has begun to examine the interactive effects between climate change on agricultural crop productivity and the farmer workforce and indicates that that climate change not only reduces crop yields with important impacts for global food security, but also impacts labor productivity as outdoor workers are increasingly exposed to climate change hazards.³ Approximately 28% of Viet Nam's total land area is suitable for agricultural with the highest production capacity in lowland areas.⁴ Reports by the Ministry of Natural Resources and Environment (MONRE) in Viet Nam show average temperature increases between 1.9 and 3.1 degrees Celsius with most extreme increases in the Central Region of more than 3.1 degrees Celsius.⁴ MONRE projects that the days with temperatures above 35 degrees Celsius are predicted to increase by 10-20 days nationally.⁴

Agricultural workers are one of the populations most exposed to climate change-related occupational safety and health hazards.^{3,5-8} In comparison to the general workforce, outdoor agricultural workers face increased exposure to climate change related hazards, including heat, UV radiation, increased pesticide and herbicide exposure, and exposure to vector borne diseases.⁹ The health effects of internal metabolic heat produced from physical activity combined with external heat in the environment and solar radiation, can result in heat stress and/or exacerbate existing chronic health conditions.⁹⁻¹¹ In addition, other climate change related hazards for outdoor agricultural workers include an increase in extreme weather events that can trigger mental fatigue and increases the risk of occupational accidents, cancers related to ultraviolet radiation (UV), water scarcity, exposure to vector borne diseases, increased usage of pesticides and herbicides, and hazards related to sea level rise such as salinity intrusion which has been linked to increasing prevalence of hypertension.¹²

Beyond these direct effects of climate change on agricultural worker safety and health, indirect effects of climate change pose challenges. The United Nations Development Programme estimates that sea level rise could reduce rice productivity by 9%, threatening livelihoods, and pushing agricultural workers to transition crops or farming strategies, such as alternating rice and shrimp

farming, that could lead to greater occupational safety and health hazards without corresponding training and safety protections in these new practices.^{13,14} Increasingly, global attention has focused on the intersection of climate change and mental health and wellbeing. Increased stress related to uncertainty of livelihood sustainability can lead to anxiety and depressive disorders; extreme weather events are closely linked to Post-Traumatic Stress Disorder (PTSD), and evidence also suggests that these stressors can exacerbate pre-existing psychiatric conditions and lead to increased prevalence of intimate partner violence.¹⁵⁻¹⁷

Another indirect effect of climate change is projected increases in human migration from susceptible regions (mountainous and delta regions in floodplains) to other regions.¹⁸ Seasonal or permanent migration can further destabilize families and communities already vulnerable to climate change.⁵ For example, if male head of households migrate away from home, women are responsible for completing all agricultural work within the existing family plot, which can increase women's exposure to heat stress, pesticides, herbicides, vector-borne diseases and extreme weather events.^{19,20} Their exposure to climate change-related OSH risks is also increased by inequality in accessing OSH training. Studies show that women are less likely than men to receive OSH training in response to climate variability because their dual responsibility for caregiving and household chores limits time available to attend trainings.²¹ This gap in equal access to occupational safety and health training by gender is crucial, especially as migration by male heads of households due to climate change is expected to increase.²²⁻²⁴ Migration by male heads of households will increase women's workload on the farm and their exposure to OSH risks, generally and in relation to climate change.

Further, extensive evidence supports that women in Low- and Middle-Income Countries (LMIC) are already more vulnerable to climate change impacts and have lower access to resources that enable adaptive capacities in comparison to men.^{21,25-27} In Viet Nam, female farmers comprise half of the agricultural labour force.²⁸ Traditional gender norms have been cited as potential determinants of women's increased risk for climate change impacts.²⁰ For example, women are often responsible for water collection for households potentially increasing risk for heat stress and vector-borne disease.^{20,29} In Viet Nam, MONRE reported that the poorest women are at highest risk for climate change impacts including effects on food security and mental wellbeing.^{30,31} Despite the factors that increase women's exposure to stress, study results show women are active in contributing to decisions over farm work.³² Women's rights over land use significantly determine adaptive capacity for climate change impacts, however approximately 60% of farmers in one study reported that both husband and wife have rights over land use while 31% reported that only the husband has land-use rights.³⁰ Still, in comparison to other Asian countries, equality in land ownership in Viet Nam is better because of land reforms launched by the government.³³ Gender differences also exist in preferences for climate change adaptation strategies with men preferring shorter-term solutions and women preferring longer-term, technical adaptation strategies.²¹ A better understanding of the intersection of climate change and Occupational Safety and Health is needed to design and implement appropriate preventive and adaptive strategies tailored to countries, provinces and communities.

A Multi-sectoral Research Approach

Viet Nam is comprised of varied terrain which creates geographic and sector specific differences by region. To develop as broad a view as possible this report focuses on three provinces that represent the South, Central, and Northern regions within Viet Nam. Within each province we selected specific crop sectors in consultation with national stakeholders. Study sites were selected for three primary reasons:

1. To assess for differences in prioritizing adaptive strategies between agricultural sectors or alternatively, if cross-sectoral adaptive strategies are needed, feasible and acceptable.
2. To compare how differences in climate change related hazards are perceived and what adaptive capacities or resources are available by sector.
3. To understand how cross-cutting worker vulnerabilities (e.g. gender) is experienced differently across sectors.

Rice Sector

Agriculture in Viet Nam is dominated by rice production, which comprises approximately 75% of the total agricultural production value.⁴ Rice is an important source of income for over 60 million people in Viet Nam.⁴ The two main rice producing regions in Viet Nam are the Mekong River Delta and the Red River Delta.³⁴ The area of rice cultivation has declined on an annual basis since 2016-2017, in part due to the areas being susceptible to salinity intrusion.³⁴

Can Tho

Can Tho is located in southern Viet Nam on the banks of the Hau Giang River. It has an estimated population of 1,250,792 making it the fourth largest city in Viet Nam.³⁵ Particularly in Can Tho, the rice cultivation area spans approximately 80,000 hectares, with the majority of farmers cultivating rice three times a year. According to reports from the agricultural sector, mechanization in rice production, especially in planting and harvesting, has reached almost 98%. In Can Tho, 71.5% of residents live in urban areas, while 28.5% live in rural areas.³⁵ The city recorded a 12.65% growth in Gross Regional Domestic Product (GRDP) in 2022, its highest recorded increase.³⁶ The largest growths in GRDP are due to industry and construction centre with 18.18%, accounting for 31.03% of the cities total GRDP. This is followed by the service sector accounting for 52.47%, and agro-forestry and fishery accounting for 9.65% of the GRDP.³⁶ A study in the Mekong Delta found two times more female rice farmers than men.³²

Coffee Sector

Coffee is an important part of the rural economy of Viet Nam, employing 3% of the total agrarian labour force, and 1.4 million agricultural workers, second only to rice.³⁷ While the Viet Nam economy experienced improvement from 1998 to 2002, more than half the population of the coffee producing regions was still living in poverty.³⁷ Despite this dependence of the region on coffee production, it is estimated that under unmitigated climate change scenarios growing conditions in Viet Nam will become unsuitable.³⁸

Lam Dong

Lam Dong province is in the Central Highlands region of Viet Nam where 70% of its area is covered in forest and has a population of just over 1.3 million people with 43 ethnic groups.³⁹ In Lam Dong, 21.7% of the land is for agricultural cultivation.³⁹ In 2020, the region had a GRDP of 112.2 million USD. The GRDP economic growth rate is high, with an average increase of 8% from 2016-2020.³⁶ The region is known for its coffee production, flower cultivation, vegetables, tea, and other agricultural products.

Fruit & Vegetable Sector

The fruit and vegetable sector in Viet Nam has been rapidly growing, from contributing USD 56.1 million from exports in 1995 to USD 300 million in 2007.⁴⁰ Like rice, the primary growing regions are the Mekong River Delta and the Red River Delta which are responsible for 21% and 26% of the total fruit & vegetable growing area in the country, respectively.⁴⁰ However, due to urbanization, the cultivation areas around Ho Chi Minh City and Hanoi have been diminishing.⁴¹

Ninh Binh

Ninh Binh is in the southern Red River Delta and has a population of 1,007,600 people.³⁵ Ninh Binh is known for rice production and rice is a staple crop, however, fruit cultivation such as oranges, pomelos, litchis, and bananas is an important sector. 21.49% of people in the region live in urban areas, while 78.51 % live in rural areas.³⁵ The region has a GRDP of 3.61 billion USD, or 3,118 USD per capita, with a growth rate of 10.09%. Construction is the largest contributor to Ninh Binh's economy at 46.7%, followed by services at 41.8%, and agriculture, forestry, and fishery at 11.5%.³⁵

Project Phases

Within this context, the overall aim of this project funded by the International Labor Organization (ILO) was to identify the main climate change-related safety and health hazards to which agricultural workers in Viet Nam are exposed. The present study sought to raise awareness and identify opportunities to increase resilience of direct beneficiaries such as ILO's tripartite constituents (governments, employers', and workers' organizations) and other key stakeholders to climate change-related occupational safety and health hazards. Ultimate beneficiaries for mitigating vulnerabilities are women and men working in the agricultural sector.

The project consisted of 3 phases: 1) inception and desk review, 2) field data collection, 3) co-creation of adaptive solutions. The project ran from April 2023 to October 2023. Details on the methodology can be found in Annex 1.



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A farming woman spreads fertilizer in a paddy field, ILO 2024



RESULTS

Climate Change Policies and Programs in Viet Nam

1. National Climate Change Strategy (Decision No.1326/QD-TTg): This program aims to enhance the capacity of national and local authorities to address climate change and develop adaptation and mitigation measures. It includes projects related to renewable energy, sustainable agriculture, natural resource management, and disaster risk reduction.

2. National Target Program on Climate Change Response (Decision No. 2145/QD-TTg): This program focuses on implementing climate change adaptation and mitigation measures. It includes initiatives such as afforestation, sustainable land management, climate-resilient infrastructure, and capacity building for vulnerable communities.

3. Viet Nam's Just Energy Transition Partnership (JETP): JETP is a collaborative initiative that aims to facilitate a sustainable and equitable transition towards cleaner energy sources in Viet Nam. The primary goal of the JETP is to promote the adoption of renewable energy sources while ensuring fair and inclusive for vulnerable workers. The initiative seeks to mitigate social and environmental impacts, promote energy access and affordability and enhance overall sustainability in Viet Nam's energy sector.

4. Intended Nationally Determined Contributions (INDC) and Nationally Determined Contributions (NDC): Viet Nam submitted its INDC to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 and subsequently converted it to an NDC. The NDC outlines Viet Nam's commitment to reducing greenhouse gas emissions and improving climate resilience. The specific targets include reducing emissions by 8% by 2030 compared to business-as-usual (BAU) levels and increasing the share of renewable energy in the total primary energy supply to around 10% by 2030.

5. National Council of Sustainable Development: Established in 2005, this council leads implementation of the Strategic Orientation for Sustainable Development in Viet Nam and is chaired by the Deputy Prime Minister. The Council is charged with organization of cross-sectoral and cross-regional activities in development planning.

6. Renewable Energy Development Strategy (Decision No. 428/QD-TTg): Viet Nam has set a goal to increase the share of renewable energy in its energy mix. The government has implemented various mechanisms and incentives to promote renewable energy projects, including feed-in tariffs, tax exemptions, and preferential loans. The aim is to reduce dependence on fossil fuels and increase the use of sources such as solar, wind, and biomass energy.

7. National REDD+ Program: Viet Nam has been actively participating in Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiatives. The National REDD+ Program aims to reduce greenhouse gas emissions by incentivizing forest protection and sustainable management. It involves various activities such as improving forest governance, enhancing law enforcement, and promoting sustainable livelihoods for local communities dependent on forests.

8. Resolution on National Food Security (Resolution No. 63/2009/NQ-CP): Adopted in 2009, this resolution is a policy that outlines the government's strategies and measures to ensure food security. The resolution includes both short-term measures to stabilize food supply and prices, as well as long-term strategies to enhance domestic production, improve food distribution systems, and to strengthen agricultural resilience to climate change.

9. Agricultural Industry Structural Plan for 2021-2025 (Resolution No. 26/2008/NQ-TW): Adopted in 2008, this resolution outlines agricultural development policies, programs and investments to enhance the sector's productivity, sustainability, and competitiveness. It prioritises diversification of agricultural products, sustainable agricultural practices, modernization of agricultural infrastructure, technology adoption, agricultural research, and strategies to enhance rural development and livelihoods.

10. Scheme for Restructuring Viet Nam's Rice Sector by 2025 and 2030 (Decision No. 555/QD-BNN-TT). Sets specific objectives such as maintaining 3.6 hectares in paddy production by 2025; reducing use of chemical fertilisers by 30% by 2025; reduce GHG emission in rice production by 5% by 2025; and ensuring that farmers receive at least 30% profit by 2025.

11. Governmental Strategies to Promote Sustainable Coffee Production: The Vietnamese government coffee production sustainability strategy includes limiting coffee cultivation to 600,000 ha, integrated pest management (IPM) and promoting responsible use of chemicals, adoption of agroforestry systems and shade-grown coffee cultivation, soil and water conservation, certification programs such as Rainforest Alliance, UTZ, and FairTrade certification and research to optimize crop management practices.



Occupational Safety and Health Laws, Policies and Programs in Viet Nam

Occupational health and safety laws, regulations and programs are governed by the Ministry of Labour, Invalids and Social Affairs (MOLISA). Key documents are summarized below.

1. Law on Occupational Safety and Health (Law No. 84/2015/QH13): The Law on Occupational Safety and Health (OSH Law) sets the legal framework for ensuring safe and healthy working conditions in Viet Nam. It establishes the rights and obligations of employers, employees, informal workers, household business and relevant authorities regarding OSH.

