Building Agricultural Resilience to Natural Hazard-induced Disasters

INSIGHTS FROM COUNTRY CASE STUDIES

OECD

Food and Agriculture Organization of the United Nations

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Foreword

The agricultural sector is facing unprecedented shocks and stresses. In recent years, natural hazard-induced disasters have ranged from powerful typhoons in Southeast Asia, to more active Atlantic hurricane seasons, severe droughts in many countries, and huge swarms of desert locusts in countries across the Greater Horn of Africa, the Arabian Peninsula and Southwest Asia. Climate change is increasing the frequency and intensity of such events, causing production losses, damaging land and assets in agricultural sectors, and threatening livelihoods around the world.

In the face of these trends, a "business-as-usual" approach to disaster risk management will not be sufficient to enable agriculture to rise to the triple challenge of supplying safe and nutritious food to a growing global population, providing sustainable livelihoods along the agrifood chain, and managing the earth's natural resources sustainably. Simple attempts to build back as before risk perpetuating the sector's vulnerabilities.

This joint OECD-FAO report, which is funded by the Italian Government and an outcome of Italy's G7 Presidency in 2017, presents a resilience-based approach to managing the impacts of natural hazard-induced disasters. It shows that moving from a risk coping to a resilience approach means emphasising the importance of planning to prevent and mitigate the adverse impacts of disasters before they happen, enabling farmers to be better prepared to recover from disasters, and helping the sector to adapt and transform so that they are less vulnerable to future disasters.

The report draws from seven country case studies in Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States to explore the governance arrangements, policy measures, and on-farm strategies that governments, farmers and other agricultural sector stakeholders are already using to build the sector's resilience to natural hazard-induced disasters. It offers insights and concrete recommendations on how countries at all stages of development can build agricultural resilience to natural hazard-induced disasters and enable the sector to continue to play its critical role in contributing sustainable development.

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Table of contents

FIGURES

TABLES

Acronyms

ACEP-ALE	Agricultural Conservation Easement Program – Agricultural Land Easements (United States)
AFAD	Disaster and Emergency Management Presidency (Ministry of Interior, Turkey)
AGEA	Italian Agricultural Payments Agency (Italy)
Agroseguros	Agro Insurance Committee (Chile)
ANBI	National Association of Consortia (Italy)
BDIARI	Bahri Dağdaş International Agricultural Research Institute in Konya (MAF-TAGEM, Turkey)
BSE	Bovine Spongioform Encephalopathy
CAP	Common Agricultural Policy
CBPP	Contagious Pleuropneumonia (lung sickness)
CDEM	Civil Defence and Emergency Management (New Zealand)
ÇEM	General Directorate for Combating Desertification and Erosion (MAF, Turkey)
CES	Cooperative Extension System (United States)
CIMMYT	International Maize and Wheat Improvement Centre (Turkey)
CPD	Civil Protection Department (Italy)
CREA	Council for Agricultural Research and Economics (Italy)
CREA-PB	CREA - Policies and Bioeconomy (Italy)
CRIs	Crown Research Institutes (New Zealand)
CRP	Conservation Reserve Program (United States)
CSB	Ministry of Environment and Urbanisation (Turkey)
CTI	Technical co-ordination centre (Italy)
DANIA	National Database of Investments for Irrigation and the Environment (Italy)
DASK	Turkish Catastrophe Insurance Pool
DIA	Department of Internal Affairs (New Zealand)
DRM	Disaster Risk Management (New Zealand)
DRM	Disaster Risk Management (United States)
DRR	Disaster Risk Reduction
DRR/M	Disaster Risk Reduction/Management
DSI	State Hydraulics Works (MAF, Turkey)
DVS	Directorate of Veterinary Services (Namibia)
ECP	Emergency Conservation Program (United States)
EDEN	Extension Disaster Education Network (United States)
EQIP	Environmental Quality Incentives Program (United States)
EU	European Union
EWP	Emergency Watershed Protection (United States)
EWPP-FPE	Emergency Watershed Protection Program – Floodplain Easements Option (United States)
FAO	United Nations Food and Agriculture Organization
FEMA	Federal Emergency Management System (United States)
FMD	Foot and Mouth Disease
FSA	Farm Service Agency (United States)
FSN	National Solidarity Fund (Italy)
GD	General Directorate of the Ministry of Agriculture and Forestry (Turkey)
GDP	Gross Domestic Product
GEF	Global Environment Facility (Turkey)
GNS	Institute of Geological and Nuclear Sciences (New Zealand)
HICs	High-Income Countries
ICARDA	International Dry Areas Agricultural Research Institute (Turkey)
INDAP	Agricultural Development Institute (Chile)
INIA	Agricultural Research Institute (Chile)
ISIL	Survey of Lombardy's Irrigation Systems (Italy)
ISMEA	Italian Institute for Food and Agricultural Market Services (Italy)
Istat	Italian National Institute of Statistics (Italy)

IUVENE	National Reference Centre for Veterinary Urban Hygiene and Non-Epidemic Emergencies (Italy)
IWWIP	International Winter Wheat Improvement Program (Turkey)
JA	Japan Agricultural Co-operative (Japan)
JMA	Japan Meteorological Agency (Japan)
LDCs	Least Developed Countries
LEP	Land and Environment Plans (New Zealand)
LMICs	Low- and Middle-Income Countries
MAF	Ministry of Agriculture and Forestry (Turkey)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
MATTM	Ministry for Environment, Land and Sea Protection (Italy)
MAWLR	Ministry of Agriculture, Water and Land Reform (Namibia)
MBIE	Ministry of Business, Innovation and Employment (New Zealand)
MfE	Ministry for the Environment (New Zealand)
MGM	Turkish State Meteorological Service (MAF)
MINAGRI	Ministry of Agriculture (Chile)
MiPAAF	Ministry of Agricultural, Food and Forestry Policies (Italy)
MIT	Ministry of Sustainable Infrastructures and Mobility (Italy)
MLIT	Ministry of Land, Infrastructure, Transport and Tourism (Japan)
MPI	Ministry for Primary Industries (New Zealand)
NACD	National Association of Conservation Districts (United States)
NamLITS	Namibia Livestock Identification and Traceability System (Namibia)
NARO	National Agriculture and Food Research Organization (Japan)
NBEOC	National Business Emergency Operations Center (United States)
NEMA	National Emergency Management Agency (New Zealand)
NFIP	National Flood Insurance Program (United States)
NGOs	Non-governmental organisations (New Zealand)
NHID	Natural hazard-induced disasters (United States)
NIFA	National Institute for Food and Agriculture (United States)
NIPP	National Infrastructure Protection Plan (United States)
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NOAA	National Oceanic and Atmospheric Administration (United States)
NPS	National Preparedness System (United States)
NRCS	Natural Resources Conservation Service (United States)
NZIER	New Zealand Institute of Economic Research (New Zealand)
OWU	Observatories on Water Use (Italy)
RAN	National Agroclimatic Network (Chile)
RBA	Rome-based Agencies
RBAs	River Basin District Authorities (Italy)
RDPs	Rural Development Plans
RMA	Risk Management Agency (United States)
RSTs	Rural Support Trusts (New Zealand)
SEGRA	Agricultural Emergency and Risk Management Section (Chile)
SHP	Soil Health Partnership (United States)
SIGRIAN	National Information System for the Management of Water Resources in Agriculture (Italy)
SIVENE	IUVENE Information System (Italy)
SLMACC	Sustainable Land Management and Climate Change (New Zealand)
SNPC	National civil protection system (Chile)
SUEN	Turkish Water Institute (MAF)
SYGM	General Directorate for Water Management (MAF, Turkey)
TAGEM	General Directorate of Agricultural Research and Policies (MAF, Turkey)
TARSİM	State Agricultural Insurance (MAF-TRGM, Turkey)
TRGM	GD Agricultural Reform (MAF, Turkey)
TUIK	Turkish Statistical Institute
TUSIAD	Turkish Industry and Business association
UF/IFAS	University of Florida's Institute of Food and Agricultural Sciences (United States)
USACE	US Army Corps of Engineers (United States)
USDA	United States Department of Agriculture (United States)
USGCRP	US Global Change Research Program (United States)
USGS	US Geological Survey (United States)
WAL	Water abstraction licenses (Italy)
WFD	Water Framework Directive
WFPO	Watershed and Flood Prevention Operations (United States)
WHIP	Wildfires and Hurricanes Indemnity Program (United States)
WUO	Water Users Organisations (Turkey)

Executive Summary

Climate change is posing new challenges for agricultural disaster risk management

Drawing from seven country case studies in Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States, this report proposes a new approach to building agricultural resilience to natural hazard-induced disasters (NHID). Climate change is increasing the frequency and intensity of natural hazards such as floods, droughts, severe storms, and animal pests and diseases, causing production losses and damaging farm land and assets in agricultural sectors across the world. Although farmers in developing countries often bear the brunt of these impacts, OECD countries are not immune. Across the globe, recurrent and more severe natural hazards are challenging even the most experienced and innovative farm managers.

Moving from coping with disaster impacts to building resilience to risk

These trends mean that a "business-as-usual" approach to disaster risk management in agriculture cannot continue if we are to increase the sustainable agricultural productivity growth needed to meet the triple challenge of feeding a growing global population, providing livelihoods along the agrifood chain and improving the sustainability of the agricultural sector, and support progress towards sustainable development. Governments and agricultural sector stakeholders need to shift from an approach that emphasises coping with the impacts of disasters, to preventing and mitigating the adverse impacts of disasters *ex ante*, and being better prepared to recover from disasters, and to adapt and transform in order to be better placed to manage future disasters. That is, to move from a risk coping to a resilience approach.

This approach entails a shift from a reliance on ex post government disaster assistance to building the capacity of stakeholders to manage risk. Frameworks that strengthen the ability of farmers and other stakeholders to prepare and plan for natural hazards; to absorb, respond to and recover from their impacts; and to more successfully adapt and transform in response to the risk of future natural hazard-induced disasters, are essential to build a more resilient agricultural sector.

Countries are already using innovative policies to build resilience

In all seven countries reviewed by the OECD and FAO, governments, farmers and other stakeholders are already using innovative policy measures, governance arrangements and on-farm strategies to increase their resilience to natural hazard-induced disasters.

To encourage farmers and other stakeholders to consider the risk landscape over the long term by helping them to understand the risks that they face from natural hazards, countries are increasingly providing farmers and other agricultural stakeholders with access to science-based and targeted information and decision-support tools developed by both public and private sector actors on climate and extreme weather

events. These tools also support risk-informed decision-making by providing options and strategies for adapting to those risks. In some countries, these tools are co-produced with farmers and other stakeholders to ensure their usability and usefulness on farms.

Countries are implementing physically effective and cost-efficient nature-based solutions to prevent and mitigate natural hazard risks and impacts. This includes solutions that leverage the potential of agricultural land to reduce specific natural hazard risks, such as the risk of flooding, but also on-farm practices that mitigate natural hazard impacts and generate productivity and sustainability benefits, even in non-disaster contexts, such as by improving soil health.

Agricultural sector stakeholders are also collaborating and building relationships to better prepare for and respond to NHID via formal networks of public and private stakeholders. These networks offer an opportunity for stakeholders to develop relationships and build capabilities before a disaster, improving the effectiveness of disaster preparedness and response – on farm, and for the wider agro-food sector.

Finally, countries are prioritising contingency planning and simulation exercises to help enhance the preparedness of all relevant stakeholders to respond to disasters. These exercises ensure that DRM frameworks, measures and stakeholders remain flexible and have the capacity to respond to unanticipated events, and to identify and manage potential cascading effects.

But more can be done to shift to an *ex ante* approach

A resilience approach requires stakeholders to prepare for natural hazards and implement strategies to reduce the risks and impacts, but also to learn from disasters. This means helping stakeholders understand the risks that they face from natural hazards and their responsibilities for managing those risks; and supporting their capacity to manage risk, and to adapt and transform to be better positioned to face future risks. To this end, this report proposes three main areas for action.

Key recommendations

Get the policy incentives right

- Building a more resilient agricultural sector requires consistent and coherent policy signals, both from disaster assistance policies and from agricultural policy frameworks more broadly.
- A common challenge lies in how to provide disaster assistance without discouraging a more resilient recovery or ongoing efforts on-farm to prepare for, prevent and mitigate natural hazard risks and impacts. Triggering criteria and types and levels of government support should be clearly defined in advance, and use of ad hoc support should be minimised, in order to provide farmers with a clear incentive to invest *ex ante* in risk prevention and mitigation measures, and preparedness capacities. Disaster assistance should also encourage farmers to "build back better" by providing guidance on, and targeting support towards, on-farm options to reduce natural hazard exposure and vulnerability.
- The wider agricultural policy environment also provides incentives and signals for farmers to prepare for, prevent and mitigate natural hazard risks – and indeed, to adapt and transform in response to future climate and natural hazard risks. Policies such as direct payments to farmers, publicly-supported risk management tools, and technical assistance can provide useful incentives to adopt new practices or encourage take-up of risk management tools. But unless these policies are carefully designed, they can reduce the cost of, and incentives to address, risk. Governments should review wider agricultural policy frameworks for their effects on farm-level incentives to

prepare for, mitigate and prevent natural hazard risks in the long term, and for opportunities to better integrate resilience considerations.