- 1. Labour Code of Viet Nam (2019):** The Labour Code of Viet Nam addresses various aspects of employment, including OSH. It outlines the rights and obligations of employers and employees and establishes minimum standards for working conditions, including workplace safety and health.
- 2. Decree No. 140/2018/ND-CP:** This decree details some articles of the OSH Law (No.84/2015/QH13), including technical inspections of occupational safety measures, OSH training and monitoring of the occupational environment.
- 3. National Program on Occupational Safety and Health (OSH) for the 2021 – 2025 period:** The program focuses on 1) Prevention of occupational accidents and diseases, 2) Improvement of occupational health services, 3) Provision of OSH training, 4) Improvement of compensation and allowances for workers who had an occupational accident or are suffering from an occupational disease, and 5) Improvement of reporting and investigation of fatal occupational accidents. Until 2025, the program aims to achieve eight targets, incl. an annual reduction of fatal occupational accidents by 4%. Multiple state agencies at national and provincial levels as well as employer and worker organisations are involved in the implementation of the program, led by MOLISA.

Socio-political Organizations

Additional support is provided to farmers through the Viet Nam's Farmers' Union (VNFU), a socio-political organization under the leadership of the Communist Party in Viet Nam which is representing the interests of farmers. It promotes learning and skills improvement among farmers and adherence to the regulations set by the Communist Party and the government. It also plays an important role in promoting occupational safety and hygiene to safeguard the health of farmers. The Farmers' Union at central level guides the association in administrative and political matters. The Farmers' Union at provincial, district and commune levels implements the VNFU's policies and programs.

The Viet Nam Women's Union (VWU) is another important socio-political organization, represented throughout the country. It represents and promotes the legal and legitimate rights and interests of women workers in Viet Nam, including female farmers. Its primary role involves advocacy and mobilization to support women. They implement strategies, policies and programs that contribute to gender equality. While they do not directly engage in agricultural production, they do empower women to participate in agricultural production.

National Health Care System

Viet Nam's health care is built on a 4-tier system (central, province, district, and commune). In 1992 Viet Nam implemented the Viet Nam Health Insurance Program (VHI) providing the right to health care for all citizens. In 2003, the Health Care Fund for the Poor was launched, a government financed program for poor, ethnic minorities in selected mountainous areas and all households living in communes officially designated as highly disadvantaged. In 2008, Viet Nam instituted the first Health Insurance law, moving towards an integrated social health protection system. In 2018 population coverage reached 87.7% with an estimated 71.5 million people covered by social health insurance. Viet Nam also has a growing private healthcare sector, though private healthcare is more prevalent in urban areas.⁴² Viet Nam has placed emphasis on disease prevention and control through public health immunization campaigns, infectious disease surveillance, health education and environmental health initiatives.

The ILO/WHO Policy Brief on Mental Health at Work (2022) reports that in 2019 globally 301 million people lived with anxiety, 280 million people lived with depression, and 12 billion working days are lost every year due to anxiety and depression. Also, 50% of total societal cost of mental health conditions is driven by indirect costs such as reduced productivity. With 60% of the world's population in work and 61% of the world's population working in the informal economy, these figures suggest that a high percentage of the global workforce is affected by mental health issues. Workers in the informal economy, including in agriculture, are particularly vulnerable as they operate in environments with no regulatory protection. These workers may face heightened threats to their mental and physical health through lack of structural support. Apart from working in unsafe and unhealthy conditions, they may also have to work long hours, have low income, have little or no access to social or financial protections, and face discrimination - all of which may further undermine mental health and limit access to mental health care.⁴³

The compounding effect that climate change can have on farmers' livelihoods and the OSH risks they are exposed to increases their risk to suffer from work-related stress and other mental health outcomes. Based on information from the Mental Health Atlas 2022, Viet Nam has, since 2020, a Mental Health Policy in place, and mental health is promoted through the National Target Program on Population and Health. While it covers work-related mental health prevention and promotion, mental health and the psychosocial component of disaster preparedness and disaster risk reduction are not included yet. There were 7 community-based mental health services in the country (incl. community-based outpatient facilities and mental health residential facilities for adults). The number of community-based mental health facilities per 100,000 population was 0.007, which leaves the rural population largely underserved if they are in need of mental health support and treatment.⁴⁴

Occupational Safety & Health Survey: General Findings

In total, 41 agricultural workers who were not involved in other work completed brief surveys (Annex 3) after participating in focus group discussions, including 20 male and 21 female participants. For some questions there was missing data. Results reported reflect percentages for participants who did respond to the question. The analytical sample was composed of participants from Can Tho (N=17), Lam Dong (N=14), and Ninh Binh (N=10). The mean age of participants was 51 years.

In total, 17.5% of respondents indicated that they were injured because of work and 63% reported that they were sick because of work. Repetitive movements with hands or wrists for at least 3 hours per day was the most reported hazard (N=23; 57.5%), followed by lifting or carrying items heavier than 20kg at least ten times during the day (N=18; 43.9%). Four questions assessed workers' occupational safety and health knowledge on a four-point Likert scale (1=strongly disagree to 4=strongly agree). On average, workers agreed that they are aware of rights and responsibilities in relation to OSH (Mean: 3.4; Std. Dev.: 0.8), know how to perform their job safely (Mean: 3.6; Std. Dev.: 0.8), have the knowledge to assist in responding to an OSH concern (Mean: 3.6; Std. Dev.: 0.5), and know the necessary precautions to take doing their job (Mean: 3.7; Std. Dev.: 0.5).





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Climate change-related Hazards: Findings

Four primary climate change-related hazards emerged as priority areas for adaptation, namely: (1) Extreme weather events (within this category, flooding and drought were identified as important events); (2) Increasing temperatures; (3) Sea level rise and salinity intrusion; and (4) Increase in biological hazards and exposure to vector-borne diseases, as well as increased reliance/use/exposure to agrochemicals. A summary of these climate hazards, including primary affected regions and associated safety and health-related impacts is provided in Table 3.

Table 3. Climate change-related hazards by region

Climate change related hazards	Primary Regions	Summary
Extreme weather events	North, Central, South	Frequency of acute illness after working fields in harsh weather, increased risk to fatal/nonfatal injuries and deaths, limited timely access to health facilities.
Flooding	South, Central	Increased risk to injury and death, reduced food availability and fresh water, limited availability of comprehensive risk assessments and corresponding flood management plans, support to strengthen and disseminate community efforts.
Drought	South, Central, North	Increased risks to physical health, financial impacts, farmers willing to adapt but need government support, adaptation primarily focused on technical
Increasing Temperatures	North, Central, South	Disparities in the number who experience symptoms related to high temperatures (83%) and those that seek medical care to manage these symptoms (22%). ⁴⁵
Salinity Intrusion	South	Reduced profitability leads to the need to work longer hours, negative impacts to mental health, need to transition from crops to aquaculture or livestock. Need for new skillsets and training to support transition. Insurance as an effective strategy to protect against salinity impacts.
Increase in biological hazards	South, North, Central	Increased spread of pests and disease, increased use and exposure to agrochemicals (pesticides and herbicides), limited knowledge of safe practices in use of agrochemicals, limited use of PPE because of lack of comfort using PPE in heat.

Extreme Weather Events

Climate modelling has shown that there is uncertainty around both precipitation trends as well as the increasing intensity of extreme weather events.⁴⁶ In the South-Central region annual rainfall has increased up to 20% over the last half-century while the Northern part of the country has experienced decreases in annual precipitation,⁴⁷ with 89% of participants reporting that droughts have gotten worse over the last 10 years. As one female member of the Can Tho focus group noted, *“in the past, we saw only storms. Now, superstorms appear more frequent.”* Additionally, *“excessive rainfall can lead to dangerous landslides, as seen in Đà Lạt, where lives were lost”* which was described by participants in Lam Dong.

Of all climate change related hazards discussed, extreme weather events and disasters show the most direct attributional effects on mental health and wellbeing. 85% of the participants acknowledged a change in rainfall patterns. As noted by a male participant from Can Tho, *“natural disasters and floods no longer follow a regular pattern...affect[ing] people’s lives in numerous and substantial ways.”* Direct effects from disasters have clear impacts on psychosocial health (PTSD, anxiety, depression, suicide), however, indirect effects also impact mental health caused by damage to physical and social infrastructure, food and water shortages, displacement, and loss of livelihood.⁴⁸ As noted by a male participant in Lam Dong, *“some years, we experience prolonged periods of drought, while in other years, there’s excessive rainfall. [This is] one of the most significant [climate related] impact on agriculture, affecting crop yields.”* Inattention to the mental health of agricultural workers is a critical gap given that psychological impacts from any disaster or extreme weather events exceeds physical injuries by 40 to 1 and climate change disasters have increased by 46%.⁴⁹

Flooding

River flooding is one of the most substantial environmental hazards in Viet Nam. In 2020 it was estimated that 11.8 million people in Viet Nam were directly exposed to intense flood risk, and under varying climate change models this figure could increase by several million more people per year by 2070-2100.⁴⁶ While 60% of participants attribute frequent flooding to climate change, 83% acknowledged an increase in flooding over the past 10 years. Flooding was one of the more commonly researched hazards as it relates to agricultural worker health and safety in Viet Nam. Slipping, falling, and traffic accidents arise due to slippery conditions and steep terrain, which was echoed in the Lam Dong focus female focus group where a participant noted, *“Heavy rain, slippery conditions, landslides. The terrain here is steep, making transportation difficult. Safety issues arise such as slipping, falling, traffic accidents, etc.”* Common concerns of floods include drowning and the spread of disease.⁵⁰ Focus group participants shared with us instances of drowning “because there were no signs or warning signs.” These tragic losses could be prevented by training agricultural workers and union leaders in the risks of open/ accessible water without proper signage and methods to reduce this risk (e.g., gating off standing water). Other impacts discussed included those on infrastructure, crop yield, and human life.

In a study of 459 households in the Mekong Delta, researchers found that nearly half of participants disagreed with the statement *“I am confident that the health of my family members will not be negatively affected by floods.”*⁵¹ Farmers highlighted that the unpredictability of weather and floods have significant impacts on their psychological wellbeing. Workers who live in low-lying areas and near riverbanks are especially concerned about the risk of landslides. Electricity and water were brought up as a secondary concern.

Farmers noted that during lightning storms there is the possibility of electrocution. This was echoed in the validation meeting where there was a concern of increased electrocution due to having faulty electrical equipment in the fields during floods. Flooding also has direct mental health consequences with psychological impacts more commonly reported than physical effects.⁴⁸

Droughts

From 1900 to 2018 Viet Nam experienced 6 droughts affecting 7.8 million people.⁴ Droughts have become more severe, frequent, and erratic in the Central Highlands.⁵² Currently Viet Nam faces a 4% annual probability of experiencing a severe meteorological drought.⁴ While in the short term exposure to drought can lead to increased illness risk, exposure to prolonged drought in early life can affect nutritional status which has the potential to lead to delays in schooling, declines in total educational attainment, and lower lifetime earning potential.⁵³ Droughts can degrade the quality of potable water increasing the spread of infectious diseases.⁵⁴ Farming is highly dependent on water availability.

Drought can lead to mental distress when the lack of water impacts agricultural productivity.⁵⁴ This was discussed in the focus groups with a coffee farmer in Lam Dong highlighting that that *"in years when sunshine and drought come early, coffee beans become very small with thicker shells, impacting the yield, productivity of coffee plants, and people's livelihood."* The effect of drought was summarized by another Lam Dong participant, *"drought affects productivity and has an impact on people's lives, making lives of farmers more challenging."* Empirical data supports this observation. It has been shown that farmers who live in more drought-affected areas had a 40% reduction in rice production compared to those living in less drought-affected areas.⁵³ This is important as 89% of participants reported that droughts have gotten worse in the past 10 years.