Target policy investment towards developing a resilience toolkit for farmers

- While clear and consistent policy signals are necessary to encourage farmers and other agricultural sector stakeholders to take responsibility for building their resilience to natural hazard-induced disasters, it is crucial that farmers have the capacity to act on those incentives – including the necessary skills, information and tools.
- Governments should support stakeholders to build their resilience to NHID where gaps exist in stakeholders' capacities. This includes:
    - targeted training and extension services that help farmers develop their entrepreneurial and risk management skills, and to adapt and transform in response to uncertainty and a changing risk environment.
    - providing targeted and science-based information about risk that is tailored to the needs of farmers to support risk-informed decision-making on adaptation to climate and natural hazard risks.
    - consistently and systematically assessing agricultural damage and losses in the wake of a disaster, and ensuring that these data are available and accessible to all stakeholders.
    - investing in public goods and services, including appropriate infrastructure for reducing disaster risks, and supporting the implementation of nature-based solutions on farms.

Engage with trusted stakeholders to motivate farm-level change

- The above efforts are unlikely to be successful if breakdowns in the "last mile" between research outputs and farmers mean that information on natural hazard risks, and new innovations in risk mitigating investments and management practices do not reach some groups of farmers.
- Policy makers should engage closely with trusted stakeholders – including farm and industry organisations, agricultural co-operatives and local extension agents – to promote the benefits of prevention, mitigation and preparedness to reduce exposure to natural hazard risk, as well as to better understand farm-level constraints to adopting practices that improve farm resilience.

1 Introduction

This introductory chapter provides an overview of the report. It outlines the motivation for the report and then presents the structure of the following chapters.

Managing natural hazard risk is inherent in agriculture, given the sector's reliance on climate and weather conditions and the natural resource base. However, more frequent and intense natural hazards,[1] and the compounding and systemic nature of that risk, pose a challenge for the sector – for farmers in developing countries, who often bear the brunt of natural hazard impacts (FAO, 2021[1]), but also for farmers in OECD countries. Around the world, recurrent and more severe natural hazards are challenging even experienced and innovative farm managers. More frequent and intense natural hazard-induced disasters (NHID) – implying higher costs in terms of direct impacts on agriculture, as well as from the cascading effects of disruptions to farm operations and in related sectors – also present a policy challenge for governments, who face a greater burden if a "business-as-usual" approach continues for disaster risk management[2] (DRM) in agriculture (OECD, 2020[2]).

These trends in natural hazard risks and impacts underscore the need for DRM frameworks that build agricultural resilience, defined here as the ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards (and other risks) (OECD, 2020[2]). Recognising this, in 2017, G7 Agriculture Ministers in Bergamo noted the effects of natural hazards on farmers' lives, agro-food systems, agricultural production and productivity in regions all over the world, and that climate change is projected to amplify many of these impacts. Ministers also noted the importance of strengthening the resilience of farmers to natural hazards (G7 Agriculture Ministers, 2017[3]).

In this context, the joint OECD-FAO project on *Building agricultural resilience to natural disasters: Insights from country case studies* examines DRM frameworks in seven countries – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States – to identify what governments and agricultural sector stakeholders can do to build the resilience of farmers and the agricultural sector to NHID.[3] This report explores the impacts of NHID on agriculture – and the agricultural sectors of the seven case study countries in particular – and identifies good practices for building agricultural resilience in the seven case study countries. These include policy measures, governance arrangements, on-farm strategies and other initiatives that provide incentives for, or support the capacities of public and private stakeholders to prepare and plan for NHID, absorb and recover from their impacts, and to adapt and transform in order to increase resilience to future disaster risks.

The report is structured as follows. Chapter 2 provides a high-level overview of trends in NHID over recent decades, and the impacts (losses and damages) on agriculture. It shows that the number of NHID, including geophysical, hydrological, meteorological and biological disasters (such as outbreaks of animal and plant pests and diseases) have steadily risen in the last few decades, and climate change is expected to further increase the frequency and intensity of weather- and climate- related NHID. It also explores the impacts of NHID on agricultural sectors in different regions, including the significant impacts on developing countries. Finally, the chapter highlights the key elements of DRM – disaster risk governance; risk identification, assessment and awareness; prevention and mitigation; risk preparedness; response and crisis management; and recovery and reconstruction – and how they can contribute to building agricultural resilience.

Chapter 3 sets out the approach that was used to identify good practices at all stages of the DRM cycle in the seven case study countries, which was based on principles and recommendations in key international frameworks for managing the risks posed by disasters. The chapter summarises the key principles and recommendations from those frameworks – the OECD's Holistic Approach to Risk Management for Resilience in Agriculture; the Sendai Framework for Disaster Risk Reduction; the OECD Recommendation on the Governance of Critical Risks; and the Joint Framework for Strengthening resilience for food security and nutrition of the Rome-based Agencies. It then proposes four *Principles for Effective Disaster Risk Management for Resilience*.

Chapter 4 synthesises the main insights from seven country case studies. It highlights the innovative policy measures, governance arrangements and on-farm strategies that governments, farmers and other agricultural sector stakeholders are using to increase the sector's resilience to NHID in the seven countries

– Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States. It also offers recommendations for how countries can shift from an approach that emphasises coping with the impacts of NHID, to being better prepared *ex ante* to prevent, mitigate and recover from them, and to adapt and transform in order to be better placed to manage future natural hazards risks.

Finally, Chapters 5-11 summarise the key insights and good practices from the seven country case studies. Six of the case studies focus on a specific natural hazard in order to explore how different policy measures, governance arrangements, on-farm strategies and other initiatives contribute to building resilience. The Italy, Namibia and Turkey case studies focus on drought, whereas Japan, New Zealand and the United States case studies focus on floods and water-related natural hazards as a result of severe storms or heavy rain events. The Chile case study focuses more generally on climate-related risks.

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Notes

[1] According to UNDRR (formerly UNISDR), a hazard is a "dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". Hazards of natural origin arise from a variety of sources, including: geological (e.g. earthquakes), climatological (e.g. droughts), meteorological (e.g. storms), biological (e.g. animal diseases, insect infestations or epidemics) and hydrological (e.g. floods) sources (UNISDR and CRED, 2015[11]). Hazards become disasters when they cause great damage, destruction and human suffering.

[2] UNISDR (2016[10]) defines disaster risk management as the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

[3] See Baldwin and Casalini (2021[4]), Shigemitsu and Gray (2021[5]), Casalini, Bagherzadeh and Gray (2021[6]), OECD (2021[12]), Gray and Baldwin (2021[7]), and FAO (2021[8]) (2021[9]) for the full case studies;

2 The case for building agricultural resilience

This chapter provides an overview of the increasing global trend in the occurrence of natural hazard-induced disasters, in particular the rise of weather- and climate-related hazards during the past decades. It describes the adverse impacts of these types of disasters on the agricultural sector, especially the crop and livestock subsectors, in developed and developing countries. It also outlines the key elements of the disaster risk management framework for agriculture, which include disaster risk governance, risk identification, assessment and awareness, prevention and mitigation, preparedness for response and recovery, emergency response, and recovery, rehabilitation and reconstruction. Examples of agricultural activities are provided for each of these key elements.

Key messages

- The number of natural hazard-induced disasters, including geophysical, hydrological, meteorological as well as biological disasters such as outbreaks of animal and plant pests and diseases, have steadily risen in the last few decades.
- The majority of the natural hazard-induced disasters were weather- and climate- related. It is expected that climate change will further exacerbate and increase these types of disasters in frequency and severity.
- Strongly reliant on weather and climate to thrive, agriculture, is highly vulnerable to the adverse impacts of climate change and climate related disasters. Therefore, building agricultural resilience is critical to reduce significant damage to agricultural facilities, equipment and infrastructure and losses in the crops, livestock, forestry, fisheries and aquaculture subsectors.
- The disaster risk management framework considers disaster risk management as a continuum, thus an ongoing process of interrelated actions, which are initiated before, during and after disasters occur. The key elements of this framework for agriculture include disaster risk governance; risk identification, assessment and awareness; prevention and mitigation; preparedness for response and recovery; emergency response; and recovery, rehabilitation and reconstruction.

2.1. Introduction

Disasters – whether natural- or human-induced, have significant impacts on people, communities and countries. Beyond their immediate, short-term effects, disasters can also substantially set economies back and can undermine national development gains that have taken decades to build. Moreover, disasters respect no boundaries – they affect both developed and developing countries.

At the global level, the number of natural hazard-induced disasters, including geophysical, hydrological, meteorological as well as biological disasters, such as outbreaks of animal and plant pests and diseases, have steadily increased from the 1970s onwards (CRED and UNDRR, 2016[1]; FAO, 2021[2]). Natural hazard-induced disasters in particular have significantly increased, from 4 212 events during 1980-1999 period to 7 348 events between 2000-2019 (CRED and UNDRR, 2020[3]).

An increasing trend can also be observed in recent decades regarding the weather- and climate-related disasters. These types of disasters include, for example, drought, extreme temperatures, storms, heavy rainfall events and floods. It is estimated that during these two periods of 1980-1999 and 2000-2019, around 87% and 91% of the total number of natural hazard-induced disasters were weather- and climate-related. The number of people affected by these types of disasters has increased – from 3.25 billion in 1980-1999 to 4.03 billion people in 2000-2019, while the economic losses caused amounted to USD 2.97 trillion in 2000-2019, compared to USD 1.63 trillion[1] in 1980-1999 (CRED and UNDRR, 2020[3]). These figures mainly reflect the occurrence of rapid-onset and large-scale disasters, while slow-onset hazards and sub-national, localized or small-scale disasters are generally not included. As a result, the actual number of disasters therefore lies higher than those reported.

It is expected that with climate change, weather- and climate-related disasters will further increase in frequency and severity (IPCC, 2012[4]). Due to the climate sensitivity of agriculture, the sector is already negatively impacted, as a result of damage to, and destruction of agricultural-related infrastructure, and losses in crops, livestock, forestry, fisheries and aquaculture production (FAO, 2016[5]). Also, plant and animal pests and diseases are expected to rise due to climate change, extreme weather events and

seasonal variability, and are already impacting the sector, food security and agricultural livelihoods (Box 2.1) (FAO, 2005[6]).

Moreover, the coronavirus disease 2019 (COVID-19) has globally spread and has devastated lives, livelihoods and economies worldwide. The COVID-19 pandemic unfolded on top of other shocks and stresses, such as floods, storms, earthquakes, droughts and desert locusts. Some of these disasters are linked or aggravated by the effects of climate change, which will further increase the exposure and vulnerabilities of people, societies and economies. The pandemic has shown the changing risk environment, as well as the systemic and overlaying nature of risks that have cascading adverse impacts on all sectors, including agriculture and food systems. Hence, the need for multi-hazard and multi-sectoral preventive and anticipatory approaches that ensure the integration of disaster, climate and crisis risk management to strengthen the resilience of people, their agricultural livelihoods and the ecosystems they depend upon (Khim, 202[8]).

Box 2.1. Desert locust outbreak in 2020 across Greater Horn of Africa, Arabian Peninsula, and Southwest Asia

Huge swarms of desert locusts during the first few months of 2020 ravaged thousands of hectares of cropland and pastures, and threatened food security and agricultural livelihoods in countries across the Greater Horn of Africa, the Arabian Peninsula and Southwest Asia. It was considered the worst desert locust outbreak in 25 years in Ethiopia and Somalia, and the worst observed in over 70 years in Kenya. The upsurge in Eastern Africa and Yemen was triggered by two cyclones that allowed three generations of breeding, which resulted in an 8 000-fold rise in locust numbers between June 2018 and March 2019. The situation worsened due to lack of access to some areas as a result of insecurity and ongoing conflicts, which shows the colliding and mutually reinforcing impacts of food chain crises with climate change and conflicts (FAO, 2020[7]).

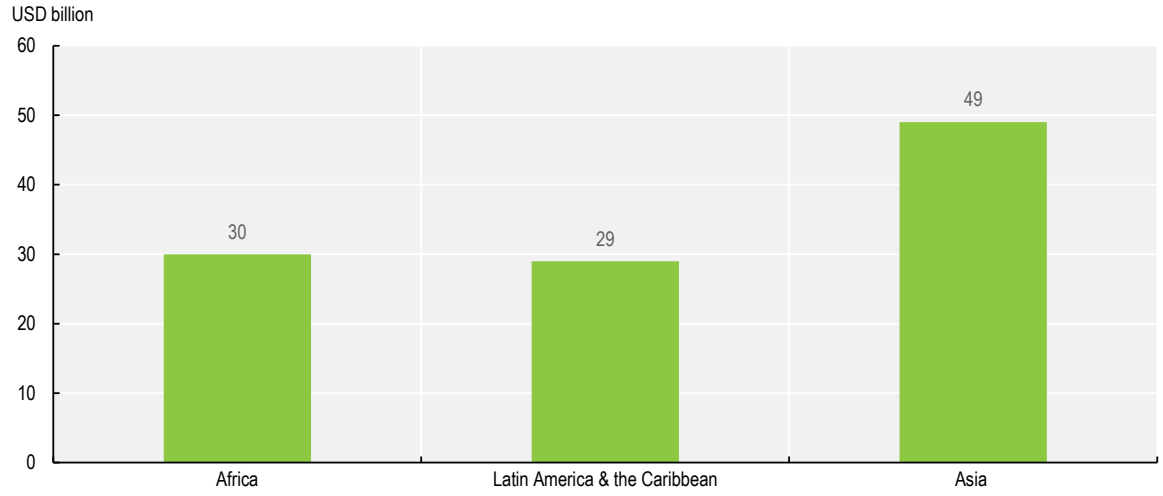
2.2. Impacts of natural hazard-induced disasters on agriculture

As natural hazard-induced disasters have become more frequent and severe over the past decades, these events have resulted in increasing economic losses worldwide. For instance, for the first time globally, annual economic losses from disasters surpassed USD 100 billion during the three consecutive years of 2010-2012, and far exceeded humanitarian aid. While absolute economic losses are higher in developed countries, the impacts of natural hazard-induced disasters on developing countries are more significant. For instance, the costs of the 2011 East Japan 9.0-magnitude earthquake were among the highest in history at around USD 200 billion, equivalent to 3% of Japan's Gross Domestic Product (GDP), while the costs of the 2010 earthquake in Haiti were around USD 14 billion, equivalent to 160% of Haiti's GDP. Moreover, while disasters affect everyone, the most affected are the vulnerable people who are less able to cope with and recover from their impacts, due to their lack or limited access to and control over resources (Oxfam International, 2013[9]; UNISDR, 2013[10]).

Natural hazard-induced disasters are a leading cause of food insecurity (FAO, IFAD, UNICEF, WFP, and WHO, 2018[11]). The impact of these disasters extend beyond the economic realm – they destroy food, and people's ability to produce, access and intake of food, which affect all four dimensions of food security through reducing the *availability* of food; limiting physical and socio-economic *access* to food; affecting food *utilisation*, which refers to the body's ability to absorb the nutrients in food that is consumed; and, disasters undermine food *stability* at all times, as access, availability and utilisation of food are disrupted (FAO, 2008[12]).

According to the FAO study (2021[2]),[2] the agricultural sector absorbed between 2008 and 2018, 26% of the overall impacts caused by medium- to large-scale disasters in least developed countries (LDCs) and in low- and middle-income countries (LMICs). During this period, around USD 108.5 billion was lost alone due to declines in crop and livestock production in LDCs and LMICs as a result of disasters (Figure 2.1). While across all income groups, including in the upper-middle income countries (UMICs) and high-income countries (HICs), loss in crop and livestock production amounted to USD 280 billion.

Figure 2.1. Total crop and livestock production loss in LDCs and LMICs, 2008-2018



Source: FAO (2021[2]).

The FAO study (2021[2]) also revealed that if the crop and livestock production loss in LDCs and LMICs is converted into nutritional values, a total of 6.9 trillion kilocalories per year is lost, which equals the annual calorie intake of 7 million adults. These figures disaggregate to a loss of 559 calories per capita per day during this ten-year period, which is 20% of the recommended daily allowance (RDA) in Africa, 40% of RDA (or 975 calories per capita per day) in Latin America and the Caribbean, and 11% of RDA (or 283 calories per capita per day) in Asia.

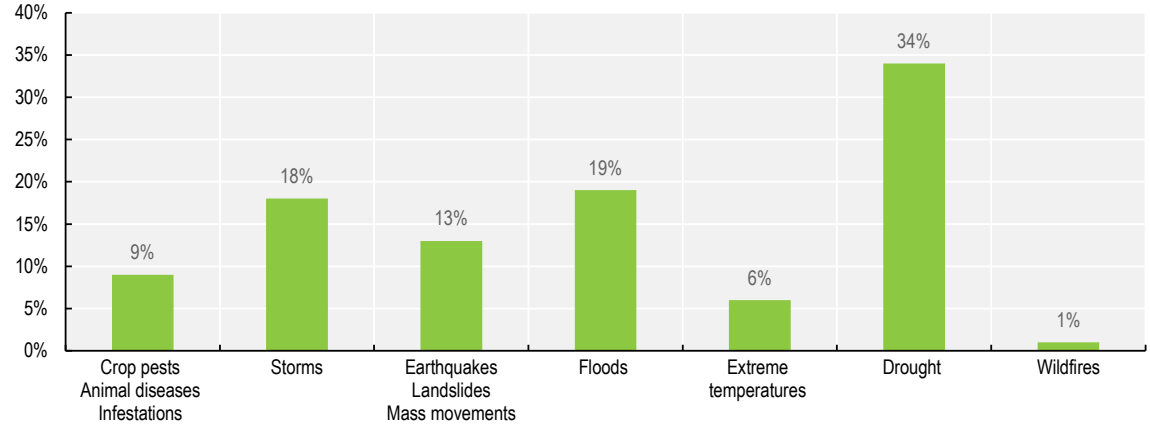
In addition, these natural hazard-induced disasters can severely disrupt global supply chains, thereby affecting market access, trade, food supply and access, which can in turn reduce incomes, deplete savings and erode livelihoods. In addition, disasters can substantially impact supply chains, even when a disaster occurs in another part of the world. As supply chains are increasing global, connected and linked, these are thus increasingly exposed to disaster risks (UNISDR, 2013[10]). Moreover, the effect of disasters on food prices can also be significant. For instance, the continuous increase in agricultural commodity prices between 2002 and 2011 resulted in the value of the FAO Food Price Index more than doubling. This was the result of various factors, including biofuel policies, export restrictions, speculations, low food stocks as well as the occurrence of several disasters, such as the three droughts in Australia from 2001 to 2007 and a heatwave during the summer of 2010 in Central Asia (FAO, 2009[13]; Caldecott, Howarth and McSharry, 2013[14]).

Disaggregating damage and loss caused by natural hazard-induced disasters on agriculture

According to the international disaster database EM-DAT, at the global level, floods occurred the most frequently during 2000-2019 (44% of natural hazard-induced disasters), followed by storms (28%), earthquakes (8%), extreme temperatures (6%), and landslides and drought (5%). In terms of the impacts of these disasters on people, floods affected the largest number of people (41% of total people affected), followed by drought (35%), storms (18%) and earthquakes (3%) (CRED and UNDRR, 2020[3]).

At present, a global study on the impact of different types of disasters on agriculture does not exist. However, according to the FAO study (2021[2]) that assessed the impact of disasters in LDCs and LMICs between 2008 and 2018, the seven major types of disasters that adversely impacted agricultural production systems were drought, followed by floods, storms, earthquakes/landslides/mass movements, plant and animal pests/diseases, extreme temperatures, and wildfires (Figure 2.2).

Figure 2.2. Total crop and livestock production loss per disaster type, LDCs and LMICs, 2008-2018

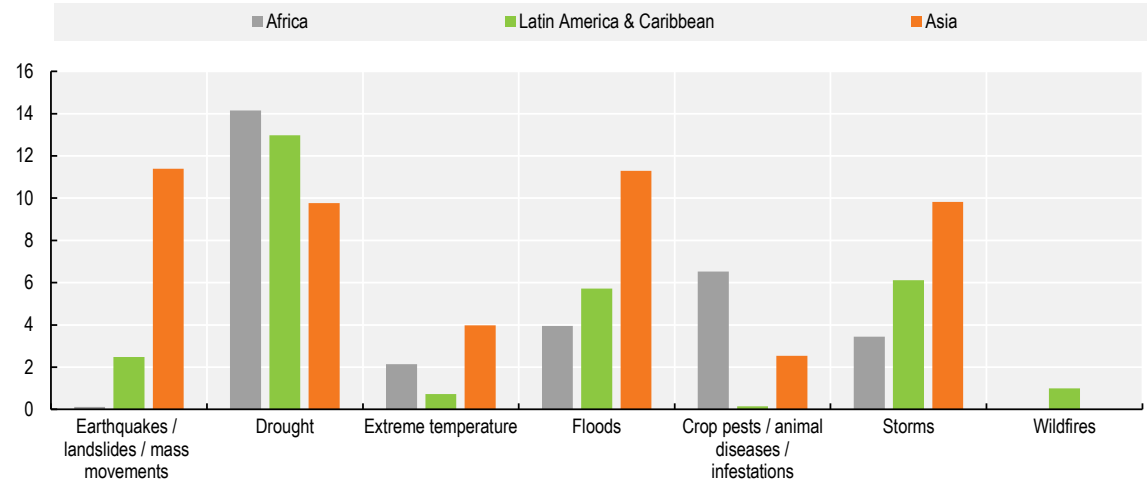


Source: FAO (2021[2]).

Drought is the single greatest cause of agricultural production losses.[3] Over 34% of crop and livestock production losses in LDCs and LMICs are due to drought, costing the sector USD 37 billion overall between 2008 and 2018. Agriculture is the sector that is thus most affected by droughts, and absorbed 82% of all drought impacts, compared to 18% in all other sectors during this period (FAO, 2021[2]).

The impacts of natural hazard-induced disasters on agriculture – including the type and magnitude of natural hazard-induced disasters – vary by region. During the 2008-2018 period, drought caused the largest crop and livestock production losses in Africa (over USD 14 billion), followed by losses due to plant and animal pests and diseases (USD 6.5 billion). Overall, the impact of drought on agriculture was also the greatest in the Latin American and the Caribbean region (USD 13 billion in crop and livestock production loss), followed by storms (USD 6 billion). In contrast, in Asia, geophysical disasters caused the highest amount of losses (USD 11.4 billion), closely followed by floods (USD 11 billion) and storms (USD 10 billion) (Figure 2.3).

Figure 2.3. Total crop and livestock production loss by region and per disaster, LDCs and LMICs, 2008-2018



Source: FAO (2021[2]).

Estimates of the economic costs of natural hazard-induced disasters provide an insight into the potential magnitude of the impacts in some developed countries, such as:

- In Australia, total agricultural losses arising from bushfires in 2009 were estimated at AUD 733 million. The combined agricultural losses from flooding and a cyclone in 2011 were estimated at AUD 1.4 billion (Productivity Commission, 2014[15]).
- In the United States, a severe drought in 2012 was estimated to have caused around USD 40 billion crop and livestock losses (WEF, 2014[16]), while the 2014 drought caused direct losses of around USD 1.5 billion and total economic losses of USD 2.2 billion (Munich Re, 2015[17]), 2015[17]). It is estimated that on average, over the last 110 years, 10-20% of the country annually experiences moderate to extreme drought (Wilhite, Svoboda and Hayes, 2005[18]).
- In Europe, natural hazard-induced disasters have resulted in economic losses of USD 550 million between 1980-2019, of which around 81% of the total losses was caused by climate- and weather-related extreme events (EEA, 2020[19]). Due to the warming trend over the last four decades, the region has experienced more frequent droughts that have substantially impacted the agriculture sector. The drought that occurred from April to November in 2018 was declared by the German government as a crisis of national proportions as the prices of some vegetables increased by 30% (DW, 2020[20]; Reuters, 2020[21]).

The cost to governments of providing post-disaster relief to agricultural producers can also be significant. For instance, during the 2000-2019 period, China and the United States provided an annual average of USD 1.7 billion and USD 1.6 billion, respectively, while the EU Member States provided an annual average of USD 1.2 billion (OECD, 2020[22]).

Due to the increasing frequency and intensity of natural hazard-induced disasters – and particularly climate related events – that adversely impact agriculture and food security, it is of utmost importance that the extent and causes of disaster impacts are better understood and quantified. This will help to assess the benefits of the disaster risk reduction investments made by farmers as well as public and private investments in the sector. Thus, a sound evidence base on disaster impacts on agriculture and food security can help to develop tailored and effective resilience policies, inform cost-effective disaster risk reduction/management interventions and track progress towards the targets set under the relevant international frameworks, including the Sendai Framework for Disaster Risk Reduction 2015-2030, the

Paris Agreement, and the 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals.

The key disaster risk management terms are defined in Box 2.1.

Box 2.2. Disaster risk management terminology

Building Back Better: The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment.

Damage: Refers to the total or partial destruction of physical assets and infrastructure in disaster-affected areas, expressed as replacement or repair costs.

Disaster risk management: The application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards of natural origin arise from a variety of sources, including geological (earthquakes), climatological (droughts), meteorological (storms), and hydrological (floods) sources.

Losses: Refer to the changes in economic flows arising from the disaster (FAO, 2016[5]).

Natural hazard-induced disasters: A serious disruption of the functioning of a community or a society at any scale due to natural hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Source: UNDRR (2021[23]).

The following section outlines the key disaster risk management elements and provides examples of agricultural-related actions for each.

2.3. Key elements of the disaster risk management (DRM) framework for agriculture

In order to reduce disaster risk and increase resilience to disasters, it is important to implement disaster risk management (DRM) actions. The disaster risk management framework considers DRM as a continuum, thus an ongoing process of interrelated actions, which are initiated before, during and after a disaster has occurred. The aim of DRM actions is to strengthen the capacities and resilience of people and communities to protect their lives and livelihoods, by undertaking measures to avoid the creation of new risks (prevention), reduce existing risks and mitigate their impacts (risk reduction/mitigation) and build capacities to be better prepared for response and recovery (preparedness), including the integration of ‘building back better’ activities with the aim of addressing the root causes of vulnerabilities and risks.

In this section, the following key elements of the disaster risk management framework for agriculture will be described:

- Disaster risk governance
- Risk identification, assessment and awareness
- Prevention and mitigation
- Preparedness for response and recovery
- Emergency response
- Recovery, rehabilitation and reconstruction

These key elements of the DRM framework directly correspond to the four priorities for action of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, which particularly focuses on significantly reducing disaster risks. Implementing disaster risk reduction measures is key in order to ensure that potential hazardous events will not evolve into disasters.

Disaster risk governance

Disaster risk governance is defined as "the system of institutions, mechanisms, policy and legal frameworks and other arrangements to guide, coordinate and oversee disaster risk reduction and related areas of policy" (UNDRR, 2021[23]). Governance for DRM in agriculture includes the mainstreaming of DRR/M into sectoral laws, policies, plans and strategies and equally for national and local DRR/M laws, policies, plans and strategies to be cross-sectoral in nature and prioritise agriculture as one of the sectors to implement DRR/M interventions. It also requires the alignment and coordination between different climate change, food security, social protection and development plans, policies and strategies and to ensure that vulnerable agricultural households have access to projects and programmes that aim to reduce their vulnerabilities and risks, and contribute to ensure their food and nutrition security and sustainable livelihoods (FAO, 2008[24]; Koloffon and VonLoeben, 2019[25]).