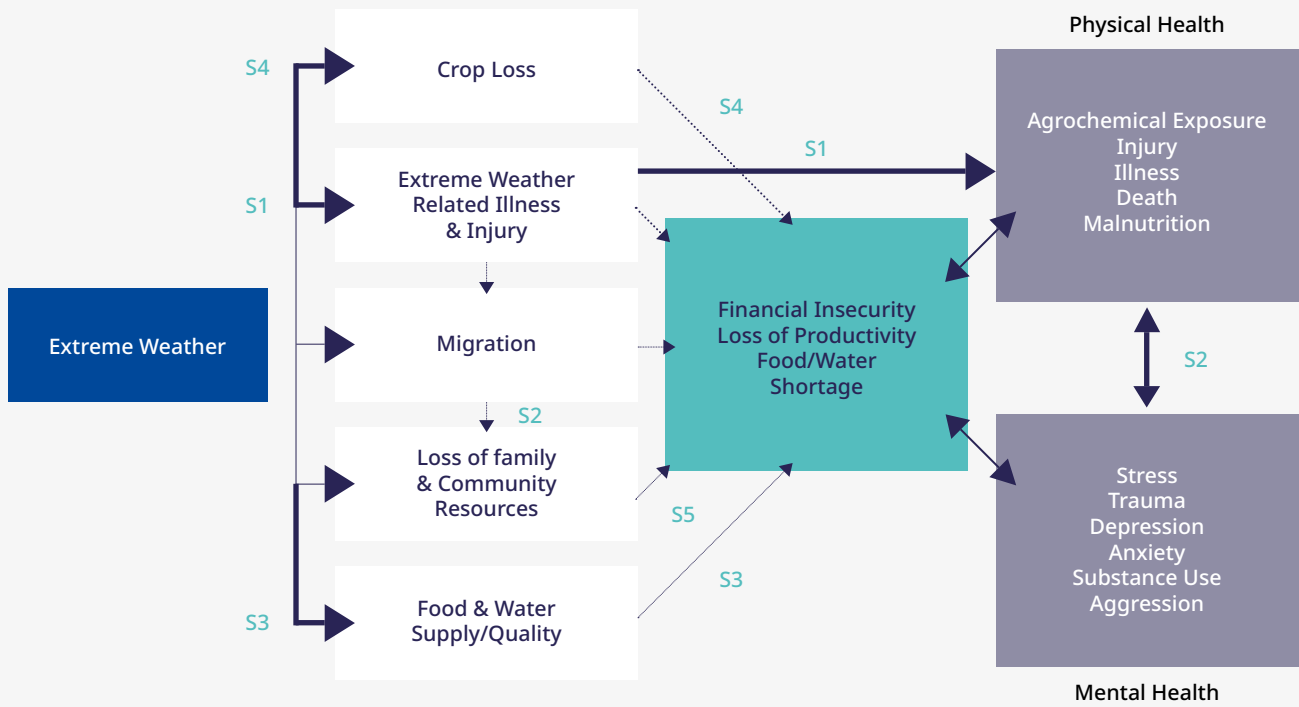
High-risk group of workers

Research has found that ethnic minority communities are most at risk of experiencing negative impacts of flooding due to being marginalized geographically, socially, economically, and politically.⁵⁵ The most sensitive groups are those living without health insurance, without adequate food, no land tenure document, and those who rely on natural water resources.⁵⁵ The ability to discharge water was discussed during the focus groups, noting that when farmers can discharge water it can help prevent floods. Individuals who rely on wells for drinking water are highly susceptible to the physical health impacts of drought.⁵⁴

Extreme weather events increase risks to mental health and wellbeing. Mental health impacts of extreme weather events include Post-Traumatic Stress Disorder (PTSD), anxiety and depressive disorders, behavioural disorders and can worsen pre-existing mental health conditions.^{56,57} Children and adolescents may be particularly vulnerable because they have less coping strategies than adults and are dependent on caregivers and their environment.⁵⁸ Meta analyses also show that female, lower socio-economic status, and lower education level were population groups at high risk to mental health conditions because of exposure to extreme weather events.⁵⁹ While statistics specifically for workers are unavailable, in Asia mental health impairment because of extreme weather events is estimated to affect 26.4% of the general population.⁶⁰

Recommendations to Mitigate OSH Risks Linked to Extreme Weather

Figure 5. Extreme Weather and Health Impact Path Model



*Note: solid lines indicate direct pathways; dashed lines indicate indirect pathways; thickness of lines is representative of the strength of evidence from the literature review, qualitative analysis and validation meeting.

S1: Technical support for disaster preparedness plans and training: (1) surveillance, monitoring, and rapid communication of disaster risk; (2) farming methods to mitigate disaster impacts; (3) efficient mobilization of resources to respond to disaster; (4) training in signs and symptoms of illness and injury as well as general awareness around OSH and disasters, for example exposure to hazardous substances in the aftermath of a natural disaster (for example debris made of asbestos).

S2: Increase mental health preparedness for extreme weather events: (1) Train workers to improve knowledge of appropriate psychosocial responses to extreme weather; (2) improve self-efficacy in response to acute distress; (3) expand coping skills with death and other negative events; (4) invest in a preparation for stepped-care approaches following disasters that support different levels of interventions dependent on the timing of the event and the level of distress; (5) improve access and funding to mental health care systems.

S3: Implement targeted strategies to maintain food and water supply/quality: (1) implement surveillance systems that alert needs for food and water distribution; (2) develop disaster preparedness plans for distributing water and food; (3) rapid response to divert irrigation water to potable water during extreme events; (4) remodel irrigation and drainage systems to meet demands of an increasingly diversified agricultural sector;⁶¹(5) use agroforestry methods that use diverse and resilient species that have multiple uses, including food, feed and goods for cash.⁶²

S4: Invest in long-term strategies to support crops that are more resilient to extreme weather: (1) modifying cultivation practices (e.g. fruit trees instead of rice in flood-prone provinces or combined agriculture/aquaculture rotation); (2) diversify crops; (3) consolidate farms for collective sharing of work; (4) test varieties of crops more resilient to extremes (floods/droughts); (4) land use planning (e.g. investing in more effective firebreaks)

S5: Build capacity for microfinance loans: (1) support collective efforts to mobilize resources for loss of crops, livelihood, destruction of assets by building capacity to deliver loans, design collective saving schemes, insurance and other financial services⁶³; (2) ensure transparency and accountability in resource use; (3) prioritize access by populations most vulnerable and sensitive to extreme weather event impacts to support equity.

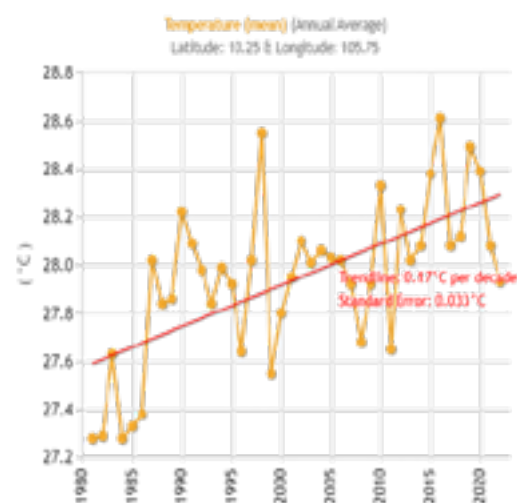
Potential implementing agencies: disaster preparedness and management authorities at national, provincial, district and community levels, specialized technical departments of the Ministry of Agriculture and Rural Development, government agencies tasked with social protection and social assistance programmes, agricultural advisers, health care service providers, microfinance agencies.

Increasing Temperatures and Heat

Increasing temperatures associated with climate change is one of the most well researched climate related hazardous exposures in relation to occupational safety and health. Increasing temperatures was also the hazard most attributed to climate change by participants (88%).

In Asia, nearly 75% of the workforce is exposed to excessive heat.⁶⁴ While Viet Nam has a diversity of environments, in Can Tho province average annual temperatures have increased nearly 0.2°C over the last 4 decades (Figure 6). Over 90% of participants reported that it has been hotter over the past 10 years. In the northern part of the country, Thanh Hoa province recorded the highest ever temperature on record for the country at 44°C in May 2023, with temperatures only expected to continue to increase. It is estimated that by 2080-2090 average temperatures could be 1-3.4°C higher than they were in 1986-2005.⁴⁶ Notably, poor households in the Northern Midlands and Mountain areas are most likely to be impacted by increasing temperatures.⁴⁶

Figure 6. Temperature increases in Can Tho. Image source: ClimateChip.org



Workplace heat stress refers to the state in which excess heat is stored in a worker's body.⁶⁴ When this excess heat is not released into the environment, the worker's core body temperature will rise which can lead to heat-related illnesses ranging from dehydration to heat stroke.¹¹ Additionally, laboring under conditions of heat stress can result in cardiovascular disease, respiratory impacts and diseases, acute and chronic kidney injury, mental health impacts, and an increase in occupational accidents and injuries.⁶⁴ A comprehensive review of the occupational safety and health concerns of increasing temperature can be found in the 2024 ILO Report [Heat at Work: Implications for Safety & Health](#).

Heat stress is the most uniformly reported health concern related to climate hazards between provinces in Viet Nam.⁶⁵ While it is estimated that nearly 85% of farmers have experienced symptoms of heat-related illness, only 22% sought healthcare services related to the issue.⁶⁶ As described by a participant in Ninh Binh, *"Working under the intense heat, with high temperatures, can lead to headaches, dizziness, fatigue, increased blood pressure, and mental exhaustion."* New research by the WHO and ILO found that exposure to ultraviolet solar radiation causes work-related cancer deaths, with nearly one in three deaths from non-melanoma skin cancer caused by working under the sun.⁶⁷ As noted by a female participant in Lam Dong, *"when there is excessive sunlight, the problem of skin pigmentation also increases, and ultraviolet rays affect human health."*

Growing evidence indicates that extreme heat is associated with increased risks to mental health. For example, extreme heat can be linked to an increase in hospitalizations for mood and behavioural disorders.^{49,68} Results from a meta-analysis indicate that there will be a 2.2% increase in mental health related mortality and 0.9% increase in mental health related morbidity per 1-degree Celsius rise in temperature.⁶⁹ Additionally, risk of suicide is associated with rising temperatures.^{49,70} Adverse effects of heat may impact mental health also through biological pathways including reduced thermoregulation that causes neurological responses. Heat exposure can also result in inadequate use of PPE that can be uncomfortable to wear in higher temperatures and lead to higher exposure to agrochemicals. Agrochemicals have been associated with increased risk for mental health conditions such as depression and anxiety.⁷¹⁻⁷⁴ Agrochemical exposure is shown to be a risk factor for suicidal behavior with males and older farmers more likely to be depressed or die by suicide.⁷³

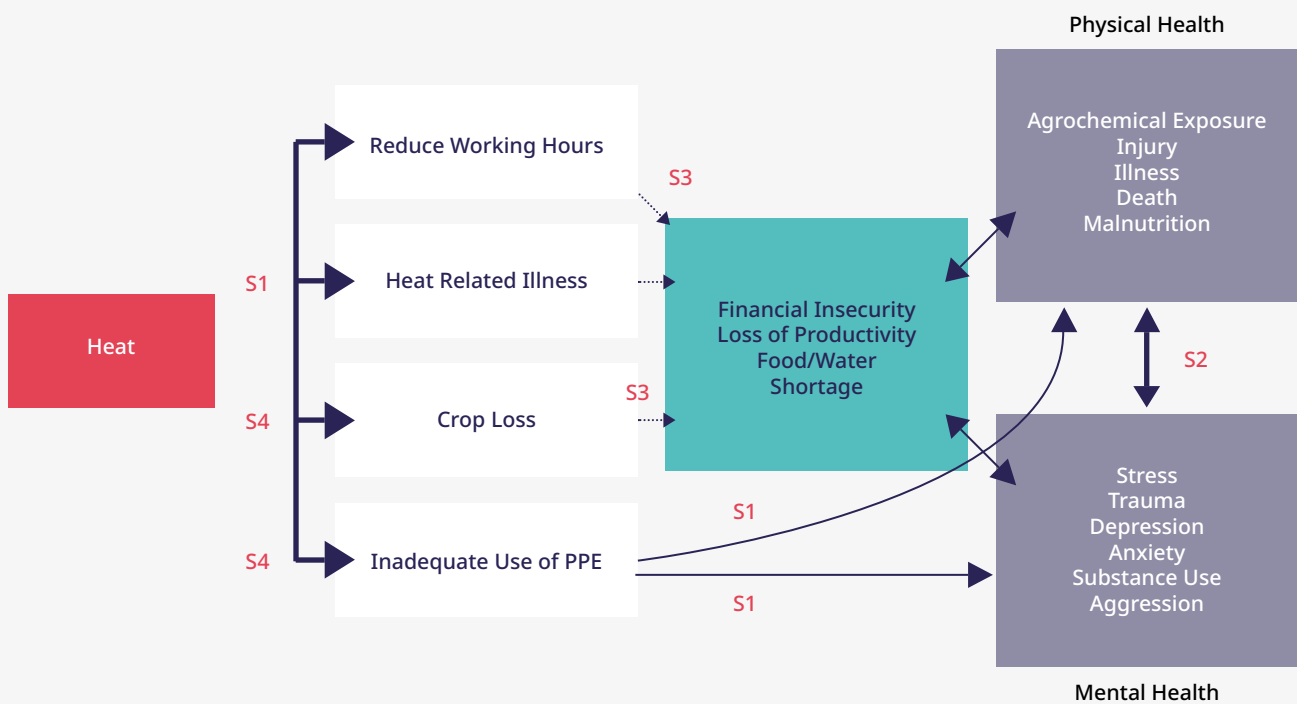
In addition to the physical and mental health outcomes of increasing temperatures and heatwaves, focus group participants identified the impact on livelihood. Male farmers spent about a third of the total focus group discussion time discussing the impact of climate change on their productivity. As workers described, it simply becomes too hot for them to work. **100% of participants noted a reduction in crop production in the past 10 years**, when asked *"Do you believe there has been a reduction in crop production in the past 10 years?"*. In multiple instances farmers reflected on the fact that they now must leave the fields earlier in the day because it is too hot. The specific concern is the reduction in crop yield. Because market "prices [for crops] are also unstable and fluctuating [this] sometimes [leads to] more loss than gain." There is a fear that this will lead to "farmers [having] to abandon farming." These concerns are valid. Recent studies indicate that a 1% increase in temperature results in a nearly 3% decrease in agricultural production in the long term.⁶¹

High-risk group of workers

There are many personal and behavioural factors that influence the body's ability to tolerate heat. These include age, socioeconomic status, medication usage, pregnancy, the use of personal protective equipment and clothing type, and chronic health conditions.⁷⁵ In Viet Nam it was found that farmers who had two or more heat-related health symptoms were more likely to be younger, perform heavier tasks in the field, spend more time outside in the heat, have pre-existing chronic health conditions, and drink less water.⁶⁶ These sensitivities are concerning because 44% of participants reported lifting or carrying items heavier than 20kg at least 10 times a day. Mental health outcomes, including crop yield related stress and anxiety, are amplified for those who are food insecure⁷⁶ or underemployed.⁷⁷ People with pre-existing mental health conditions, people taking prescription medications (lithium, neuroleptic and anticholinergic drugs), and people with substance abuse problems may be limited in their ability to thermoregulate explaining increased risk and hospitalizations in extreme heat.⁴⁹

Recommendations to Mitigate OSH Risks Linked to Heat

Figure 7. Heat and Health Impact Path Model



*Note: solid lines indicate direct pathways; dashed lines indicate indirect pathways; thickness of lines is representative of the strength of evidence from the literature review, qualitative analysis and validation meeting.

S1: Develop capacity for prevention and treatment of heat-related illnesses: (1) training to support behavior change such as hydration, self-pacing and work/rest breaks in shade; (2) provide training in PPE such as use of personal UV resistant and protective clothing; (3) facilitate access to shaded rest areas and cool potable water; (4) provide access and training on meteorological monitoring; (5) address economic and market demands that prevent workers from self-pacing; (6) ensure access and availability to health care for prevention and treatment for illnesses, accidents, and diseases linked to workplace heat stress.

S2: Train community health workers in psychological preparedness to increase mental health preparedness for extreme heat: (1) Test behavioral change strategies that support mental wellbeing; (2) identify if different strategies are needed by agricultural sector and gender; (3) train workers in identifying those that may be most vulnerable to mental health impacts of heat (e.g., individuals on medication or with pre-existing mental health conditions).

S3: Income diversification and collective sharing: (1) leverage collectives to share work responsibilities (shared work in harvesting); (2) supporting livelihood and household needs (e.g. childcare); (3) pooled resources and equitable access to loans; (4) communicate benefits of what governments, scientists and farmers are doing to improve agricultural production in Viet Nam to encourage uptake of new biotechnologies.⁶¹

S4: Technical support to improve crop yields and efficiency: (1) Test strategies currently being implemented (e.g. maintaining humidity in soil by cutting grass longer rather than shorter in between planting cycles); (2) supporting biodiversity in planting to improve soil nutrients; (3) adjusting irrigation methods to maximize production; (4) complete risk/benefit analysis of use of fertilizers and pesticides including type and quantity for future recommendations; (5) promote selection of crops varieties with higher temperature resistance/tolerance.

Potential implementing agencies: OSH training providers, health care providers, agricultural advisers, agricultural research institutes, community organisations, cooperatives, companies.

Sea Level Rise and Salinity Intrusion

Sea levels have been rising along the coast of Viet Nam at a rate of 2.8mm/year.³¹ It is estimated that up to 7% of Viet Nam's agricultural land may become submerged due to increasing sea level rises. This translates to up to 12-million people becoming affected by coastal flooding by 2070-2100.⁴⁶ This is especially true for residents in the North Central, Central Coastal, and Mekong Delta regions.⁴⁶ In 2016 saltwater intrusion occurred more than 90km inland from the coast affecting 11 of the 13 provinces in the Mekong Delta region.⁷⁸ In our survey, Nearly 80% of participants noted that salinity or saltwater intrusion has gotten worse over the past 10 years. A study of farmers from the Mekong Delta region found that 84% of farmers reported needing to spend more time mitigating the negative impact of saline intrusion on their land and crops.⁷⁸ As it was noted in focus group discussions in Can Tho, *"if the water source is not affected by salinity, we can do farming normally. However, if the water sources [are] affected, we have no other choice."* Water quality negatively influences crop production and farm income.⁷⁹

In addition to impacting crop health, salinity intrusion also affects the availability of fresh water for human consumption.⁷⁹ High salinity in drinking water has been associated with increased hospital visits

related to cardiovascular disease, diarrhoea, and abdominal pain.⁸⁰ Lack of freshwater availability has led to the cost for irrigation increasing significantly. Previous coping mechanisms included the ability to dig wells in farmers' gardens to obtain freshwater for use. But *"at present, the groundwater is polluted, and people dare not use it because they use a lot of fertilizers and pesticides that seep into the groundwater."* The reduction in productivity and lack of low-cost solutions results in anxiety of farmers.⁷⁹ As a male participant in Can Tho noted, *"With low productivity and high expenses leading to minimal profits, farmers can't sustain their livelihoods, so farmers have to abandon farming."* Without sufficient opportunities or knowledge of livelihood opportunities that can replace farming, workers who do feel they must abandon farming need alternative opportunities for employment and income generation.

Strategies are available to adapt to sea level rise and salinity intrusion. These can include agricultural adaptations such as selecting salt-tolerant crops, converting to aquaculture, combining agriculture and aquaculture in a rotation, irrigation methods to conserve water, and constructing sluice and dykes to control and prevent salinity intrusion.⁸¹ A study in the Mekong Delta found that adoption of agricultural adaptations in rice farming in response to increased salinity, improved efficiency of rice production by 13-14%.⁸² Research suggests a dual 'adaptation and control' policy that includes control at the provincial and country level through construction of dykes and hard barriers which should be paired with adaptive strategies at the community and household level.⁸³

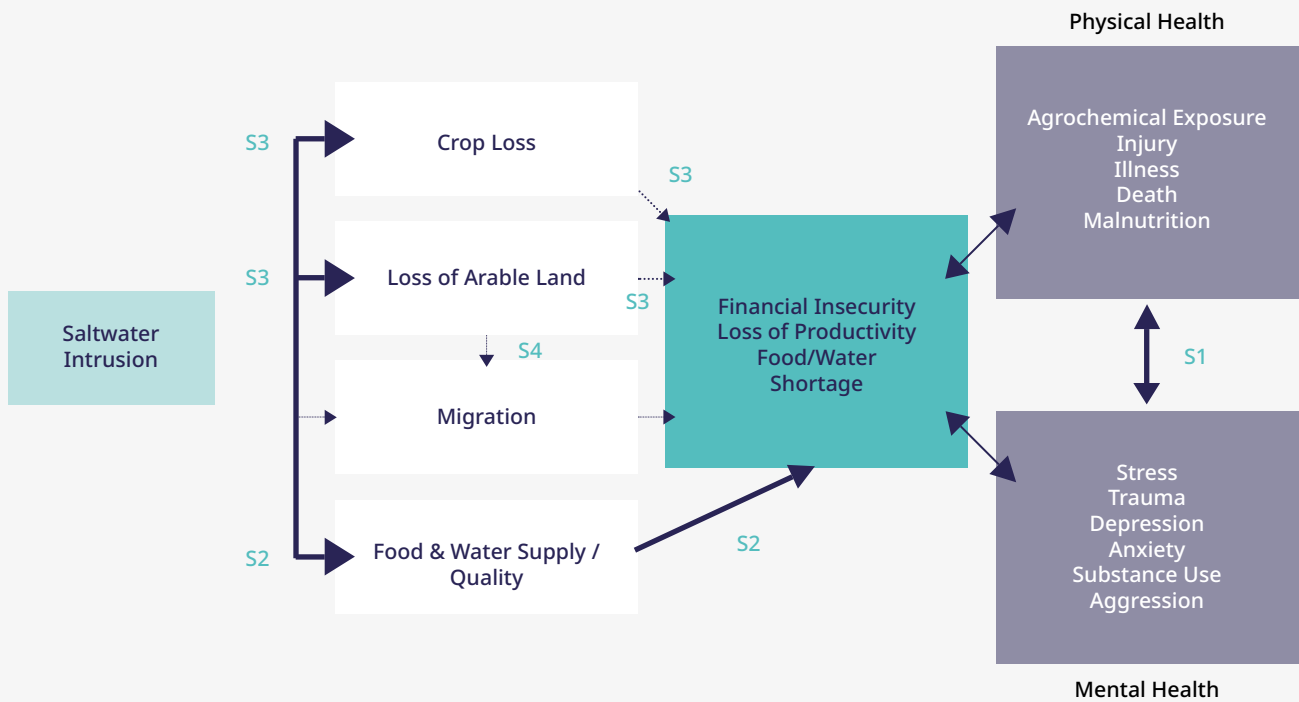
High-risk group of workers

Farmers living in coastal areas, especially along the Mekong River Delta are at high risk to salinity intrusion. By the end of the century, salinity intrusion is projected to affect 132,500 to 331,000 ha in the Mekong River Delta with profound effects expected for the irrigation systems in Go Cong, Ba Lai, and South Mang Thit.⁸⁴ Salinity intrusion effects agricultural cultivation and the supply of water for irrigation and human consumption.⁸⁴ Seawater intrusion can affect the salt level of drinking water and may be a risk factor for those with hypertension.⁸⁵ Another study found that higher saline levels in drinking water exceeded recommended limits and was associated with hypertension during pregnancy.⁸⁶

Given their social positions, women are more likely to be negatively impacted by changing ecosystems.⁸⁷ Socioeconomic status like land rights, access to financial assistance, and material resources often differ between the sexes.⁸⁸ Out-migration of men searching for more profitable labour opportunities increases the burden on women to maintain their agricultural land and become exposed to agricultural activities they have not yet received OSH training on, thereby increasing risk of injury, illness or death.⁸⁷ Farmers with smaller plots of land will have more devastating impacts from saline intrusion. Increased food insecurity caused by loss of arable land is a risk factor for a wide variety of health conditions, with women, children, the elderly and those with disabilities having higher sensitivity to reduced food security.

Recommendations to Mitigate OSH Risks Linked to Salinity Intrusion

Figure 8. Salinity Intrusion and Health Impact Path Model



*Note: solid lines indicate direct pathways; dashed lines indicate indirect pathways; thickness of lines is representative of the strength of evidence from the literature review, qualitative analysis and validation meeting.

S1: Train workers and health staff in occupational safety and health: (1) update training in OSH for new entry into agricultural sectors, aquaculture and/or new income generation activities; (2) ensure that internal migrants receive OSH training and have access to health care in the receiving areas; (3) test drinking water for salt levels to reduce risks for those with hypertension or pre-existing conditions that put them at risk for hypertension.

S2: Comprehensive and equitable strategies to maintain food and water supply: (1) consider changes to land use zoning to ensure equitable access to clean water; (2) support water reuse and recycling such as the Alternate Wetting and Drying method shown to improve efficiency of water use⁸⁹; (3) provide education in safe rainwater harvesting; (4) promote equity in accessing water resources

S3: Technical support to adapt to increases in salinity: (1) water resource management including measures for monitoring freshwater, salinity intrusion and acidification; (2) changes in farming methods and crops that utilize data on salt tolerance ratings of agricultural crops and consider converting paddy land into aquaculture; (3) implement sluice gates along the main Mekong River to prevent salinity intrusion; (4) combine small irrigation systems into larger systems to prevent salinity intrusion and preserve water supply; (5) long-term strategies to restore and preserve shorelines and drainage systems

S4: Develop responsive migration strategies: (1) land exchange programs, primarily for populations in coastal areas; (2) planned seasonal or permanent migration strategies; (3) leverage migrant experiences in the form of non-financial remittances and by sharing experiences in other regions to help diversify skills and local economies to increase resilience.⁹⁰

Potential implementing agencies: OSH training providers, health service providers, agricultural research institutes, agricultural advisers, national agencies responsible for land use planning and internal migration in the context of climate change.

Increase in Biological Hazards

Incidences of vector-borne diseases, such as malaria, dengue fever, diarrheal diseases, and influenza are projected to increase in Viet Nam due to climate change. Farmers can be at risk for a vector-borne disease when planting rice, irrigating fields, getting in contact with flood water, doing harvesting work (being exposed to insects and plant pests), performing tasks in aquaculture, handling/taking in food and water for human consumption, taking care of animals, handling waste, preparing compost and engaging in organic fertilizing.

Infectious diseases are sensitive to climate variation that precipitate changes in pathogens, vectors, hosts and living environments.⁹¹ Viet Nam experienced 12 epidemic disease events from 1900 to 2018.4 Dengue fever, malaria, diarrheal disease, and influenza were common climate-sensitive diseases present in Viet Nam between 1997 and 2016. Patterns of disease transmission suggest that modest increases in expected temperatures in the Northern and Central portions of the country will result in an increasing disease burden due to Dengue fever.² Focus group members in Lam Dong noted that *“with the increased rainfall, mosquitoes thrive, and this year, dengue fever has been spreading rapidly.”* Indeed, the World Health Organisation projects an increase in Dengue fever cases with Asia representing around 70% of the global disease burden. Under this scenario, dengue fever prevention is key including mosquito control, bed nets and vaccine.⁹²

Changes in temperatures can accelerate the growth of bacteria in water sources that farmers are in contact with, either through field irrigation or human consumption. This is expected to increase transmission of diarrheal diseases including cholera,⁹³ salmonellosis,⁹⁴ shigellosis,⁹⁵ and cryptosporidiosis.⁹⁶ This increased transmission is expected to result in a 10%-15% increase in mortality by the year 2030.⁹⁷

Warmer weather and increasing extreme weather events has led to increasing prevalence of pests on plants and animals, resulting in an increased use of agrochemicals.⁸⁷ The increased use of agrochemicals can cause water contamination, air pollution and soil degradation and also the development of herbicide-resistant weeds. Increased use of pesticides or herbicides can also reduce

the use of natural pest control methods. Notably, agrochemical exposure has important health consequences to those workers who apply them. With farmers most at risk, acute exposure to agrochemicals is estimated to have resulted in 3,000,000 hospitalisations for acute poisoning and over 300,000 deaths annually in low- and middle-income countries.⁹⁸

Agrochemical exposure has also been linked to many chronic health outcomes. While the chronic health effects are dependent on the type of agrochemical, some have been shown to affect the nervous system, irritate the skin or eyes, be known carcinogens, or disrupt the endocrine system in the body.⁹⁹ A female FGD participant in Lam Dong summarized her view on climate change, use of pesticides and health outcomes as follows, *“Excessive rainfall leads to more plant diseases, which means that farmers have to use more pesticides. This requires more effort for farmers [to manage pests] and increases farmers’ exposure to pesticides. Women, who come into contact with harmful chemicals, are at particular risk as exposure to chemicals can affect their reproductive health.”* Further, agrochemical exposure is linked to increased risk to mental health such as depression and other neurobehavioral and neurological disorders.¹⁰⁰

In our study, 13% of participants reported working with hazardous substances. A female worker in Can Tho indicated personal protective equipment is available for pesticide application but that it is too uncomfortable to wear when working in the heat, stating *“primarily, we use masks, but I think it can only provide partial protection [from pesticides]. However, in outdoor conditions, it can get very hot, and it becomes exhausting and difficult to breath with a mask on. We [also] wear long-sleeved shirts and gloves [for protection], but we can only wear them for a while. When it becomes too hot, we can’t breathe, so we have to take the mask off.”*