In addition, governance for DRM in agriculture requires clear vision, competence, guidance and coordination within the sector and across other related sectors – such as water and energy – as well as the participation of all relevant stakeholders. It requires that the roles and responsibilities of institutions be outlined in DRR/M and sectoral laws and policies so that their mandates are enforced and clear synergies are drawn among the various agriculture-relevant stakeholders. Moreover, the establishment of horizontal and vertical coordination mechanisms (between the various governance levels – national to local and vice versa), as well as institutional inter-linkages within and between sectoral agencies, are important to deliver DRM in a systemic and consistent manner. These coordination mechanisms and inter-institutional linkages are also key to ensuring appropriate channeling of resources and information, among others (FAO, 2008[24]; Koloffon and VonLoeben, 2019[25]).

As an example, disaster risk governance can be strengthened by focusing on developing legal and policy frameworks, and other arrangements that enable institutions and other relevant stakeholders to perform their functions effectively and efficiently to deliver DRR/M. In this respect, it is important to take advantage of opportunities for cooperation and collaboration, avoid duplication of efforts to deliver risk sensitive actions across all sectors and at all levels (FAO, 2008[24]).

Risk identification, assessment and awareness

An understanding of disaster risks, including risk drivers and underlying risk factors, is highly important in order to better understand risks, vulnerabilities and coping capacities of exposed farming communities, and to inform policies, strategies, and plans for the implementation of specific DRR/M interventions (UNISDR, 2017[26]). Risk identification for the agriculture sector involves conducting multi-hazard, vulnerability and risk assessments to determine the nature and extent of risk by analyzing potential

hazards, their location, intensity, frequency and probability as well as assessing existing conditions of exposure and vulnerability, including the physical, socio-economic and environmental dimensions, and to evaluate the effectiveness of existing and alternative coping capacities within potential risk scenarios (UNISDR, 2009[27]). In order to identify and monitor hazards and risks, data and information systems for DRM need to be in place, available and accessible. This includes multi-risk and vulnerability profiles and sector-specific maps where the risks, vulnerabilities and exposure of farming communities and of the sector are identified and prioritized to inform and enhance decision-making and planning capacities for the agricultural sector (FAO, 2008[24]).

Another important element of understanding risks and reducing the underlying vulnerabilities of the agriculture sector is knowledge sharing and awareness raising. These activities proactively inform agricultural producers and their communities how to reduce existing vulnerabilities and how to prevent or mitigate current and future risks (FAO, 2008[24]). It includes enhanced outreach to farmers and their communities through information events, campaigns and trainings aimed to enhance disaster risk reduction planning as part of institutional capacity building. This includes education and training to demonstrate, validate and replicate agricultural good practices and technologies that help to reduce vulnerabilities and contribute to mitigate the adverse impacts of natural hazard-induced disasters on agriculture. Another example is the use of seasonal forecasts and advisories to help farmers to make appropriate decisions, such as adjusting their cultivation practices or selecting more drought-tolerant varieties in order to ensure their food security and incomes (FAO, 2013[28]).

Prevention and mitigation

Prevention and mitigation activities aim to avoid and lessen or minimize the adverse impacts of a hazardous event, and therefore reduce risks (UNDRR, 2021[23]). Vulnerability reduction measures for the agriculture sector include, for example, the implementation of agricultural good practices and technologies at the farm level, such as the use of crop, livestock and tree varieties that are more resilient to floods, droughts or saline conditions; the use of soil and water conservation practices, like conservation agriculture; mulching; the vaccination of livestock against certain animal diseases; fodder conservation; (community) seed storage; livestock shelters; agroforestry; as well as diversification of farmers' income sources through livelihoods diversification. These strategies can help to decrease vulnerability to production failure due to the negative impacts of natural hazard-induced disasters (FAO, 2013[28]).

In addition, the implementation of shock-responsive risk transfer mechanisms, including e.g., social protection schemes and risk insurance, can help to reduce people's vulnerabilities and exposure to financial impacts, as well as underlying risks to food and nutrition insecurity (Glauber et al., 2021[29]). Risk-informed social protection schemes can provide cash or in-kind support (i.e. food or agricultural assets), conditionally or unconditionally, which can help to improve farmers' welfare and livelihoods through reducing cash, savings and liquidity constraints. These schemes can thus protect assets and livelihoods to help better manage risks. In addition, it can assist producers' organizations or farmers' cooperatives to manage contingency funds, savings and loan schemes as well as risk-sharing schemes (i.e. grain reserves, warehouse receipt systems and revolving funds) In contrast, insurance, such as crop insurance and weather index-based insurance can help spread the risk of income loss to farmers and it can help to avoid farmers from having to sell their assets (i.e. crops, livestock) as a coping strategy after the negative impacts of a disaster (FAO, 2013[28]).

Preparedness for response and recovery

Increasing disaster risk means there is a need to strengthen capacities in proactive disaster preparedness for response and recovery at all levels. Preparedness for response and recovery focuses on the knowledge and capacities to effectively anticipate, monitor and be prepared to respond to and recover from the impacts of disasters, and helps to ensure orderly transitions from disaster response to a sustained and

resilient recovery. It also involves a sound understanding of disaster risks as well as strong linkages with single or multi-hazard early warning systems in order to enhance the capacity to predict, monitor and ability to act early and quickly when needed. The implementation of adequate and disaster risk-informed preparedness measures before a disaster occurs includes strengthening response capacities of individuals, communities and relevant stakeholder organisations, and can help make response actions more effective, efficient and timely, and can save lives and livelihoods (UNISDR, 2008[30]).

Examples of preparedness activities in the agriculture sector include national and local preparedness planning, specific contingency planning, simulation drills and exercises, stockpiling of equipment and supplies, establishment of coordination mechanisms for evacuation, rapid risk assessment, dissemination of public information (UNISDR, 2009[27]; FAO, 2013[28]). It also includes the regular monitoring and improved forecasting – that is, predicting the timing and likelihood that a hazard occurs – linked to the dissemination of timely, reliable and accurate single/multi-hazard early warnings to enable farmers, their communities and other stakeholders to make risk-informed decisions and implement early actions to help protect agriculture-related assets and property, as well as critical on-farm and community-based infrastructure. These anticipatory actions may include pre-allocation of inputs, and moving supplies, people, or livestock (FAO, 2013[28]; UNISDR, 2009[27]).

Emergency response

Emergency response refers to interventions undertaken immediately after a disaster with the aim of saving lives and livelihoods, as well as to ensure public safety. It focuses on providing relief efforts to help meet the basic subsistence needs of those affected and safeguarding their assets as quickly as possible (UNDRR, 2021[23]). While there is a clear distinction between the preparedness and the emergency response phases, the division between the response and recovery phases may sometimes not be so clear cut as certain response interventions, such as the supply of temporary housing and water, may also extend into the recovery stage (UNISDR, 2009[27]).

Specific agricultural emergency response actions include the provision of, among other resources, food, seeds, fertilizer, fodder, fishing equipment and agricultural tools, in order to safeguard agricultural livelihoods immediately after the impact of a disaster. It may also support the restoration of local food production through the provision of training to community animal health workers to save livestock, and efforts to enhance farmers' knowledge and skills on water conservation techniques to help establish a basis for agricultural recovery (FAO, 2007[31]).

Recovery, rehabilitation and reconstruction

Recovery involves the rehabilitation and reconstruction of physical, economic, social and environmental assets, systems and activities of a community or society that has been affected by a disaster and enabling the restoration and rebuilding of people's livelihoods. Rehabilitation encompasses the restoring of basic services and facilities for the full functioning of a community or a society affected by a disaster, while reconstruction focuses specifically on the medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing and facilities (UNISDR, 2009[27]).

The overarching aim of implementing recovery, rehabilitation and reconstruction measures in agriculture, including through the application of 'building back better', is to rebuild more resilient agricultural livelihoods and reduce future disaster risk by addressing root causes of vulnerabilities. It includes more long-term oriented post-disaster measures, such as the rehabilitation or reconstruction of hazard-resilient agricultural infrastructure, like drainage and irrigation systems, seed storage facilities and animal shelters as well as efforts to protect the health of surviving animals through vaccination, and the implementation of more drought-resistant and/or flood-tolerant crop varieties, among others (ADB, 2012[32]; FAO, 2013[28]).

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Notes

[1] These figures are adjusted to inflation for USD 2019.

[2] The report analysed the impacts of 457 disasters in 109 countries, including upper-middle income countries (UMICs) and high-income countries (HICs) for the first time. Between 2008-2018, of the 109 countries that recorded disaster-related agricultural losses, 86% of these were LDCs and LMICs, and 85% of disasters occurred in LDCs and LMICs.

[3] Due to the slow onset nature, the lack of visible physical damage, blurred temporal boundaries, and wide geographical reach, is difficult to assess the exact impact of droughts. As a result, the evidence base is often missing. Therefore, the adverse impact of this type of disaster, in terms of agricultural damage and losses, is often underestimated.

3 Principles for effective disaster risk management for agricultural resilience

Recent and projected trends in natural hazards-induced disasters (NHID) underscore the importance of building agricultural resilience through disaster risk management (DRM) that strengthens the ability of farmers and other agricultural sector stakeholders to prepare and plan for NHID; to absorb, respond to and recover from their impacts; and to more successfully adapt and transform in response to the risk of future NHID. This chapter sets out the approach that was used to identify good practices at all stages of the DRM cycle in the seven case study countries. Specifically, it proposes four *Principles for Effective Disaster Risk Management for Resilience*, which are based on recommendations and principles in key international frameworks for managing the risks posed by disasters.

Key messages

- Recent and projected trends in natural hazards-induced disasters (NHID) underscore the importance of building agricultural resilience through disaster risk management (DRM) that strengthens the ability of farmers and other stakeholders to prepare and plan for NHID; to absorb, respond to and recover from their impacts; and to more successfully adapt and transform in response to the risk of future NHID.
- This chapter develops a framework for identifying good practices at all stage of the DRM cycle based on principles in key international frameworks for managing the risks posed by disasters, including OECD recommendations and the Sendai Framework for Disaster Risk Reduction. Specifically, it proposes four Principles for Effective DRM for Resilience:
  - An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience.
  - A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities.
  - An *ex ante* approach to natural disaster risk management.
  - An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazards.
- According to these four principles, policy measures, governance arrangements, on-farm strategies and other initiatives are identified as "good practices" because they encourage stakeholders to consider the risk landscape over the long term; and provide incentives, and support the capacity of stakeholders to, take responsibility for building their resilience to NHID.

3.1. Introduction

Agriculture[1] is highly vulnerable to natural hazards. Natural hazard-induced disasters[2] (NHID) caused by droughts, earthquakes, fires, floods and severe weather conditions can have significant, widespread and long-lasting impacts on the sector through the serious damage they cause to farm assets, infrastructure and farmland, and through crop and livestock losses. There can also be costs due, for example, to the impacts on social wellbeing and animal welfare (Productivity Commission, 2014[1]). The impacts of natural hazards are particularly severe in developing countries, where they can significantly affect agricultural growth, rural livelihoods and food security, and impede progress towards sustainable development (FAO, 2021[2]; UNISDR, 2015[3]). A large share of global disaster losses over the period 2008-18 – around 39% – were concentrated in least-developed and lower-middle-income countries, where agriculture accounts for a significant share of formal and informal economic activity (FAO, 2021[2]).

While the impacts of individual natural hazard events can be severe, natural hazard risk – and indeed, disaster risk more broadly – is becoming increasingly compound and interacting. Droughts and floods can trigger pest and disease outbreaks; weather-related hazards are expected to intensify and increase in frequency because of climate change (IPCC, 2013[4]); and in many countries, natural hazards such as severe storms, droughts and pest outbreaks have compounded the effects of the COVID-19 pandemic on agriculture (FAO, 2021[2]). Interlinkages between agriculture and other sectors and systems also mean that natural hazards can affect agriculture and disrupt farm business activities by interrupting or shutting down critical infrastructure for the sector, such as irrigation and drainage systems and transport networks that connect farmers to inputs and markets (WEF, 2016[5]; Bailey and Wellesley, 2017[6]; FAO, 2018[7]). These

same linkages also mean that even when the most direct impact is reduced production, the effects can cascade along the entire agro-food value chain, affecting rural livelihoods, and placing all dimensions of food security and nutrition at risk, particularly in affected areas (FAO, 2021[2]).

Given the compounding and systemic nature of natural hazard risk, disaster risk management[3] (DRM) frameworks that strengthen the ability of farmers to prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards, are essential to build agricultural *resilience* to these hazards. This is particularly important for natural hazards, but also applies to broader systemic risks affecting the agricultural sector, including those presented by the COVID-19 pandemic (Box 3.1). Effective DRM requires public and private stakeholders to understand the risks they face from natural hazards, and to take responsibility for managing the risks that these pose to their assets and activities. It also depends on sound governance frameworks for making decisions on how best to manage disaster risk to ensure resilience.

Box 3.1. COVID-19 and increasing the resilience of agriculture and food sectors to systemic risks

The ongoing COVID-19 pandemic has highlighted the importance of agriculture and food sectors that are resilient to systemic threats, including unknown risks. As with weather-related hazards, systemic risks such as the COVID-19 pandemic, and the measures put in place to manage them, can have cascading effects across agricultural and food supply chains – from farm production to outlets for final demand – that impact both the supply of and demand for food (OECD, 2020[8]). Moreover, they can interact with other, more well-known threats such as natural hazards, compounding the impacts on agriculture. Given the potentially significant impacts, effective DRM is important to ensure that agro-food sectors continue to function during a crisis, as disruptions can cause serious harm to social welfare, and negatively impact the livelihoods of producers and other food sector workers.

There are differences between shocks like the COVID-19 pandemic and those from weather-related hazards, not least in terms of the nature of the impacts on agriculture and food sectors – for example, weather-related hazards such as floods and drought can cause significant damage to agriculture's natural resource base. Nevertheless, the principles for effective natural disaster risk management for resilience developed for the joint OECD-FAO project on *Building agricultural resilience to natural hazard-induced disasters* are likely to be relevant for a broad range of systemic risks facing the sector

Note: Epidemics are classified as a hazard of natural origin (biological) in UNISDR and CRED (2015[9]) and the EM-DAT International Disaster Database (EM-DAT, n.d.[10]).

The joint OECD-FAO project on *Building Agricultural Resilience to Natural Hazard-Induced Disasters: Insights from Country Case Studies* examines DRM frameworks in selected OECD and developing countries to identify what governments and agricultural sector stakeholders can do to build the resilience of farmers and the agricultural sector to NHID – resilience defined here as the ability of farmers to prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards (OECD, 2020[11]). The project identifies good practices for ensuring resilience in DRM in agriculture, emphasising in particular:

- Policies and strategies available to governments, including:
  - *Ex ante* measures to assess natural hazard risks and the sector's vulnerability to them, to prevent or reduce the probability of a natural hazard-induced disaster occurring, and to mitigate the potential impacts.

  - *Ex post* measures to help farmers cope with and recover from a NHID once it has occurred, and to "build back better" [4] during recovery, rehabilitation and reconstruction.
- Governance arrangements, including for:
  - Allocating responsibilities and resources for managing natural disaster risk among stakeholders, including crisis management and disaster response.
  - Deciding among policy options to "manage" natural disaster risks, including between investing in *ex ante* measures such as risk prevention and mitigation, and providing *ex post* assistance to help farmers cope with and recover from a natural disaster.
  - Ensuring the coherence of agricultural sector frameworks and measures with national DRM frameworks, and with broader objectives for the sector.

3.2. Approach for the project

The project follows a case study approach. DRM frameworks in the seven case study countries – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States[5] – were analysed qualitatively, using information obtained through a questionnaire provided to countries, interviews with stakeholders, field visits and desktop research. This approach ensures that each case study reflects the context-specific aspects of DRM for agriculture in each country, including the role played by formal and informal organisations. Each case study provides an overview of governance arrangements for natural hazard-induced disaster risks (including national, cross-sectoral frameworks), and the measures in place to identify risks, prevent and mitigate, prepare for, and recover from natural hazard-induced disasters in agriculture. That said, each case study focuses on a particular natural hazard to explore how measures and governance arrangements contribute to building agricultural resilience.

Good practices in the case study countries are identified at each stage of the DRM cycle – risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction – according to principles and recommendations from key international frameworks for managing the risks posed by disasters and other risks. This includes the OECD's Holistic Approach to Risk Management for Resilience in Agriculture (OECD, 2009[12]; 2011[13]; 2020[11]) and other international frameworks – specifically, the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015[3]); the OECD Recommendation on the Governance of Critical Risks (OECD, 2014[14]); and the Joint Framework for Strengthening resilience for food security and nutrition of the Rome-based Agencies (FAO, IFAD and WFP, 2019[15]). These are outlined in the following section.

3.2.1. Relevant OECD and international frameworks for resilience

OECD Holistic Approach to Risk Management for Resilience in Agriculture

OECD analysis has found that an efficient and effective policy approach for risk management in agriculture will take into account the interactions and trade-offs between different risks, on-farm strategies and government policies, and offer differentiated responses to different types of risk. Specifically, the OECD holistic framework for analysing risk management policies in agriculture distinguishes normal business risks (to be borne and managed by farmers) from larger but less frequent risks requiring market solutions (such as insurance systems and futures markets) and comparatively rarer catastrophic risks – such as natural hazard-induced disasters – requiring public intervention (OECD, 2009[12]; OECD, 2011[13]). In terms of disaster assistance, this work emphasises the importance of defining explicit boundaries for catastrophic risks and establishing an *ex ante* framework that determines when *ex post* disaster assistance will be provided. The framework has been applied in studies of risk management systems in Australia, Canada, the Netherlands, New Zealand and Spain; a review of policy approaches for the sustainable management

of droughts and floods in agriculture; and a review of policy approaches for managing weather-related disasters in Southeast Asian agriculture.[6]

More recent work argues that a resilience approach to agricultural risk management requires public and private actors to consider the risk landscape over the long term, and to place a greater emphasis on what can be done *ex ante* to reduce risk exposure and increase preparedness. It highlights the trade-offs inherent in agricultural risk management, including between the interests of different stakeholders and between different measures to manage risk, such as investing in risk prevention and mitigation *ex ante* and providing *ex post* disaster assistance. It recommends that governments adopt participatory approaches to define disaster risk frameworks and ensure that all stakeholders are aware of risks and understand their responsibilities for managing risk. It also identifies a role for no-regret (or win-win) policies and appropriate investments in public goods that build agricultural resilience to risk under a wide range of future scenarios, and contribute to agricultural productivity and sustainability even in the absence of a shock. Finally, it argues that farmers need to invest in their own capacities to manage risk – for example, entrepreneurship and human capital, and on-farm strategies such as diversifying production and income sources, and savings – to increase their resilience to all types of risks, including catastrophic events (OECD, 2020[11]).

OECD analysis finds that an optimal approach to risk management in agriculture will include appropriate *ex ante* and prevention policies, and emphasise the capacities farmers need to adapt to – or transform in response to – a more uncertain future (OECD, 2020[11]). The work has yielded several findings that are relevant for natural disaster risk management. To design effective policies, governments should:

- Focus on extreme, infrequent but catastrophic events – such as natural hazard-induced disasters (NHID) – that cause significant damage, affect many or all farmers over a wide area, and are beyond farmers' or markets' capacity to cope.
- Provide incentives for farmers to manage normal business risk, invest in managing risks to their assets, including from natural disasters, and develop their capacity to plan for, absorb, respond, recover from, and more successfully adapt to risks, including catastrophic events.
- Avoid crowding out the development of market tools, such as private insurance, for managing natural disaster risks.
- Invest in key sectoral capacities that build agricultural sector resilience to risk – and contribute to agricultural productivity and sustainability – under a wide range of future scenarios.

Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) is the global instrument to manage disaster risk adopted by the Third UN World Conference on Disaster Risk Reduction in March 2015. It builds on and ensures continuity with the work carried out by countries and other stakeholders under the Hyogo Framework for Action (2005–2015), the first plan to explain, describe and detail the work that is required from different sectors and actors to reduce disaster losses (UNISDR, 2015[3]; 2015[16]).

The Sendai Framework signals a shift away from *post facto* management of disasters towards proactively reducing their risks, lowering vulnerability, and enhancing resilience before disasters occur. It emphasises that disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective. It has three goals: preventing the creation of risk, reducing existing risk, and strengthening the resilience of people and assets to withstand residual risk. It establishes four priority areas for action that, together, can effectively address the risk of natural hazards: 1) understanding disaster risks; 2) strengthening disaster risk governance to manage risk; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness to enable "building back better" during recovery, rehabilitation and reconstruction. States and all other stakeholders are required to implement the

priority areas in line with 13 guiding principles that help establish what needs to be done. These guiding principles include, first and foremost:

- Primary responsibility of states to prevent and reduce disaster risk, including through co-operation
- Shared responsibility between central and local authorities, sectors and stakeholders
- Protection of persons and their assets, while promoting and protecting all human rights, including the right to development
- Engagement by all of society
- Full engagement of all state institutions of an executive and legislative nature at national and local levels
- Coherence of policies, plans, practices and mechanisms across different sectors and agendas.

The remaining guiding principles are: Decision-making to be inclusive and risk-informed while using a multi-hazard approach; Accounting for local and specific characteristics of disaster risks when determining measures to reduce risk; Addressing underlying risk factors cost-effectively through investment, versus relying primarily on post-disaster response and recovery; *Build Back Better* for preventing the creation of, and reducing existing, disaster risk; The quality of global partnership and international co-operation to be effective, meaningful and strong; and Support from developed countries and partners to developing countries to be tailored according to needs and priorities as identified by them.

The Sendai Framework also recognises that many disasters are exacerbated by climate change, and that increased coherence between countries' approaches to disaster risk reduction and climate change adaptation under the 2016 Paris Agreement can support progress towards poverty reduction under the Sustainable Development Goals. While the Sendai Framework and Paris Agreement refer to their respective goals and objectives, each guides progress towards a more sustainable, resilient and equitable future. Domestically, responsibilities for climate change adaptation and disaster risk reduction tend to be spread across different institutions and stakeholders; internationally, they are supported by separate UN agencies and related processes. The different approaches and mechanisms inevitably result in overlaps and gaps (OECD, 2020[17]). Ensuring credible links, as appropriate, between these processes will contribute to building resilience to natural disaster and climate risks and achieving the global goal of eradicating poverty.

OECD Recommendation on the Governance of Critical Risks

Broader OECD work on risk governance highlights the important role of institutions in boosting disaster resilience (OECD, 2014[18]; OECD, 2017[19]). Effective institutions are crucial in influencing decisions by individual actors on whether or not to invest in resilience measures. Gaps in resilience levels may be due to stakeholders in government bodies, the private sector or individual households lacking awareness about risks; about which measures exist to increase resilience; or about their responsibilities for managing disaster risk. Specifically, the OECD finds that governments need to address widespread disincentives for public and private risk management that lead to an over-reliance on the government for post-disaster risk financing (OECD, 2014[18]).

The OECD has argued that governments should re-evaluate their approach to disaster risk management to ensure the effectiveness of current investments in disaster risk reduction. The 2014 *OECD Recommendation on the Governance of Critical Risks* proposes a fundamental shift in risk governance towards a whole-of-society effort. It proposes actions that governments can take at all levels of government, in collaboration with the private sector and with each other, to better assess, prevent, respond to and recover from the effects of extreme events, as well as take measures to build resilience to rebound from unanticipated events (OECD, 2014[14]):

- Establish and promote a comprehensive, all-hazards and transboundary approach to country risk governance to serve as the foundation for enhancing national resilience and responsiveness.
- Build preparedness through foresight analysis, risk assessments and financing frameworks, to better anticipate complex and wide-ranging impacts.
- Raise awareness of critical risks to mobilise households, businesses and international stakeholders and foster investment in risk prevention and mitigation.
- Develop adaptive capacity in crisis management by co-ordinating resources across government, its agencies and broader networks to support timely decision-making, communication and emergency responses.
- Demonstrate transparency and accountability in risk-related decision making by incorporating good governance practices and continuously learning from experience and science.

Joint framework for Strengthening Resilience for Food Security and Nutrition

The Joint framework for *Strengthening Resilience For Food Security and Nutrition* is a conceptual framework for collaboration and partnership among the Rome-based Agencies[7] (RBA) to support the resilience of food-insecure people in relation to shocks that affect their livelihoods and food systems (FAO, IFAD and WFP, 2019[15]). The framework provides a way for the agencies to seek and build complementary alignment across existing agency-specific approaches to support the resilience of food-insecure people, rather than develop new approaches, thereby ensuring that RBA collaboration is cost-effective.

The common focus of RBA work is to strengthen the resilience of rural poor, vulnerable and food insecure people's livelihoods and production systems. The emphasis is on situations where the capacities of supporting structures and institutions − notably government systems, national and local institutions and farmers' organisations − are not in a position to offset or buffer the impacts of shocks and stressors.

According to the RBA, resilience is essentially about the inherent capacities (abilities) of individuals, groups, communities and institutions to withstand, cope, recover, adapt and transform in the face of shocks. This implies that all interventions must begin by identifying and building upon existing capacities and resources. The RBA conceptual framework aims to strengthen three types of capacities of target populations and organisations: absorptive capacity; adaptive capacity; and transformative capacity. While the importance of these three resilience capacities are widely recognised [for example, see OECD (2020[11])], the RBA definitions are most relevant for the target groups of the RBAs (as defined in the joint framework). Specifically, *absorptive capacity* is defined as the capacity to withstand threats and minimise exposure to shocks and stressors through preventative measures and appropriate coping strategies to avoid permanent, negative impacts. *Adaptive capacity* is defined as the capacity to adapt to new options in the face of crisis by making proactive and informed choices about alternative livelihood strategies based on an understanding of changing conditions. Finally, *transformative capacity* is defined as the capacity to transform the set of livelihood choices available through empowerment and growth, including governance mechanisms, policies/regulations, infrastructure, community networks, and formal and informal social protection mechanisms that constitute an enabling environment for systemic change (FAO, IFAD and WFP, 2019[15]).

The conceptual framework is guided by six principles and practices for resilience, food security and nutrition:

- *Local and national ownership and leadership*: people, communities and governments must lead resilience-building for improved food security and nutrition.
- *Multi-stakeholder approach*: assisting vulnerable people to build their resilience is beyond the capacity of any single institution.
- *Combine humanitarian relief and development*: planning frameworks should combine immediate relief requirements with long-term development objectives.

- *Focus on the most vulnerable people*: ensuring protection of the most vulnerable people is crucial for sustaining development efforts.
- *Mainstream risk-sensitive approaches*: effective risk management requires an explicit focus in the decision making of national governments, as well as enhanced monitoring and analysis.
- *Aim for sustained impact*: interventions must be evidence based and focused on results.