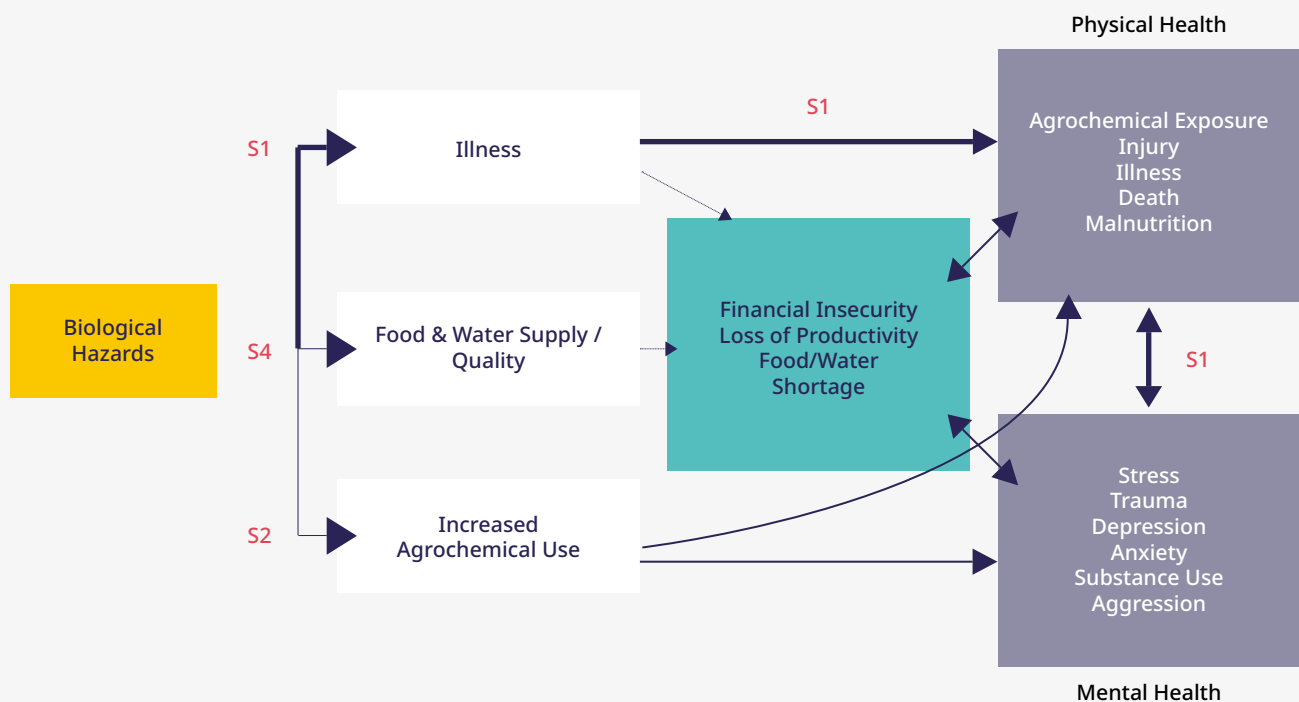
Use of personal protective equipment is the most common means of protection against chemical exposure risks by farmers. However, its effectiveness is rather limited, especially if it is inadequate or where farmers decide not to wear it due to heat-related discomfort. It remains therefore important to apply, where possible, the hierarchy-of-controls strategy¹⁰¹ by eliminating the hazard or substituting it (for example by using a less hazardous pesticide), where it cannot be eliminated.

High-risk group of workers

Children, women, and older adults are the most susceptible to vector-borne diseases.¹⁰² Often times women are at greater risk of exposure due to social and cultural factors as well as the division of work tasks. Children, women of reproductive age and workers with pre-existing health conditions are sensitive to exposure to pesticides whether direct or secondary (after application).¹⁰³

Recommendations to Mitigate OSH Risks Linked to Biological Hazards

Figure 9. Biological Hazards and Health Impact Path Model



*Note: solid lines indicate direct pathways; dashed lines indicate indirect pathways; thickness of lines is representative of the strength of evidence from the literature review, qualitative analysis and validation meeting.

S1: Develop and implement vector-borne disease prevention plan: (1) surveillance and identification of hazards, disaggregated by agricultural sub-sector and gender; (2) early warning systems for prioritized climate sensitive diseases (dengue fever, malaria, influenza, and diarrhea); (3) train agricultural workers and community health workers in prevention of spread of disease and identification of symptoms of vector-borne diseases and disease treatment; (4) ensure access and availability to health care for prevention, treatment, and control of emerging diseases in a changing climate; (5) reducing transportation costs to treat vector borne diseases by ensuring access to essential medications at community health centers.

S2: Technical support and training in reducing use/need for agrochemicals and safer application:

(1) natural or alternative pest control measures that reduce need for pesticides; (2) ensure access to PPE, (3) train workers in risks of pesticide exposure for physical and mental health; (4) reduce risks to vulnerable groups that may have secondary exposure to pesticides during or after application (e.g. women farm workers cleaning PPE, children).

S3: Train workers in psychological preparedness: (1) promote mental health literacy by training agricultural workers, community health workers, and NGO and governmental stakeholders to identify mental health symptoms; (2) provide training in basic psychological preparedness response skills; (3) encourage self-care practices to promote mental wellbeing.

S4: Plans to protect and manage food and water supplies: (1) protect groundwater and ensure equitable distribution of water; (2) management of rainwater harvesting that reduces the risk of vector borne diseases (e.g. covering rainwater harvesting barrels); (3) management of standing water (e.g. ponds), including training workers in drowning prevention.

Potential implementing agencies: public health institutes specialized in the prevention and management of vector-borne diseases, health care service providers, agricultural advisers, local authorities tasked with vector-borne disease prevention, farmers implementing prevention measures.



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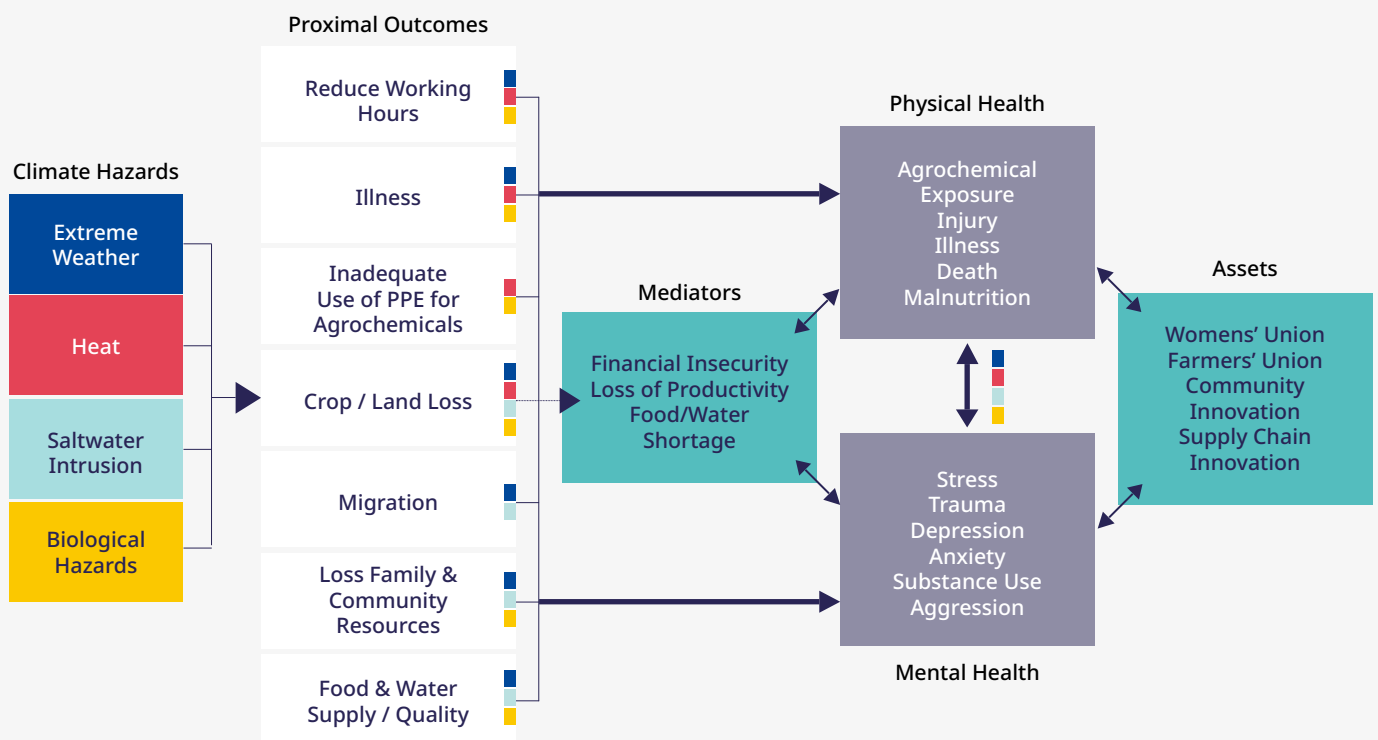


Summary of Recommendations

Adaptations to climate change are defined as actions people, organizations and institutions take in response to, or in anticipation of changing climate to reduce adverse impacts to safety, health, and wellbeing of agricultural workers.⁶³ To synthesize results related to each individual climate hazard, we colour coded how each climate change-related hazard is related to categories of proximal outcomes or interactions between outcomes (Figure 10). This visual representation shows how different leverage points for adaptation might address multiple climate change-related hazards with one targeted strategy. An integrated and comprehensive adaptation strategy must include leadership from farmers, collectives, provincial, non-governmental organisations and governmental institutions and private organisations with resources to support climate resilience of agricultural workers.

Social dialogue will be of crucial importance to ensure that all agricultural workers (informal/formal/groups of workers most at risk) will have access to/will benefit from adaptation strategies that mitigate the impact of climate change on their safety and health. Furthermore, adaptation strategies should be embedded into relevant national policies and action plans to enhance cross-sectoral coordination and application.

Figure 10. Synthesis of Climate Change-related Hazard Health Impact Path Models



Alignment with the Viet Nam Strategy on Climate Change

Several of our recommended mitigation strategies are aligned with the Viet Nam Strategy on Climate Change until 2050. The following strategy content areas are reflected in the national strategy:

1. Be able to **control deterioration of water resources and land resources**, and ensure adequate water supply for daily activities, industrial activities, services, and important economic sectors.
2. **Develop a sustainable value chain of agricultural**, forestry, and fishery products; ensure food security and balance national nutrition.
3. Essential infrastructures for adapting to climate change are built with pre-disaster safety criteria, especially structures that prevent natural disasters, tidal waves, **saltwater intrusion**, storing fresh water serving daily activities and production, and **preventing flooding** in major urban areas.
4. **Science and technology capacity for producing meteorology**, hydrology forecast, and early disaster warning matches with that of developed countries in Asia; capacity of supervising climate change and managing disaster risks matches with that of leading countries in the region; satisfy requirements for provision of basic climate services.
5. Effectively manage water and land resources, improve environment quality to serve socio-economic development; ensure stability of national water resources. **Continue to develop modern agriculture that effectively adapts to climate change** and produces high-added value.
6. **Level and capacity of producing disaster warnings, forecasting, supervising climate change, and managing disaster risks match with those of developed countries**; climate services meet socio-economic development requirements. Resistance of disaster prevention structures are improved to ensure safety in case of natural disasters according to design while considering the impact of climate change.

Implementation of Adaptation Strategies to Mitigate the Impact of Climate Change-related Hazards on Workers' Safety and Health

There is a *"need to persist in constructing, disseminating, and scaling up climate change adaptation models."* [Farmer's Union, Can Tho] Adaptive strategies can address multiple climate change related hazards and associated risks, with a focus on groups of workers at high risk of being affected. Risk assessment and control needs to be implemented in each workplace with the participation of management and workers..

Prioritizing adaptation strategies should also consider inequities in the experience of climate change impacts by sector/region, gender, age, and between formal and informal workers. For example, a recent study found that men were more than 5 times more likely to adopt a climate change adaptation strategy.¹⁰⁴ As trainings have been shown to be significantly predictive of adoption of climate change adaptation strategies in Viet Nam¹⁰⁵, government agencies and other organisations as relevant should aim to minimize inequities in accessing training as well as in accessing resources and support through national policies and programmes (e.g., social protection schemes) to ensure that they reach all groups of workers of all genders, including vulnerable groups of workers at high risk of being affected by climate change – related hazards.

Moreover, previous evidence from research in Viet Nam indicates that farmers are more likely to implement adaptive strategies if they perceive higher risk of climate change and attribute changes in agricultural productivity to climate change. Similarly in many countries research indicates a significant linkage between climate variability perception and intention for adaptation.¹⁰⁶ For these reasons, integrating occupational safety and health training with climate change training and potential adaptations is an opportunity to promote positive behaviour change and intention for adaptation.