3.3. Principles for effective disaster risk management for resilience

The four frameworks outlined above highlight a number of aspects of DRM that are critical for building agricultural sector resilience to NHID, including strong, effective and participatory disaster risk governance, and the importance of *ex ante* frameworks for disaster response and recovery, including to enable building back better after a disaster. Based on these frameworks, the case studies assess country-specific situations according to the following four principles for effective DRM for resilience, which were developed jointly by the OECD and FAO. The principles are closely aligned with the four Sendai Framework priorities for action and OECD recommendations, and propose a menu of actions that governments and agricultural sector stakeholders can take to improve the effectiveness of DRM for resilience in agriculture. Specifically, good practices for effective DRM for resilience in agriculture are identified according to the following four principles:

- An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience
- A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities
- An *ex ante* approach to natural disaster risk management
- An approach emphasising preparedness and planning for effective crisis management, disaster response, and to “build back better” to increase resilience to future natural hazards

An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience

Strong and effective governance arrangements are crucial for building agricultural resilience to NHID. An inclusive, holistic and multi-hazards approach, which takes into account the trade-offs and interactions between disaster risks, farmer strategies and wider DRM policies, is important to identify priorities and ensure that resources are allocated to those disaster risks that are the most significant (OECD, 2009[12]; 2018[20]). Institutions play an important role in influencing decisions by farmers, government bodies and other stakeholders on whether or not to invest in building resilience, by defining stakeholders’ roles and responsibilities in managing natural disaster risk and providing incentives for investments in risk prevention and mitigation (OECD, 2014[18]; UNISDR, 2015[3]).

In contrast, fragmented DRM frameworks – for example, based on a specific type of natural hazard, sector, or across government agencies – and governance gaps may reduce the effectiveness and efficiency of investments in resilience (OECD, 2009[12]; UNISDR, 2015[3]). Governance gaps can include: a lack of visibility around the benefits of *ex ante* investments in resilience at all levels – the national and local levels, and also on farms; policy signals that create the expectation of post-disaster assistance; barriers to stakeholder engagement and co-operation across agencies; and inflexible DRM policies and strategies (OECD, 2014[18]; 2017[19]).

To this end, governments should seek to:

- Integrate the agricultural sector into national (multi-hazard) strategies for governing disaster risks, including establishing leadership to drive integration, connect policy agendas and align competing

priorities across sectors and agencies. Equally, DRM and resilience priorities should be integrated into sectoral policies and plans, and their implementation.

- Engage relevant stakeholders, including farmers, industry organisations, critical infrastructure owners and operators, academia and scientific and research institutions, and actors from all relevant levels of government, and clarify (public and private) stakeholders' roles and responsibilities for managing natural disaster risk using participatory approaches.
- Demonstrate transparency and accountability in risk-related decision making by incorporating good governance practices and continuously learning from experience.
- Establish necessary mechanisms and incentives to ensure compliance with existing sectoral laws and regulations, including those that address land use and urban planning, building codes, environmental and resource management standards relevant for agriculture. These should be regularly updated to ensure an adequate focus on DRM for resilience.
- Evaluate relationships and co-ordination of agricultural DRM frameworks at all levels with instruments, institutions and procedures for catastrophic risk management outside the agricultural sector.
- Evaluate the coherence of DRM frameworks and objectives and measures with broader agricultural policy frameworks and development objectives for the sector.
- Establish operational mechanisms that link institutions at the national and local levels, and translate national disaster risk reduction policies (DRR) and plans into practical and incentives-based approaches for DRR to be implemented at the local level.
- Assess the coherence of DRM, climate change adaptation and sustainable development approaches and measures, to better understand opportunities for synergies and complementarities, while avoiding potential overlap with structures and actions in agricultural sectors.

A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities

A shared awareness and understanding of natural disaster risks is important to encourage investments in risk preparedness, prevention and mitigation (OECD, 2020[11]; FAO, 2021[2]). Gaps in agricultural resilience – for example, due to deficiencies in protective or other critical infrastructure, or other preparedness capacities – and gaps in DRM frameworks may be due to stakeholders in government bodies, industry organisations or individual farmers lacking awareness of risks or of their responsibilities for managing them, or the particular impact disasters have on agriculture. This can reduce the incentives for public and private risk management, leading to an over-reliance on national governments for post-disaster assistance (OECD, 2014[18]; OECD, 2017[19]). More broadly, information gaps can constrain decision-making, including between policy options to manage natural disaster risks, during crisis management, and in the disaster response and recovery stages.

To this end, all stakeholders should seek to increase their awareness of natural hazard risks and risk reduction approaches; their vulnerability to disaster risks; and their capacity to manage those risks. Governments can support greater awareness among stakeholders through:

- Facilitating access to training, formal and non-formal education; utilising social media and mobilising key stakeholders, and by addressing policy disincentives to investments in building resilience. This can entail:
  - establishing a shared understanding of acceptable levels of risk and responsibility for managing risk across all risk layers
  - developing integrated platforms for information on natural disaster risk and impacts that are accessible to all stakeholders

  - raising awareness of the benefits of *ex ante* investments in resilience
- Investing in risk, vulnerability and capacity identification, assessment and two-way communication to improve awareness of natural disaster risk among stakeholders where public benefits outweigh costs, including foresight exercises and periodic reassessments, taking into consideration a changing risk environment due, for example, to climate change. This includes:
  - taking interactions between different types of risks and cascading effects into account in risk assessments, to help set priorities and inform allocation of resources
  - assessing agricultural losses and damages in the wake of natural disasters and ensuring the establishment, management and accessibility of databases that include this type of data
  - developing and disseminating climate and weather information products and services tailored to the needs of farmers
  - building scientific and technical capacities and strengthening the science-policy interface for effective policy making
- Identifying the agricultural sector's capacities and vulnerabilities in natural disaster risk management, including infrastructure and services that are critical for ensuring the continuation of farm business activities after a shock.

An ex ante approach to natural disaster risk management

There is a need to shift the focus from coping with NHID in agriculture to integrated and anticipatory DRM for resilience based on trends and losses. An *ex ante* approach means considering the risk landscape over the long-term, including unknown future risks, in order to achieve an appropriate balance between *ex ante* measures such as structural and non-structural measures for disaster prevention and mitigation, including opportunities for nature-based solutions (OECD, 2020[21]), versus *ex post* recovery and reconstruction efforts. Agricultural DRM policies that focus on coping with and recovering from NHID, rather than mitigating and preparing for future hazards, may undermine the sector's resilience to natural disaster risk in the future (OECD, 2020[11]).

In contrast, reducing natural disaster risk and increasing preparedness can be a cost-effective investment in preventing future losses in agriculture, particularly in developing countries. Moreover, many farm-level practices and technologies to reduce natural disaster risks yield productivity and sustainability benefits, even in non-disaster contexts (FAO, 2019[22]; UNISDR, 2015[3]; UNDP, 2012[23]). This includes promoting risk prevention efforts to build resilience and reduce underlying vulnerabilities (including as part of broader development efforts), and enhancing the capacities of stakeholders – in government bodies, industry organisations or individual farmers – to prevent, plan for, absorb, respond, recover from, and more successfully adapt and transform in the face of NHID (FAO, IFAD and WFP, 2019[15]).

To this end, all stakeholders should consider the risk landscape over the long-term, including the possibility of unknown future risks, when making decisions about how to manage natural hazards in agriculture. This includes factoring in climate change as a risk driver.

- For farmers, this includes decisions to invest in building their own resilience capacities; and decisions on whether to adapt their operations by adopting resilience-enhancing strategies, practices and technologies, or indeed transform their operations entirely.
- For governments this includes decisions between *ex ante* policies, investments and planning processes versus *ex post* assistance.

To support an *ex ante* approach to natural disaster risk management in agriculture, governments should seek to:

- Develop *ex ante* frameworks and institutions for when *ex post* disaster assistance will be provided, to discipline *ex post* assistance and ensure that the natural disaster response is effective.

- Promote (including as part of development) all-society prevention efforts to build resilience and reduce underlying vulnerabilities, and enhance the capacities of the sector and government to proactively mitigate impacts of NHID in the future.
- Encourage (public and private) stakeholders to identify and address gaps in resilience measures and disaster risks to their own assets, including structural and non-structural measures. This includes:
  - ensuring that public investments in key sectoral capacities build resilience and the capacities to absorb, adapt and transform in response to risk – and contribute to productivity and sustainability – under a wide range of future scenarios
  - ensuring that farmers and other stakeholders are exposed to incentives and signals to pursue strategies that will reduce their exposure to all levels of risk, both now and in the future, and have the capacity to act on opportunities to do so, including by addressing policy disincentives and information constraints
  - promoting the mainstreaming of disaster risk assessment, mapping and management into land-use policy and rural development planning, implementation and management to reduce risks
- Promote – and where appropriate, support – farmers investing in building their own resilience capacities, including developing entrepreneurship and human capital, and increasing uptake of resilience-enhancing strategies, practices and technologies.
- Promote mechanisms for disaster risk sharing and transfer.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazards

Disaster preparedness and planning are crucial for effective crisis management and to enable "building back better" during recovery, rehabilitation and reconstruction (UNISDR, 2015[3]). Rather than rely solely on being able to prevent and absorb the impacts of shocks, a resilience approach also emphasises the importance of recovering and adapting following a disruption (Hynes et al., 2020[24]). There is a need for a greater emphasis on preparedness and planning for NHID in agriculture, while ensuring that DRM frameworks, measures and stakeholders remain flexible and have the capacity to respond to unanticipated events. Rehabilitation and reconstruction efforts should build resilience by addressing underlying vulnerabilities and building the capacities of the sector and government to better manage natural disasters in the future (FAO, IFAD and WFP, 2019[15]). Moreover, all stakeholders – including farmers – should learn continuously from NHID in order to adjust DRM frameworks and measures with a view towards long-term resilience (OECD, 2014[14]; OECD, 2020[11]).

To this end, all stakeholders should increase their preparedness for NHID by investing in knowledge and capacities that allow them to anticipate and respond to a likely, imminent or current NHID, and support a more resilient recovery.

- For farmers, this means accessing and using available information to better prepare for NHID, and taking advantage of opportunities to address underlying vulnerabilities and reducing future risk exposure during the recovery – by adapting to climate and natural disaster risks.

To support a greater emphasis on preparedness and planning for effective crisis management, disaster response, and to "build back better" after a NHID, governments should seek to:

- Invest in building flexible capacities of agricultural sector stakeholders involved in crisis management and natural disaster response, including by leveraging scientific and research institutions and conducting regular disaster preparedness, response and recovery exercises at all relevant levels.

- Ensure that sufficient regulatory flexibilities are in place to accommodate crisis situations, including allowing for temporary derogations on certain regulations or establishing agreements between government agencies to allow for additional staffing in emergency situations.
- Incorporate "building back better" principles into *ex post* assistance and disaster response and recovery plans and programmes for agriculture.
- Promote the integration of DRM for resilience into post-disaster recovery and rehabilitation processes, and facilitate the link between relief, rehabilitation and development.
- Invest in developing, maintaining and strengthening people-centred and actionable multi-hazard forecasting and early warning systems, disaster risk and emergency communications mechanisms.
- Learn from, and where possible adapt to, natural disasters through continued learning and evaluation of natural disaster impacts and DRM frameworks. This includes:
    - Establishing participatory and inclusive processes for monitoring, evaluating and updating agricultural DRM programmes and frameworks following a disaster event, with the involvement of relevant institutions.

3.4. Bringing it all together: Identifying good practices for building agricultural resilience

DRM frameworks can build agricultural resilience by strengthening the ability of farmers and the sector more broadly to prevent, mitigate, prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards. This means emphasising preparedness and planning for natural hazards on farm, but also within government agencies and other stakeholders in the private sector that have responsibilities for risk prevention and mitigation, and disaster response, recovery and reconstruction.

This framework identifies four principles for effective DRM for resilience in agriculture. For each of these principles, it also identifies a menu of actions that governments can take to manage natural disaster risk in agriculture, taking into account local and natural-hazard contexts, and sector-specific needs. Specifically, governments should seek to have:

- An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience
- A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities
- An *ex ante* approach to natural disaster risk management
- An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazards.

Within the above principles, good practices for building agricultural resilience are identified according to the *OECD Approach to Risk Management for Resilience*, and encompass policy measures and governance arrangements that encourage public and private stakeholders to address gaps in their resilience levels. This can be done by helping these stakeholders understand the risks that they face from natural hazards and their responsibilities for managing the risks these pose to their assets. For example, while rarer catastrophic risks such as NHID may require public intervention, on-farm strategies and the individual farmer's overall capacity to manage risk also play a critical role in reducing risk exposure to catastrophic events, particularly over the long term (OECD, 2009[12]; OECD, 2020[11]). Specifically, policy measures, governance arrangements, on-farm strategies and other initiatives were identified as "good practices" because they:

- Encourage public and private sector actors – including farmers – to consider the risk landscape over the long term, including to take into account the potential future effects of climate change on

the agricultural sector, and to place a greater emphasis on what can be done *ex ante* to reduce risk exposure and increase preparedness.

- Provide incentives and support the capacity of farmers to prevent, mitigate, prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards.
- Consider a wide range of future scenarios, including expected environmental, economic and social structural change, and contribute to agricultural productivity and sustainability, even in the absence of a shock or stress.
- Take into account the trade-offs inherent in natural disaster risk management, including between measures to build the capacities of the sector to absorb, adapt, or transform in response to natural disaster risk, and between investing in risk prevention and mitigation *ex ante* and providing *ex post* disaster assistance.
- Are developed with the participation of a wide range of actors, to ensure that all relevant stakeholders are equally involved in the design, planning, implementation, monitoring and evaluation of interventions; and share a common understanding of the risk landscape and their respective responsibilities for managing natural disaster risk.

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Notes

[1] For the purpose of this study, the focus is on crop and livestock subsectors.