Pilot testing strategies is an opportunity to introduce innovative adaptation measures and iterative learning cycles before implementing strategies at scale. Rigorous implementation assessment, using frameworks such as the Consolidated Framework for Implementation Research (CFIR),¹⁰⁷ can identify implementation facilitators and barriers and assess feasibility and acceptability. Participatory techniques such as community based participatory research methods (CBPR) can be successful for identifying facilitators and barriers that inform potential for scalability and sustainability. Additionally, implementation facilitators and barriers may differ by sector and therefore pilot tests should consider designs that pilot strategies in multiple regions/sectors. A study examining sustainable farming practices in the Mekong River Delta of Viet Nam found that sustainable behaviour change depended on the acceptability, feasibility and perceived benefit of recommended adaptation strategies.¹⁰⁸

This project found that participation in farmers' unions and women's unions were an opportunity to disseminate training and monitor uptake of recommended strategies because farmers rely on an experiential system in collectives to evaluate adaptive practices.¹⁰⁸ These organisations offer an opportunity to enhance participation in designing supply chain strategies that offer a conducive environment to disseminate training and test new approaches. For example, a study in Viet Nam

found that farm size was predictive of adoption of climate change adaptation strategies, prompting researchers to suggest consolidation of farms as a promising approach to increase climate change adaptation by agricultural workers in Viet Nam.¹⁰⁵ These strategies are most successful when paired with financial assistance, loans or collective insurance schemes.¹⁰⁹ Providing opportunities to share back with local communities, beneficiaries and key stakeholders and help support institutionalization of best practices and policy development to support promising adaptations. Supporting investment in policy and implementation capacity at the local community level can help to ensure uptake of adaptation actions.^{110,111} Additionally, policies to encourage or create incentives to participate in climate change adaptation may be integral to ensuring equitable adoption of best practices.¹¹²

Research on climate change impacts to mental health are rapidly increasing. Empirical results indicate several direct and indirect effects that disproportionality affect the most vulnerable.⁴⁹ Due to the reciprocal relationships between physical and mental health, it is advised that implementation of adaptation strategies consider opportunities to address both physical and mental health. For example, growing evidence indicates that psychological preparedness training is significantly associated with disaster preparedness and self-efficacy in dealing with the impact of disasters at the population level.¹¹³ Poor mental health may impact individual's ability to recognize risks, and studies show that risk perception mediates the relationship between knowledge and behaviours.¹¹⁴ Training workers in psychological preparedness integrated within climate change adaptation strategies can reduce the effects of climate-change related hazards on mental health and support uptake of occupational safety and health training by agricultural workers.¹¹⁵⁻¹¹⁷ Investment in mental health care for agricultural workers and health care workers is urgently needed as the impacts of climate change on psychosocial health are profound and disproportionately affect the most marginalized. By providing workers with the skills to address mental health challenges and cope with the psychological impacts of climate change, such as extreme weather events and environmental disruptions, organizations can enhance the overall resilience and well-being of their workforce. This, in turn, can create a more receptive environment for the adoption of occupational safety and health training, ultimately contributing to a safer and healthier working environment for agricultural workers. Integrating mental health care into adaptive strategies is an opportunity to effect change in both mental and physical health.⁴⁸

While short-term strategies are needed to address agricultural worker vulnerability to climate change hazards, longer-term strategic planning enables maintenance of a future that reduces exposures to hazards, emphasizes equity enhancing and just solutions, supports sustainability and scalability.^{118,119} A focus on green jobs and ensuring a just transition as Viet Nam adapts to climate change. This approach recognises that adaptation strategies can change labour market conditions, and seeks to implement strategies that are fair and inclusive, particularly for vulnerable groups.¹²⁰ For example, promoting agroecology, organic farming, sustainable forest management, and nature-based solutions can provide employment while also contributing to biodiversity and climate resilience; leveraging supply chain innovation to enhance market access can support sustainable livelihoods.^{120,121}

Evaluation of Adaptation Strategies

Evaluation of adaptation strategies should assess effectiveness and efficiency of adaptation strategies. There are several monitoring and evaluation frameworks with detailed methodology available. The Organisation for Economic Co-operation and Development provides a comprehensive review of methodological approaches to monitoring and evaluation of climate change adaptation strategies with high level considerations summarized here.¹²²

First, establishing baselines and targets are needed to monitor and attribute changes produced through adaptation strategies. Sequential targeting can enable adaptation strategies to be flexible to changing contexts and support intended impacts.¹²² Setting achievable milestones in the short term ensures flexibility and iteration in implementation of adaptive strategies. Long-term strategic planning can then adjust to intermediate outputs and outcomes achieved in the short-term.

Attributing changes to adaptive strategies in response to climate change is a complicated challenge given the variability in climate change related hazards over time and geographic location. For this reason, it is recommended that multiple and mixed-method evaluation strategies be employed. Qualitative methods can help to ensure that experiences are grounded in contextual factors and local experiences to improve the operationalization of programs.¹²² Quantitative methods can be used to objectively assess changes because of implementation of adaptive strategies and to track progress in the short and long term. These methods can also be used to estimate baselines and to project shifting baselines. Triangulation of mixed methods can contribute to the evidence base needed to prioritize adaptive strategies.

Economic valuation of impacts resulting from pilot studies will inform prioritization of strategies. Further economic valuation of impacts will enable allocation of appropriate budgeting support needed to scale strategies. Efforts to assess health care costs associated with climate change should include financial costs of utilizing medical care and pharmaceuticals, as well as disability associated with injury or illness.⁵⁷ These efforts can be facilitated through potential partnership with the Ministry of Health and World Health Organization. Transparency in the allocation of resources to adapt to climate change will be critical to ensure accountability of recipients of resources and to support continued funding.¹²²

Long-term impact assessment can use new approaches such as the Trade-off Analysis model for multi-dimensional impact assessment (TOA-MD) that simulates adoption of strategies and the associated economic, environmental and health outcomes specific to sectors and provinces.¹²³ This methodology includes survey, experimental and modelled data combined with future socio-economic scenarios based on climate change modelling. Other frameworks include the United Nations Development Program's Adaptation Policy Framework, the UK's Adaptation Policy Framework, and the IPCC's Technical Guidelines for Assessing Climate Change Impacts and Adaptations.¹²⁴ It is recommended that evaluation criteria include inputs (assessment of existing adaptive capacity and investment of resources), processes (establishing objectives, assessment of risk and vulnerabilities) and outputs (implementation facilitators and barriers, equity, communication, and dissemination). Investment in rigorous monitoring and evaluation strategies will be essential for iterative learning feedback loops and achieving sustainability at scale.

Limitations

The project sample was limited to three provinces in Viet Nam and may not be generalizable to other provinces and sectors that face different types of climate change related hazards. The study design focused on qualitative data collection methods, and though we sought to include some quantitative measures to triangulate results, a larger quantitative sample and inclusion of more comprehensive and validated survey measures would be useful in best representing climate change related stress and occupational safety, health and wellbeing impacts. Additionally, in agricultural workforces, it can be difficult to clearly define occupational vs. non-occupational exposure to hazards. For example, agricultural workers described installing ponds and wells near their home – a practice that was described as linked to increased risk for drowning and electrocution. However, it may be difficult to attribute these practices to occupational risk. One of the focus groups in Ninh Binh was a mixed-gender focus group discussion. It is possible that including both genders in the focus group discussion may have limited some participant's comfort in disclosing their perspectives. Finally, this project focused on the experiences of small-scale farmers. The occupational experiences of small-scale farmers, and their ability to implement OSH safety measures can significantly differ than those who are employed by agricultural companies.

Conclusion

Climate change poses a serious threat to Viet Nam's agricultural workers and their safety, health and wellbeing. These climate change related hazards include increased temperature, extreme weather events such as drought and floods, sea level rise and salinity intrusion, and biological hazards. Each hazard poses direct and indirect threats to agricultural workers' physical and mental health. Further, the agricultural sector is essential for maintaining food security and economic development in Viet Nam.⁶¹ Historically, climate change hazards for agricultural workers have focused on physical impacts to health. However, evidence is growing that climate change threatens not only physical health, but also mental health and wellbeing of workers including increased risk for post-traumatic stress disorder, anxiety, depression and suicide.¹²⁵ Indirect effects such as loss of crops and productivity, loss of livelihood, displacement and migration all impact mental wellbeing and these impacts are most likely to affect the most vulnerable. Given the high and growing burden of mental health conditions attributed to climate change, and the well documented reciprocal benefits between physical and mental health, integrating mental health interventions into climate change adaptation strategies should be prioritized.

Adaptation strategies that involve *collective action at multiple levels* (individual, household, community, governmental), has been shown to promote collective hope, which in turn, is positively related to engagement and uptake of recommended strategies.¹²⁶ Hope also promotes collective resilience, power and resolve to adapt and change in response to climate change.¹²⁵ Despite the high vulnerability of Viet Nam to diverse climate change hazards, agricultural workers have already demonstrated innovation, testing new strategies within collectives. In Lam Dong a participant spoke of how the younger generation of farmers is adopting new practices. She described, "*the farmers themselves have to consider which [guidance] is suitable for the characteristics of their land and*

garden, and the farmers have to explore it on their own... For example, my father often cuts the grass regularly, but I usually let the grass grow for a few months before cutting it...I find the crop yield from my father is not high." Centring and empowering agricultural workers in adaptation strategy design through community based participatory research, will enable identification of what strategies work best, for whom, and under what contextual circumstances. Investment in studies designed to test these strategies with scientific rigor will benefit agricultural workers in Viet Nam, their families and communities, and agricultural workers in global contexts facing similar threats to health and wellbeing because of a changing climate.





Annex 1

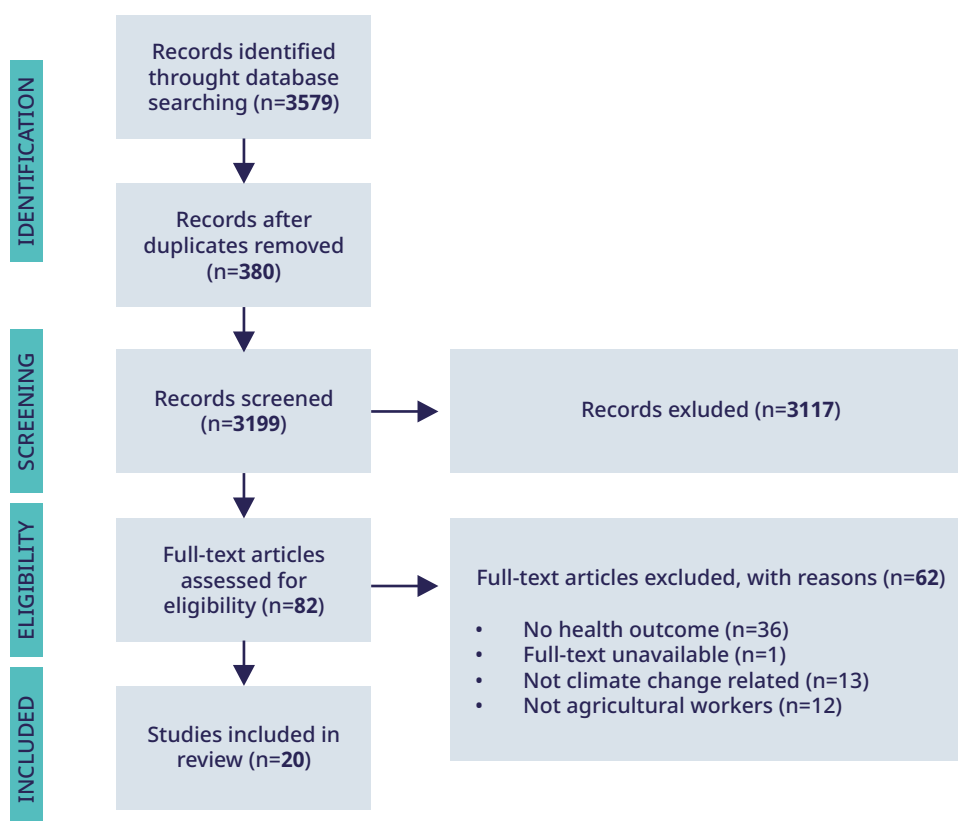
Inception

As part of the inception phase, a scoping review and complete desk review were carried out to identify existing evidence for climate change impact and adaptation in the agricultural sector in Viet Nam. Results provided guidance to both the mixed method data collection strategy, stakeholder engagement approach, and workshop with stakeholders to co-create and rank adaptive solutions. These literature reviews also identified gaps in knowledge which it is hoped this study will contribute.

Literature Review

Identification of literature was guided by the framework of Schulte et. al, 2016¹²⁷ and as adapted by Dally and Newman, 2021.¹²⁸ These frameworks identify seven climate related hazards that workers are susceptible to. Guided by this, the desk review was focused on the current knowledge base of how (1) increased ambient temperatures; (2) air pollution; (3) ultraviolet radiation; (4) extreme weather events; (5) vector-borne diseases; (6) industrial transitions, as it relates to crop transition or workers leaving the agricultural workforce; and (7) changes in the built environment, such as changes to dams and levees, that impact agricultural sectors and workers in Viet Nam. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews¹²⁹. The complete search strategy including inclusion and exclusion criteria, interrater agreement and data extraction processes is available in Annex 2. The scoping review process is summarized in Figure 1 and the location of studies included in data extraction are mapped in Figure 2.

Figure 1. PRISMA Flow Diagram



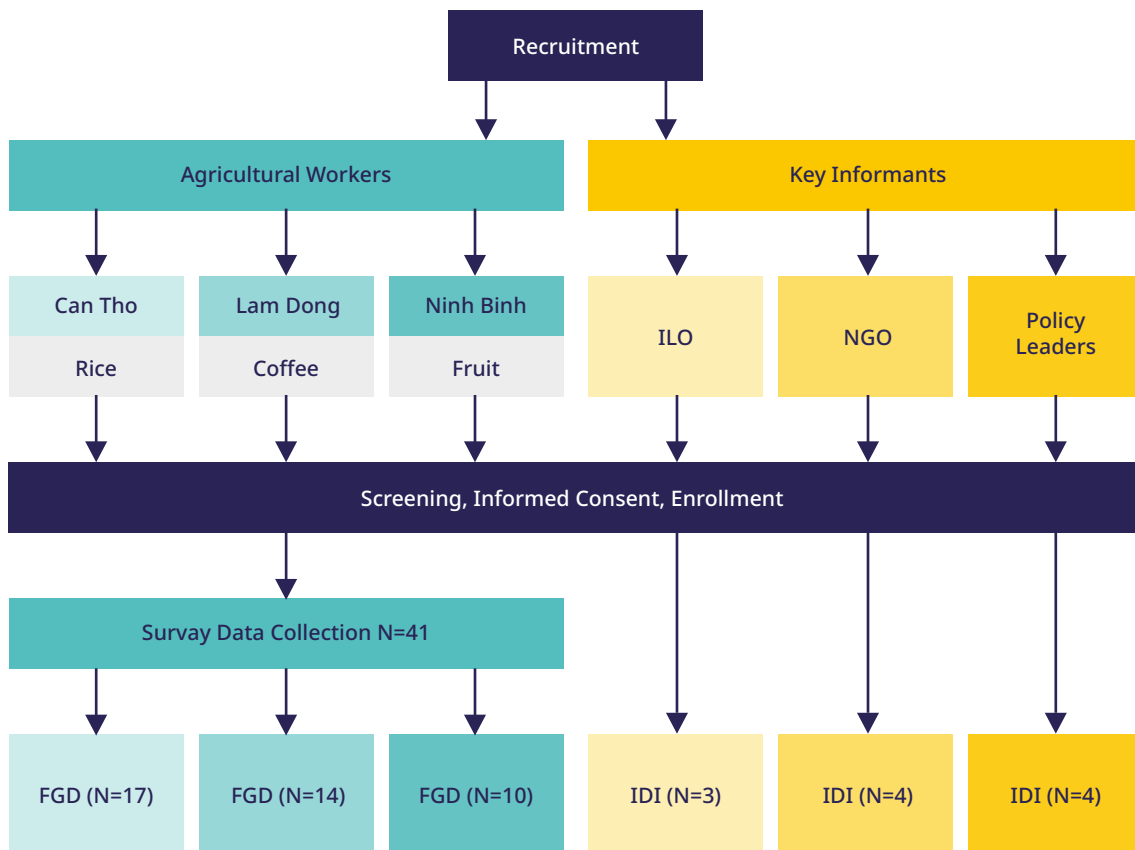
Data Collection

We conducted 5 focus groups with farmers in Viet Nam to assess the connection between climate change and occupational safety and health. In Can Tho and Lam Dong focus groups were (1 male and 1 female focus group per province) to assess any gender specific differences. In Ninh Binh, a mixed-gender focus group was conducted. After each focus group discussion participants were asked to complete a brief questionnaire. The questionnaire (Annex 3) included brief validated measures with well-established psychometric properties, and where possible, to include those that had been previously validated in Viet Nam (Table 4). The survey was translated into Vietnamese with minor modifications.

Table 4. Survey Measures	
Demographic	Viet Nam Items
General Health	Rand SF-36 ¹³⁰
Mental Wellbeing	WHO-5 ¹³¹
Workplace Health and Safety	Institute for Work and Health, 2016
Climate Change Knowledge/Beliefs	Knowledge and Beliefs of Climate Change ¹³²

In-depth interviews were conducted with representatives from the Department of Health, Department of Labour, Invalids, and Social Assistance, the Women's Union, and the Farmer's Union within each province. In-depth interviews were also conducted with representatives from VCCI and the International Labour Organization.

Recruitment of focus group discussion participants and key informants for in-depth interviews was facilitated by VCCI and provincial Farmers' Unions. Eligibility for focus group participation included: 1) over age 18; 2) primary occupation is agricultural work; 3) has lived in one of three provinces for over 2 years; 4) provided informed consent. Focus group participants were compensated for their time. Figure 3 represents the study protocol flow. Data collection was completed between April 2023 and October 2023.

Figure 3. Study protocol flow diagram

Focus Groups with Agricultural Workers

The focus group discussion guide (Annex 4) is constructed of four sections: 1) Free List Exercise, 2) Pile Sorting Exercise, 3) Qualitative Vignettes, and 4) Open-ended Discussion.

Free List Exercise

The free list exercise is a method where participants are asked to list answers in response to a single primary question.¹³³ The primary question used during the focus groups was: "How does climate change affect your work in (Coffee, Rice or Fruit) agriculture?"

Pile Sort

Pile sorting has been used previously to understand perceptions related to climate change¹³⁴. The goal was to detect and attribute climate change impacts on agricultural work and health where detection identifies which climate change hazards have been observed and attribution seeks to connect those hazards to impacts on agricultural work.¹³⁵ Focus group facilitators gave each participant the same set of cards (see Annex 4) and used a structured, unconstrained pile sort approach where each individual participant was asked to sort cards into piles that they conceptually perceive as related from two decks of cards.

Qualitative Vignettes

Qualitative vignettes are defined as, "text, images, or other forms of stimuli which respondents are asked to respond" and "short stories about hypothetical characters in specified circumstances to whose situation the

interviewee is invited to respond".^{136,137} This qualitative method has been used in many fields and is well suited to capture climate beliefs and attitudes in relationship with occupational health. The vignette is meant to capture a culturally grounded "real life" example to elicit participant responses, particularly for topics where disclosing sensitive personal information may reduce willingness to provide responses. Qualitative vignettes were co-developed with Vietnamese partners specific to represent regionally specific climate related hazards (see Annex 4).

Open-Ended Discussion

The concluding section of the focus group discussion guide is constructed of open-ended questions aimed at probing on climate change effects on agricultural work, responses to hazards affecting health, and gender differences in climate change impacts on agricultural work.

In-Depth Interviews

The full IDI guide is available in Annex 5. The semi-structured guide includes open-ended questions and example probes. Topics covered in the IDI include: 1) Impact of climate change on agricultural worker health and safety; 2) Informal mechanisms for coping with climate change hazards; 3) Formal services or programs available to agricultural workers that support occupational health and safety; 4) Gender differences in climate change related impacts on agriculture work; 5) Recommendations for adaptation strategies; 6) Barriers or facilitators to implementing adaptation strategies; 7) Stakeholders needed to effectively implement adaptation strategies; and, 8) Demand or Supply issues to consider in developing adaptation strategies.

Technical Validation Meeting

In October 2023 a technical validation meeting was held in Hanoi to present preliminary findings and recommendations to representatives from the Ministry of Labour, Invalids, and Social Assistance (MOLISA), Ministry of Health (MOH), the Ministry of Agriculture and Rural Development (MARD), Ministry of Natural Resources and Environment (MONRE), Viet Nam Chamber of Commerce and Industry Hanoi (VCCI), Viet Nam Cooperative Alliance (VCA), Viet Nam General Confederation of Labour (VGCL), Viet Nam Women's Union (Hanoi), Ninh Binh Women's Union, World Health Organization (WHO), the European Union Global Coffee Platform, IDH-Sustainable Trade Initiative, International Women's Coffee Alliance, Viet Nam (IWCA), Nestlé S.A. and Coffee Farmer Connect.

Ethics Approval

Ethics approval was received by the Colorado Multiple Institutional Review Board (COMIRB #23-1235) and the Hanoi University School of Public Health (HSPH) Institutional Review Board. Approvals and permissions were obtained from the relevant provincial leaders.

Qualitative Analysis

Qualitative data analysis followed best practices, including a deductive, theory-driven approach, and an inductive, data-driven approach.^{138,139} All recordings were transcribed and translated from Vietnamese to English verbatim. Transcripts were coded using MAXQDA qualitative software. The analytical approach included initial codes to identify common responses and similarities and differences in responses; focused codes developed by using the most significant and/or frequent initial codes; axial coding to represent the content of focused codes and to relate common codes, categories, and concepts to each other; and application of a final coding structure to each transcript.^{138,139}

Annex 2 Scoping Review Summary

Search Strategy

To identify published articles related to occupational health impacts of climate change among agricultural and aquaculture workers, the following online databases were searched: PubMed, Embase, and Web of Science. The databases were searched on March 8, 2023, with no limitation on publication date. The PubMed search strategy (Table 2) was adapted for each database (search strings for each database can be found in Annex A). While there are additional adverse effects of climate change, we constrained our search terms to those identified in the guiding framework. 127,128,140 Additional articles for inclusion were identified by a grey literature search.

Table 1. Search Strategy (PubMed)

Concepts	Viet Nam	Worker Health	Agriculture	Climate Change
Free Text (Title/Abstract)	Viet*	Worker health Employee health Occupational safety Worker safety Industrial hygiene Industrial health	Aquacultur* Farm* Coffee Rice Harvest* Corn Cassava Pork Shrimp Catfish Pepper* Nut Rubber Potato* Tea Fish*	Weather extreme Extreme weather Flood* Tsunami Air pollution Pollution Rain Ultraviolet radiation UV Vector-borne disease
MeSH (Medical Subject Headings)	Viet Nam [MeSH]	Occupational Health [MeSH]	Agriculture [MeSH]	Climate change [MeSH] Climate [MeSH] Global warming [MeSH] Sea level rise [MeSH] Extreme heat [MeSH] Extreme cold weather [MeSH] Extreme hot weather [MeSH]

Inclusion and Exclusion Criteria

Four screeners independently conducted title/abstract screening. After, a full-text screening of the identified literature was conducted by the primary screener and two additional screeners. The inclusion/exclusion criteria displayed in Table 3 was applied to the full texts to assess eligibility. We were primarily focused on identifying articles that addressed the impact of climate change on worker health and safety. Specifically, we were interested in agricultural or aquaculture workers or communities in Viet Nam, including any workers who are employed in the cultivation of food for consumption. While the study did not need to explicitly mention climate change, it had to address a hazard that is feasibly relevant to climate change. Human health and safety effects were the primary outcome of concern. This included both physiological and psychological (including stress). While a relevant component of worker wellbeing, we chose to exclude studies that examined the economic impacts, including productivity, related to climate change. Studies that mentioned well-being were considered only if they explicitly addressed health as a component of well-being. The screening process was facilitated using EndNote X9 and Covidence.¹⁴¹

Table 2. Inclusion and exclusion criteria for articles

Domain	Inclusion Criteria	Exclusion Criteria
Language	English, Vietnamese	Not in English or Vietnamese
Publication type	Published peer-reviewed articles Chapters from books Study protocols Systematic Reviews Scoping Reviews Guidelines and clinical protocols Advocacy documents Conference abstracts/ presentations	Unpublished dissertations No abstract
Publication date	1806-2023	N/A
Research setting	Viet Nam Agricultural / aquaculture Occupational Human	Not Viet Nam Animal Plant Forest
Hazards evaluated	Climate change, temperature extremes, extreme weather events, flooding, vector-borne diseases, air pollution, water quality, UV radiation, displacement, industrial transitions, Sea level rise, globalization, migration	Not related to climate change Plastic pollution PFAS Pesticides Greenhouse gas emissions from the crop/farm

Type of study		In-vitro/in-vivo Mathematical methods development
Outcomes	Impact on human health Adaptation for human health Perception of climate change impacting health Impact on mental health, incl stress Perception of effects of climate change on health Morbidity Mortality	Migration Economic Productivity Livelihood Vulnerability Index (the specific measure as it does not include accurate measures of health)

Inter-rater agreement

Agreement was reached in 95% of studies during title/abstract review. Upon full-text review, 75% agreement was reached between reviewers. Discrepancies were resolved through discussions between screeners.

Data extraction

The following data was collected from each study: (1) bibliographic information including author and year; (2) study population; (3) study design and sample size; (4) climate change related exposures; (5) health outcomes; (6) adaptation strategies and capacity; and (7) main findings. A summary database of these elements was created in Covidence.¹⁴¹

Of the 3,199 screened articles (Figure 1), 20 met inclusion criteria. Studies represented geographic diversity within Viet Nam (Figure 2). The most researched climate hazards were flooding (n = 9), drought (n = 7), and extreme weather events (n = 7). Climate related hazards differed by region. Salinity had only been studied in the South, flooding was a concern in the South and Central, and heat, extreme weather events, and drought was a concern for all regions. An indirect hazard that was identified was the increased use of pesticides due to climatic factors.

Annex 3 Survey questionnaire

This annex provides the original version of our survey. Some adjustments will be made to conform to the country context and in the translation to Vietnamese. The Vietnamese version of the survey we administered is available upon request.

I. Screening Instrument

Eligibility Criteria	
What is your age?	
What is your gender?	
How long have you lived in _ Province?	
How long have you worked in agricultural?	

II. Survey Instrument

The survey was developed using validated survey tools. During administration of the survey participants will be provided with a selection of responses to choose from.

Section I. Sociodemographic (Viet Nam Demographic and Health Survey)¹⁴²

1. What is your sex?
2. How old were you on your last birthday?
3. What is your current marital status?
4. Are you the head of household?
 - a. If you are not the head of household, what is your relationship to the head of household?
5. How many people live in your home?
6. What ethnic group do you belong to?
7. What is your religion?
8. Have you ever attended school?
 - a. If so, what is the highest grade of education you completed?
 - b. What was the main reason you stopped attending school?
9. Is farming your main source of income?
10. What were your principal crops in the last year (select all)?
 - a. If other, please specify.
11. Is the farm you work on your family's farm?
 - a. If yes, how many hectares is the farm?
12. How many years have you lived or worked on a farm?

Section II. General Health (RAND SF 36)¹³⁰

1. In general, would you say your health is: (excellent, very good, good, fair, poor)
2. Compared to one year ago, how would you rate your health in general now?
3. In the past 4 weeks, have you had any of the following problems with your work as a result of your physical health?
 - a. Cut down the amount of time you spend on work?
 - b. Accomplished less than you would like?
 - c. Were limited in the kind of work or activities?
 - d. Had difficulty performing work or activities?

Section III. Mental Wellbeing (WHO-5)¹³¹

Please indicate for each of the five statements which is closest to how you have been feeling over the last two weeks: (all of the time, most of the time, more than half of the time, less than half of the time, some of the time)

1. I have felt cheerful and in good spirits.
2. I have felt calm and relaxed.
3. I have felt active and vigorous.
4. I woke up feeling fresh and rested.
5. My daily life has been filled with things that interest me.