[2] According to UNDRR (formerly UNISDR), a hazard is a "dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". Hazards of natural origin arise from a variety of sources, including: geological (e.g. earthquakes), climatological (e.g. droughts), meteorological (e.g. storms), biological (e.g. animal diseases, insect infestations or epidemics) and hydrological (e.g. floods) sources (UNISDR and CRED, 2015[9]; UNISDR, 2016[25]). Hazards become disasters when they cause great damage, destruction and human suffering.

[3] UNISDR (2016[25]) defines disaster risk management as the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

[4] Building back better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR, 2015[16]).

[5] The OECD prepared the case studies on Italy, Japan, New Zealand, Turkey and the United States; FAO prepared the case studies on Chile and Namibia.

[6] See Kimura and Antón (2011[26]); Antón, Kimura and Martini (2011[27]); Melyukhina (2011[28]; 2011[29]); Antón and Kimura (2011[30]); and OECD (2016[31]; 2018[32]).

[7] The Rome-based agencies are the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP).

4 Insights from country case studies for building agricultural resilience to natural hazard-induced disasters

This chapter synthesises the main insights from the seven country case studies – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States. It highlights the current practices that governments, farmers and other agricultural sector stakeholders are already using to increase the sector's resilience to natural hazard-induced disasters (NHID), including policy measures, governance arrangements, on-farm strategies and other initiatives that provide incentives for, or support the capacities of public and private stakeholders to prepare and plan for NHID, absorb and recover from their impacts, and to adapt and transform in order to increase resilience to future disaster risks. It also offers recommendations for how countries can shift from an approach that emphasises coping with the impacts of NHID, to being better prepared ex ante to prevent, mitigate, respond and recover from them, and to adapt and transform in order to be better placed to manage future natural hazards risks.

Key messages

What is the issue and why is it important?

- Climate change is increasing the frequency and intensity of natural hazards such as floods, droughts, severe storms, and animal pests and diseases, causing production losses and damaging farm land and assets in agricultural sectors across the world.
- These trends mean that a "business-as-usual" approach to disaster risk management in agriculture cannot continue without impeding agricultural productivity and sustainability growth, and progress towards sustainable development.

What did we learn?

- In the seven countries reviewed in this project – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States – governments, farmers and other stakeholders are already using innovative policy measures, governance arrangements and on-farm strategies to increase their resilience to natural hazard-induced disasters. Specifically:
  - Governments are providing farmers with science-based and targeted information and decision-support tools on climate and extreme weather events. These tools support risk-informed decision-making by providing options and strategies for adapting to those risks.
  - Countries are implementing physically effective and cost-efficient nature-based solutions to prevent and mitigate natural hazard risks and impacts. This includes solutions that leverage the potential of agricultural land to reduce natural hazard risks.
  - Agricultural sector stakeholders are collaborating and building relationships to better prepare for and respond to NHID via formal networks of public and private stakeholders, improving the effectiveness of disaster preparedness and response.
  - Countries are prioritising contingency planning and simulation exercises to help enhance the preparedness of all relevant stakeholders to respond to disasters.

Key recommendations

- While good progress has been made, governments and agricultural sector stakeholders need to shift from an approach that emphasises coping with the impacts of disasters, to being better prepared *ex ante* to prevent, mitigate and recover from disasters, and to adapt and transform in order to be better placed to manage future disasters. This requires:
  - *Getting the policy incentives right*: disaster assistance policies – and agricultural polices more broadly – need to provide coherent and consistent signals for farmers to prepare for, prevent and mitigate natural hazard risks.
  - *Targeting policy investment towards developing a resilience toolkit for farmers*: governments can support stakeholders to build resilience through targeted training that helps to build needed skills; providing targeted and science-based information about risk that is tailored to farmers' needs; collecting data on agricultural damage and losses caused by disasters, and making that data available to all stakeholders; and investing in appropriate public goods and services for reducing disaster risks.
  - *Engaging with trusted stakeholders to motivate farm-level change*: industry and farm organisations, agricultural co-operatives and extension agents can connect all farmers with information on natural hazard risks and options for adapting to those risks, and improve understanding of farm-level constraints to improving resilience.

4.1. Introduction

Managing natural hazard risk is inherent in agriculture, given the sector's reliance on climate and weather conditions and the natural resource base. However, more frequent and intense natural hazards,[1] and the compounding and systemic nature of that risk, pose a challenge for the sector – for farmers in developing countries, who often bear the brunt of natural hazard impacts (FAO, 2021[1]), but also for farmers in OECD countries. Around the world, recurrent and more severe natural hazards are challenging even experienced and innovative farm managers. More frequent and intense natural hazard-induced disasters (NHID) – implying higher costs in terms of direct impacts on agriculture, as well as from the cascading effects of disruptions to farm operations and in related sectors – also present a policy challenge for governments, who face a greater burden if a "business-as-usual" approach continues for disaster risk management[2] (DRM) in agriculture (OECD, 2020[2]).

These trends in natural hazard risks and impacts underscore the need for DRM frameworks that build agricultural resilience, defined here as the ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards (and other risks) (OECD, 2020[2]). Recognising this, in 2017, G7 Agriculture Ministers in Bergamo noted the effects of natural hazards on farmers' lives, agricultural production productivity, agro-food systems in regions all over the world, and that climate change is projected to amplify many of these impacts. Ministers also noted the importance of strengthening the resilience of farmers to natural hazards (G7 Agriculture Ministers, 2017[3]).

In this context, the joint OECD-FAO project on *Building Agricultural Rresilience to Natural Hazard-Induced Disasters: Insights from Country Case Studies* examined DRM frameworks in seven countries – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States – to identify what governments and agricultural sector stakeholders can do to build the resilience of farmers and the agricultural sector to NHID. This report syntheses the good practices identified in the seven case study countries,[3] including policy measures, governance arrangements, on-farm strategies and other initiatives that provide incentives for, or support the capacities of public and private stakeholders to prepare and plan for NHID, absorb and recover from their impacts, and to adapt and transform in order to increase resilience to future disaster risks.

Good practices were identified according to principles in key international frameworks for managing the risks posed by disasters and other shocks, including OECD recommendations and the Sendai Framework for Disaster Risk Reduction,[4] where the principles provide a roadmap for DRM frameworks that build agricultural resilience to NHID (Chapter 3). Based on these frameworks, each case study assessed the country-specific situation according to the following four *Principles for Effective DRM for Resilience*, as set out in Chapter 3:

- An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience.
- A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities.
- An *ex ante* approach to natural disaster risk management.
- An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better"[5] to increase resilience to future natural hazards.

Good practices encompass policy measures and governance arrangements that encourage public and private stakeholders – including farmers – to address gaps in their resilience levels. This can be done by helping stakeholders understand the risks that they face from natural hazards and their responsibilities for managing the risks they pose to their assets. For example, while rarer catastrophic risks such as NHID may require public intervention, on-farm strategies and the individual farmer's overall capacity to manage risk also play a critical role in reducing risk exposure to catastrophic events, particularly over the long term (OECD, 2009[4]; OECD, 2020[2]). Specifically, the policy measures, governance arrangements, on-farm

strategies and other initiatives highlighted in the country case studies and this synthesis were identified as "good practices" because they:

- Encourage public and private sector actors – including farmers – to consider the risk landscape over the long term, including to take into account the potential future effects of climate change on the agricultural sector, and to place a greater emphasis on what can be done *ex ante* to reduce risk exposure and increase preparedness.
- Provide incentives and support the capacity of farmers to prevent, mitigate, prepare and plan for, absorb, respond, recover from, and more successfully adapt and transform in response to natural hazards.
- Consider a wide range of future scenarios, including expected environmental, economic and social structural change, and contribute to agricultural productivity and sustainability, even in the absence of a shock or stress.
- Take into account the trade-offs inherent in natural disaster risk management, including between measures to build the capacities of the sector to absorb, adapt, or transform in response to natural disaster risk, and between investing in risk prevention and mitigation *ex ante* and providing *ex post* disaster assistance.
- Were developed with the participation of a wide range of actors, to ensure that all relevant stakeholders are equally involved in the design, planning, implementation, monitoring and evaluation of interventions; and share a common understanding of the risk landscape and their respective responsibilities for managing natural disaster risk (OECD, 2020[2]).

4.2. Overview of the agricultural context and natural hazard profile

The seven countries – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States – represent different regions of the world and different stages of development. Differences in geography and climatic patterns in these countries contribute to diverse agricultural characteristics. For example, with limited arable land, grass-fed livestock products are the backbone of New Zealand's agriculture, whereas in Japan, rice paddy fields make up more than half of the county's agricultural land.

Nonetheless, agriculture plays a key economic role in all of these case study countries. For example, the share of agriculture in the economy (gross domestic product, GDP) and in total employment is high in Chile, Namibia, New Zealand and Turkey. Chile is a net exporter of agro-food products with a surplus of USD 5 billion. In Namibia, agriculture is a key source of income and livelihoods for the majority of the population, and agricultural exports are an important source of foreign exchange revenues. New Zealand's economy is strongly supported by agriculture, which accounts for 7.2% of GDP, 5.8% of employment and 63% of total exports. In Turkey, more than 18% of the workforce is employed in agriculture and the country's export earnings depend on agriculture. In contrast, agriculture accounts for a small share of GDP and employment in Italy, Japan, and the United States. However, Italy leads the European Union in terms of gross value added in agriculture, and Italy's agro-food system[6] accounted for 15% of GDP in 2018. Similarly, the agro-food sector[7] accounts for 10% of GDP in Japan. Finally, the United States is the world's major producer of agricultural goods and ranks as one of the world's primary exporters of a diverse array of agricultural products (OECD, 2020[5]; World Bank, 2021[6]).

Similar to other sectors – and indeed, the wider community – the agricultural sector must manage risks from a range of sources, including risk due to fluctuations in weather; market risk due to price volatility; financial risk resulting from the need to borrow funds to finance operations; and institutional or political risks from changes in policy. But given agriculture's reliance on climate and weather conditions and the natural resource base, the sector is particularly vulnerable to natural hazards. The seven case study countries are exposed to a range of natural hazards, including droughts, floods, animal pests and diseases,

and severe storms, among others, which can have significant and long-lasting impacts on agriculture, irrespective of countries' level of development, climatic conditions or natural resource base. Drought – the focus of the case studies on Italy, Namibia and Turkey – causes large losses in most of the case study countries. For example, drought can substantially reduce crop yields, particularly in rain-fed systems, and cropped area, and have negative impacts on livestock production and health (OECD, 2016[7]). Floods and water-related natural hazards as a result of severe storms or heavy rain events – the focus of the case studies on Japan, New Zealand and the United States – also have significant impacts on agriculture. In addition to crop and livestock losses, floods can cause extensive damage to farm equipment and infrastructure, and also degrade farmland through erosion, contamination and sediment deposits from upstream sources.

The scale of recent natural hazards, in terms of both their frequency and intensity, is particularly concerning for the agricultural sector. Turkey is currently experiencing its driest weather since 2015, driving groundwater levels across the entire territory to the lowest percentiles and dramatically reducing grain harvests (NASA, 2021[8]). In the United States, the 2019 Midwest Floods disrupted agricultural production in a number of states and caused an estimated USD 1 billion agricultural damage in Nebraska and USD 2 billion in Iowa (Reuters, 2019[9]; AGU, 2019[10]). In Japan, the top four most damaging typhoons since 1950 have occurred since 2018 (EMDAT, 2020[11]), causing damage and losses to the agricultural sector of USD 4.7 billion in 2018, the highest in the last ten years, and USD 4.5 billion in 2019 (MAFF, 2020[12]).

Climate-related hazards are expected to intensify and become more frequent in all case study countries as a result of climate change, posing a significant challenge to the agricultural sector. In some cases, climate change will also mean that areas that had not historically experienced natural hazards will be more exposed in the future (CPD, 2018[13]; IPCC, 2014[14]; Knutson et al., 2019[15]; Zucaro, Antinoro and Giannerini, 2017[16]).

These trends mean that strengthening the agricultural sector's resilience to NHID is ever more important. In doing so, stakeholders will also have to take into account the country-specific contexts that affect the sector's vulnerability to NHID. For example, the majority of farmers in Chile are small scale and are more vulnerable to the adverse impacts of natural hazards than the larger, commercial farms. Most farmers in Namibia and Turkey are also small scale or subsistence farmers, and disparities in income and education in rural communities may also hinder farmers' capacity to better manage natural hazard risks. In Japan, ageing and depopulation in rural areas can constrain community-based agricultural risk management and the adoption of innovations that build resilience. For this reason, applying a resilience approach to managing natural disaster risks requires both short-term strategies and investments to prevent and mitigate risks, and support a more resilient recovery, but also long-term investments that increase the agricultural sector's capacity to manage those risks in the context of existing structural, economic and demographic conditions.

4.3. How can countries shift from being reactive to being proactive on natural hazards: Insights from country case studies

This section synthesises the seven country case studies according to the four *Principles for Effective DRM for Resilience*, highlighting the good practices identified in each country. Reflecting the fact that resilience to NHID is an outcome of measures put in place before, during and after an extreme event, good practices undertaken by governments, farmers and other stakeholders were identified at each stage of the DRM cycle, and include efforts to identify, assess and raise awareness of natural disaster risks; to prevent or mitigate those risks and their impacts; to prepare for likely or imminent NHID; to manage crises and disaster response efforts; and to support recovery, rehabilitation and reconstruction.