Section IV. Occupational Health (Workplace health and safety survey)¹⁴³

1. In the past year have you been injured while doing your job?
2. In the past year has your job made you sick?
3. In your job, how often do you:
 - a. Manually lift, carry or push items heavier than 20kg at least 10 times during the day?
 - b. Do repetitive movements with your hands or wrists for at least 3 hours during the day?
 - c. Perform work tasks, or use work methods, that you are not familiar with?
 - d. Interact with hazardous substances such as pesticides?
 - e. Work in a bent, twisted or awkward work posture?
 - f. Work at a height that is 2 meters or more above the ground?
 - g. Work in noise levels that are so high that you have to raise your voice when talking to people less than one meter away?
 - h. Experience being bullied or harassed at work?
 - i. Stand for more than 2 hours in a row?
4. At your workplace are you:
 - a. Clear about your rights and responsibilities in relation to workplace health and safety?
 - b. Know how to perform your job in a safe manner?
 - c. Have knowledge to assist in responding to a health or safety concern?
 - d. Know what necessary precautions are that you should take while doing your job?

Section V. Climate Change Knowledge, Attitudes, Beliefs¹³²

1. Have you heard of what “Climate Change” means?
 - a. If yes, what types of changes in climate are you aware of (select all)
2. Do you believe there has been an increase in flooding over the past 10 years?
3. Do you believe that droughts have gotten worse over the past 10 years?
4. Do you believe that there is a change in rainfall over the past 10 years?
5. Do you believe it has gotten hotter over the past 10 years?
6. Do you believe salinity or saltwater intrusion has gotten worst over the past 10 years?
7. Do you believe there has been a reduction in crop production in the past 10 years?
8. Do you believe that climate change has an impact on human health?
9. In your opinion, who is most vulnerable to the effects of climate change?

Annex 4 Focus Group Discussion Guide

Time Target: 90 minutes

Overall goal: Identify primary areas to focus workplace climate change adaptation measures for agricultural workers in Viet Nam.

A. Introduction (3 minutes)

[Facilitator Instructions: Hello. My name is [INSERT], and I am a researcher at the Hanoi School of Public Health. We have joining us Miranda Dally who is a researcher at the Colorado School of Public Health in the United States. She will be here to observe and take notes.

Thank you all for taking the time to speak with us today. We really appreciate your willingness to participate! We're here today to talk to you about your experience working in [Coffee, Rice OR Fruit] and your experiences with climate change.

I'd like to emphasize that your participation is strictly voluntary, and all of your responses will remain completely anonymous. Neither you nor your company will be identified in anyway. It is important that what is said here, stays here so that we can create a safe environment to speak freely without judgement or negative repercussions. When presenting what we learn from these interviews we may select quotes to use, but again I'd like to emphasize that they will be completely anonymized and in no way would be linked back to you or your company.

During our chat today, we want to learn from you more about how you think about climate change and how climate change may or may not be impacting your work. You're the experts, my role today is to just guide the discussion and to gain a little more insight.

We will be recording our discussion today as we want to be able to capture everything that is said, but we will not be reporting on one specific person or disclose any information that will identify a person, company or specific location in the transcript or final reports. Can you please confirm with me that you are willing to be recorded?]

[Start the recording]

Do you have any questions? Are you ready to get started?

B. Free List (10 minutes)

Goal: Have participants free list all concerns about the effect of climate change on their work.

[Facilitator Instructions: Ask the group the Introductory question and allow participants to answer with as many points as they would like. After participants have finished responding, move on to the Free List exercise. For the Free List Exercise, use a flip chart and record every different answer on the flip chart. After everyone has responded (each participant can respond with as many points as they would like), go through the list and ask participants to raise their hand if they agree. Count how many participants responded for each item and record on the flip chart. As participants endorse each listed item, allow participants to talk more about whether they agree or disagree with each list item.]

Introductory Question: To get started let's talk about what climate change means to you. When you think about climate change, what comes to mind?

Free List Exercise: *We would like to understand a bit more about how you think climate change may or may not affect your work. Let's create a list of ways in which climate change affects your work. If you do not think climate change affects your work, feel free to say so.*

[Create list]

We would like to get a sense of how many of you agree with each of these. I will read out the list and if you agree will you please raise your hand?

[Read list, count responses]

C. Pile sorting (20 mins)

Goal: Understand how, if at all, people detect climate change effects on OSH and whether these observed/perceived impacts are being connected back to climate change.

[Facilitator Instructions: First, provide each participant with cards and ask each participant to sort the cards individually. Before moving on to the group discussion, have support staff take pictures or record each individual participant's pile sorting results. Next, as a group, facilitate discussion about why participants sorted cards the way that they did.]

Environmental Conditions Subject to Variability Due to Climate Change	OSH Conditions Subject to Variability Due to Climate Change
Salinity	Injury to person
Drought	Personal illness
Flooding	Earnings
Extreme weather events	Human health
Increasing temperatures	Animal health
Heat waves	Stress
Pollution	Depression
Climate change	Anxiety
Changes in seasons	Work demands
Water pollution	Productivity
Pesticide runoff	Type of work
Rain	Disease outbreak in animals
Rising sea levels	Disease outbreaks in humans

Now we are going to do an activity where I give you this pile of cards. I would like you to group the cards together based on similarities and differences. There are no right or wrong answers and you can have as many piles as you'd like.

[Activity]

Ok, now I'd like you to give a name to each of your piles. Let the name be brief, but descriptive.

Now let's talk a little more about the piles. Can you explain to me why you grouped these in the way that you did?

Were there any cards you felt that should have been part of this exercise that were not included?

D. Qualitative Vignettes (30 mins)

Goal: To assess knowledge and attitudes towards occupational adaptation strategies and identify potential barriers.

[Facilitator Instructions: In this next activity I am going to read you a brief description of a hypothetical incident. I want you to think about why the characters acted the way they did. After I am finished reading, I will ask your opinions on what the characters should have done.]

a. Heat Stress Vignette 1 (15 minutes)

Vinh has been working on the (coffee, rice, fruit) plantation for 5 years. Each year Vinh notices fewer workers coming to help harvest the (coffee, rice, fruit). Vinh also notices that it seems like there is less time to make sure all the (coffee, rice, fruit trees) are harvested. Vinh feels like he has been needing to work harder every day. Today is an unusually hot day for harvesting. Vinh feels more tired than usual during work, and he only takes one break before lunch. During his break he sits outside in the sun. Vinh brought a jug of water from home and drinks it while he works but does not fill it up again once he runs out. Later, Vinh eats his lunch outside in the sun. After lunch Vinh starts to have a headache and feels weaker but he keeps working. Vinh talks with Huy while they work. Huy doesn't know Vinh very well so when Vinh starts acting confused Huy doesn't think much of it. Twenty minutes later Vinh passes out.

1. In this situation, what are some things Vinh should have done to stay safe and healthy?
2. Why do you think Vinh did not do these things?

b. Heat Stress Vignette 2 (15 minutes)

Mai is responsible for her household because her husband migrated for work after a drought threatened survival of (coffee, rice, fruit). After waking up early to get her children ready for school, Mai spends the day on the (coffee, rice, fruit) plantation to try and save remaining crops. She has to make many trips to the nearest water source to collect jugs of water to bring to the crops because the irrigation system is no longer working. Mai tries not to drink too much water while she's working because she's aware that this will result in more long walks to the water source. A coworker notices Mai appears tired. She tells Mai they only have a few more hours left before the workday is over. Mai explains that after work, she needs to make more and longer water collection trips to transport water to her home because they have run out of water. Mai's kids will be leaving school, so Mai realizes she'll need to bring her kids with her to collect water. One of her children is young and it's a long walk, she wonders if she will be able to carry her child and the water to the home. Mai is so tired from carrying water to the fields, the thought of making more trips after work is overwhelming. Mai starts crying. She feels alone and worries how she can manage without her husband's support.

3. In this situation, what are some things Mai could have done to stay safe and healthy?
4. What do you think would help Mai in the future?

E. Open ended discussion (15 mins)

Goal: Facilitate an open-ended discussion about any additional topics.

1. Today we've talked about a few specific things related to health and safety at work. Are there other things that make you feel safe or unsafe doing your job?
2. In some contexts, the ways that climate change affects health is experienced differently for men and women. Is climate change stress experienced differently for men and women? Why or why not?
3. We've talked a lot today about climate change and how it may impact your work. What types of resources or information would you like to receive to help you address these concerns?
4. Before we wrap up, I'd like to give everyone the chance to share any other thoughts that they have about our discussion today.

F. Wrap-up (2 mins)

[Facilitator Instructions: We just want to thank everyone for their time today. In summary, we've talked about how climate change may impact your work, especially regarding your health and safety. We had a great conversation and have learned a lot. Over the next several months we will be completing our project and analysing results. We will share the overall results with you once we're finished. In the meantime, please feel free to reach out to us for any reason, our contact information is in the informed consent document you received, if you need another copy of that please let me know.]

Annex 5 In-Depth Interview Guide

Time Target: 60 minutes

Overall goal: Identify barriers and facilitators to workplace climate change adaptation measures for agricultural workers in Viet Nam

Section I. Introduction

Hello. My name is Miranda Dally, and I am a researcher at the Center for Health, Work & Environment at the Colorado School of Public Health. I'd like to thank you again for taking the time to speak with me today. I really appreciate your willingness to participate. As I've explained in our correspondence, the goal of our project is to identify areas of opportunities to address occupational safety and health agricultural workers as it relates to climate change. We've scheduled this interview with you given your role at [INSERT ORGANIZATION]. I'd like to emphasize that your participation is strictly voluntary and that all of your responses will be completely anonymous. It is important that what is said here, stays here so that we can create a safe environment to speak freely without judgement or negative repercussions. When presenting what we've learned from these interviews we may select quotes to use, but again I'd like to emphasize that they will be completely anonymized and in no way be linked back to you or your organization.

During our chat today, we want to learn from you more about the role your company plays in addressing the needs of agricultural workers in Viet Nam. Specifically, we are interested in your views on how climate change is impacting the health and safety of these workers. I'm interested in learning about what you identify as the primary needs of workers and what you identify as the key barriers and facilitators to addressing these needs. You're the expert, my role today is just to guide the discussion.

I will be recording our discussion today as I want to make sure I capture everything that is said, but I will not be reporting on one specific person or disclose any information that will identify you, your organization, or your location in the transcript or final report. Can you please confirm you are willing to be recorded?

[Start the recording]

Do you have any questions? Are you ready to get started?

1. While we will keep any responses confidential and not tied to your organization, would you be OK with us noting your organization's participation in our published report?
2. To try to help keep confidentially I want us to try to not use your organization's real name today. With that in mind, could you please describe your organization for me? Which agricultural sectors do you work with?
3. And what is your role in the organization? Can you please explain some of your responsibilities when it comes to the safety and health of agricultural workers in Viet Nam?

Section II. Occupational Safety and Health

1. What are the primary occupational safety and health issues that your organization has identified for agricultural workers in Viet Nam?
2. What is your organization's role in addressing the safety and health of agricultural workers in Viet Nam?
3. How has your organization addressed these issues? Can you please describe any programs to me?
4. How has your organization been successful in improving the health and safety of agricultural workers in Viet Nam? What do you think were some key components to this success?
5. What are some of the biggest challenges in improving the health and safety of agricultural workers in Viet Nam?

Section III. Climate Change

1. Has your organization thought about how climate change may affect agricultural workers in Viet Nam? If so, in what ways? If not, why do you think climate change has not been thought of as a threat?
2. Does your organization currently have any programs to help agricultural workers adapt to climate change? If so, could you please describe them to me? If not, does your organization have any plans to implement such a program?
3. [IF PROGRAMS EXIST] What do you think are some of the most successful components of the program? What do you think makes it successful?
4. [IF PROGRAMS EXIST] What do you think are some areas of the program that can be improved? Why do you think you have had difficulties with these components?

Section IV. Climate Change and Occupational Health

1. Has your organization thought about how climate change may specifically impact the health and safety of agricultural workers? If so, in what ways? If no, why not?
2. Could you please describe for me any activities your organization has taken to help address the impact of climate change on the health and safety of agricultural workers?
3. Our goal in this project is to identify areas of opportunity to address the impact of climate change on worker health and safety. Given this and our conversation today, where do you think we should focus our efforts?

Section V. Closing

Thank you very much for taking the time to talk with me today. Before we wrap up, I just wanted to give you the opportunity to ask me any questions or let me know if there is anything else you think is important for us to consider.

Just in summary, today we talked about climate change and occupational safety and health as it pertains to agricultural workers in Viet Nam. We had a great conversation, and I certainly learned a lot. Over the next few months, we will be completing our project and analysing the results. We will share the results with you once we're finished. In the meantime, please feel free to reach out to me for any reason, my contact information is in the informed consent document you received, if you need another copy just let me know.

Annex 6: Photographs from Field Work



Male rice farmers in Can Tho province participating in the pile sorting activity, August 2023.



Mechanized rice harvester at a rice cooperative in Can Tho province, August 2023.



Female rice farmers in Can Tho province participating in the focus group discussion, August 2023.



Male guava farmers in Ninh Binh province participating in the pile sort activity, August 2023.



Tractors at a rice farmer cooperative in Can Tho province, August 2023.



Rice production machine in Can Tho Province, August 2023.

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VISION ZERO FUND

Vision Zero Fund brings together governments, employers' and workers' organizations, companies, and other stakeholders to advance towards the vision of achieving zero severe and fatal work-related accidents, injuries and diseases in supply chains.

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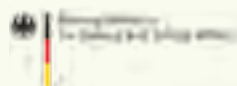
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