Six of the country case studies focused on a particular type of natural hazard in order to explore how different policy measures, governance arrangements, on-farm strategies and other initiatives contribute to building resilience. The Italy and Turkey case studies focused on drought; the Namibia case study focused on drought and animal pests and diseases; the Japan case study focused on typhoons and heavy rains; and New Zealand and the United States focused on floods – in the United States case study, extreme floods associated with Hurricane Florence in 2018 and the 2019 Midwestern Floods. In contrast, the Chile case study focused on the country's national agroclimatic risk information system, and the different financial instruments available to support agricultural producers in Chile. Although the specific natural hazards differed across the case studies – and despite the different structural, economic and demographic conditions in the seven countries – the key insights and lessons for what governments and agricultural sector stakeholders can do to build the resilience of farmers and the agricultural sector to NHID are consistent across the seven countries. These are explored in the following sections.

4.4. An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience

As noted in Chapter 3, strong and effective governance frameworks are crucial for building agricultural resilience to natural hazard-induced disasters. Institutions and policy frameworks influence decisions by farmers, government agencies and other stakeholders on whether or not to invest in building resilience, by defining stakeholders' roles and responsibilities for managing natural disaster risk, and by providing incentives to invest in disaster risk reduction (DRR), including after a disaster (OECD, 2014[17]; UNISDR, 2015[18]). Establishing and enhancing governance frameworks for agricultural DRR and DRM, as well as resilience building, also represents a core step for national governments to achieve the Sendai Framework and move towards more disaster-resilient agricultural systems (FAO, 2021[1]).

In all seven case study countries, *national frameworks for governing disaster risks* are characterised by a multi-hazard and multi-sectoral approach, where the focus is shifting towards managing disasters by proactively reducing their risk, lowering vulnerability, and enhancing resilience before they occur. Reflecting this, the case study countries increasingly emphasise measures to prevent and mitigate the adverse impacts of disasters and be better prepared to respond to disasters, including structural measures, such as protective and other infrastructure; non-structural measures, such as risk and vulnerability assessments, hazard mapping, natural resource management, and early warning systems; and by building the capacities of key public and private stakeholders in DRM.

Multi-hazard and multi-sectoral DRM frameworks allow interactions and trade-offs between disaster risks (and the potential for compounding impacts), strategies to manage those risks and wider DRM policies to be taken into account (OECD, 2009[4]; OECD, 2018[19]). For this reason, it is important that agricultural sectors are integrated into these wider frameworks, to ensure that DRM priorities for agriculture are aligned with those of other sectors and government agencies. The extent to which agriculture is integrated into national DRM frameworks varies across the seven case study countries. In Japan, the agricultural sector is fully integrated into the country's overarching frameworks for governing disaster risks – the *Disaster Countermeasures Basic Act*, which focuses on hazard-specific *ex ante* and *ex post* countermeasures; and the *Basic Act for National Resilience*, which focuses on building the resilience of critical infrastructure. In particular, these frameworks recognise that DRM measures implemented in the agricultural sector can contribute to disaster risk mitigation more broadly, tasking the Ministry of Agriculture, Forestry and Fisheries (MAFF) with managing and investing in agricultural land and infrastructure to reduce flood risks (Shigemitsu and Gray, 2021[20]). In Chile, agriculture is integrated into the country's national DRM policies, strategies and plans, and the national civil protection system (SNPC) has an active, multi-sectoral, multi-stakeholder, national DRR platform through which the sector can put forward its needs and priorities. The Ministry of Agriculture's (MINAGRI) Agricultural Emergency and Risk Management Section (SEGRA) has disaster risk management responsibilities, including monitoring and issuing agricultural emergency and

risk warnings; providing training; and designing and implementing emergency response actions. SEGRA also coordinating and providing technical assistance to implement regional agricultural emergency and agroclimatic risk management plans that are developed for each region (FAO, 2021[21]).

Agricultural policy frameworks predominantly shape DRM activities in some countries.[8] In Italy and the United States, for example, DRM in agriculture is mainly addressed through agricultural risk management policies. In Italy, this includes the portfolio of subsidised insurance policies in the National Risk Management Plan, *ex post* disaster assistance under the National Solidarity Fund, and programmes that help farmers to prevent or mitigate their natural hazard risk (Baldwin and Casalini, 2021[22]). In the United States, for example, this includes a suite of agricultural risk management and disaster assistance programmes,[9] as well as various conservation programmes to restore damaged farmland and prevent or mitigate natural disaster risks (Gray and Baldwin, 2021[23]). DRM priorities are also explicitly integrated into Japan's ten-year agricultural policy agenda, the *Basic Plan for Food, Agriculture and Rural Areas*, which explicitly recognises the need for *ex ante* efforts to reduce the risks to the agricultural sector from large-scale natural hazards (Shigemitsu and Gray, 2021[20]).

Governance frameworks for managing specific natural hazard risks and resources also influence how some natural hazards are managed in agriculture. This includes drought strategies and plans, governance arrangements for managing flood risks, water governance frameworks, and animal health-related legislation. In Turkey, for example, drought risks are primarily managed through the country's Strategy for Combatting Agricultural Drought and Action Plan (the Drought Strategy) (OECD, 2021[24]). In New Zealand, different government agencies have responsibility for different risks, albeit under a single overarching governance framework. For example, the Ministry for Primary Industries is the lead agency for drought and biosecurity risks, while floods are a responsibility of local and regional actors (Casalini, Bagherzadeh and Gray, 2021[25]).

Finally, countries can benefit from synergies and complementarities among policy approaches by increasing the coherence of their approaches to disaster risk reduction, climate change adaptation and sustainable development (UNISDR, 2015[18]). In Namibia, the agricultural sector is considered a priority in the country's 2011 *National Disaster Risk Management Plan* and *National DRM Framework and Action Plan 2017-2021*, reflecting the sector's importance for food security and livelihoods, however, DRR is not integrated into the country's key agricultural policy frameworks, although the country is currently finalising its first agriculture-specific DRM strategy, which is led by the Ministry of Agriculture, Water and Land Reform (MAWLR) (FAO, 2021[26]).

DRM frameworks influence decisions by government agencies, farmers and other stakeholders on whether or not to invest in prevention and mitigation by defining *stakeholders' roles and responsibilities for managing natural disaster risk*. In general, national frameworks establish the roles and responsibilities of all levels of government in DRM, with clear co-ordinating structures at each stage of the DRM cycle. However, while the responsibilities and roles of public actors are well defined, including those of agricultural ministries, the responsibilities of private agricultural sector stakeholders – farmers in particular, but also farm and industry organisations – are less well defined. An exception is New Zealand, where both the National Civil Defence and Emergency Management (CDEM) Plan and agricultural policy frameworks – specifically, the *Primary Sector Recovery Policy* – send clear and consistent signals to the agricultural sector that individuals and communities are primarily responsible for managing their own risk (Casalini, Bagherzadeh and Gray, 2021[25]). In other countries, farmers' responsibilities are defined in the context of particular natural hazards. For example, Namibia's *National Drought Policy and Strategy 1997* aimed to shift responsibility for managing drought risk from the government to the farmers, while in the area of animal health, farmers are responsible for reporting disease outbreaks and conditions, and complying with disease control measures. The country is currently updating this national drought policy based on its lessons learned from the 2018/2019 drought (FAO, 2021[26]).

Barriers to engagement in DRM can also contribute to a lack of clarity over public and private actors' responsibilities for managing disaster risks. All of the case study countries have systems in place to engage with key agricultural sector stakeholders, for at least some hazards or stages of the DRM cycle or in the governance of specific natural hazards. For example, the United States' *National Infrastructure Protection Plan* (NIPP) establishes a formal mechanism for engaging with the private sector owners and operators of critical infrastructure – including the food and agriculture sector – and guides how the government works with private actors to manage risks and achieve security and resilience outcomes (Gray and Baldwin, 2021[23]). In Italy, the system of Permanent Observatories on Water Use (OWUs) has provided a platform for stakeholders at the river basin level to engage in water governance and define strategies for mitigating the impacts of drought, with participants from relevant ministries – including the Ministry of Agricultural, Food and Forestry Policie (MiPAAF) –, national agencies, research institutes, irrigation consortia and water utilities (Baldwin and Casalini, 2021[22]). In Turkey, Agricultural Drought Provincial Crisis Centres have provided a valuable interface between the national and local government and local actors when planning drought responses (OECD, 2021[24]).

4.5. A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities

Information and data on climate and natural disaster risks, and the impacts of NHID on the agricultural sector, are essential for effective governance of natural disaster risks (OECD, 2020[2]; FAO, 2021[1]). To be effective, national strategies for DRR, emergency response, resilience and climate change adaptation must be firmly grounded in a comprehensive understanding of the particular impact disasters have on agriculture (FAO, 2021[1]). Gaps in agricultural resilience – for example, due to deficiencies in protective or other critical infrastructure, or other preparedness capacities – and gaps in DRM frameworks may be due to stakeholders in government bodies, industry organisations or individual farmers lacking awareness of their exposure or vulnerability to NHID, or the particular impact NHID have on agriculture. At the farm level, information gaps on climate and natural hazard risks, and strategies for reducing that risk, can constrain decision-making as well as adaptation to climate change and weather-related hazards.

Across the case study countries, research and analyses at the national and regional levels – for example, national and subnational *risk and vulnerability assessments, climate and natural hazard modelling*, and *foresighting exercises* – play an important role in increasing risk awareness across the whole community, and supporting long-term planning for those hazards. In particular, these exercises play a role in identifying priorities, capability gaps, and ensuring that resources are allocated to disaster risks and measures that are the most significant (OECD, 2009[4]; OECD, 2018[19]). In Japan, for example, the government is required to undertake a vulnerability assessment before formulating the Fundamental Plan for National Resilience (Box 4.1). This assessment focuses on the risk that certain impacts occur regardless of the type of hazard that causes them, which is then used to guide disaster risk prevention and mitigation efforts. More generally, Japan regularly reviews hazard risks and vulnerabilities, and uses that information when developing and revising DRM frameworks and systems. This helps to ensure that DRM is responsive to a changing risk landscape, focuses attention on the most significant risks, and guides resource allocation (Shigemitsu and Gray, 2021[20]).

Box 4.1. Japan: Multi-hazard vulnerability assessments guide resource allocation

Japan has increasingly focused on incorporating vulnerability assessments into the policy planning process to help to identify the level of risks in various sectors. The Basic Act for National Resilience requires the government to conduct a vulnerability assessment before formulating the Fundamental Plan for National Resilience, which takes place approximately every five years. The vulnerability assessment for the Fundamental Plan for National Resilience focuses on the risk that certain impacts occur regardless of the type of hazard that causes them. However, natural hazards are considered to pose the greatest risk. The latest vulnerability assessment conducted in 2018 simulated 45 "worst-case scenarios that should be avoided", employing flow chart analysis to organise the causal relationships and cascading effects that lead to the worst case. Based on the scenarios, countermeasures were formulated and addressed in the Fundamental Plan for National Resilience, including for agriculture

Note: Japan's Fundamental Plan for National Resilience provides overall guidelines for policies concerning building resilience. It identifies targets and measures across 15 prioritised policy areas to promote Japan's resilience to large-scale natural hazard-induced disasters.
Source: Shigemitsu and Gray (2021[20]).

While national risk and vulnerability assessments generally focus on hazards that could result in loss of life or property, all case study countries undertake risk assessments focused on the natural hazards that pose a significant threat to their agricultural sectors. In particular, most of the case study countries direct significant efforts towards monitoring and understanding the impacts of drought on agriculture (and other stakeholders). In Turkey, research institutes of the Ministry of Agriculture and Forestry (MAF) and the Agricultural Drought Provincial Crisis Centres use modelling to determine the vulnerability of different regions to drought, and to produce maps showing drought sensitive locations (OECD, 2021[24]). Chile's national agroclimatic risk information system includes the online Agroclimatic Risk Observatory Platform, which provides an early warning and monitoring system for drought. It also provides information, monitoring and forecasts on *El Niño*, hydrological updates on the flow rates of most major rivers and reservoirs, and updated forest fire information (FAO, 2021[21]). In Namibia, active and passive surveillance programmes for key animal diseases and the national livestock traceability system allow stakeholders to continuously monitor the occurrence or continued absence of animal diseases in the country (Box 4.2).

Box 4.2. Animal disease monitoring and surveillance in Namibia

In Namibia, a range of activities are undertaken continuously to monitor the occurrence or continued absence of animal diseases. This includes active surveillance programmes for key diseases such as Foot and Mouth Disease (FMD), Bovine Spongioform Encephalopathy (BSE) and residues in food, through the collection and screening of samples from suspected animals. Importantly, Namibia also implements passive surveillance strategies, including through monitoring the treatment of animals at veterinary clinics and on farms; inspections of animal gatherings, such as auctions and livestock shows; post-mortem inspections at slaughterhouses; and farm and community visits according to an annual farm inspection programme. To support the surveillance of animal diseases, Namibia also established the Namibia Livestock Identification and Traceability System (NamLITS), which is managed by the Ministry of Agriculture, Water and Land Reform (MAWLR) Directorate of Veterinary Services (DVS) in close partnership with the private sector, farmers' organisations, and the Meat Board of Namibia

Source: FAO (2021[26]).

Research undertaken at *public agricultural research institutes* also raises awareness of the local impacts of natural hazards on the agricultural sector. In Italy, research undertaken at public research institutes – including the Italian Institute of Services for the Agricultural Food Market (ISMEA) and the Research Center for Agricultural Policies and Bioeconomy of the Council for Agricultural Research and Economics (CREA-PB) – aims to better understand the impacts of drought on agriculture at a local level (Baldwin and Casalini, 2021[22]). CREA-PB also manages the linked National Information System for Agriculture Water Management (SIGRIAN) and National Database of Investment for Irrigation and Environment (DANIA).[10] Among other uses, these databases can be used to support economic evaluations of proposed interventions aimed at improving water resource management. In the United States, the United States Department of Agriculture (USDA) Climate Hubs develop regional vulnerability assessments that provide stakeholders with a baseline "snapshot" of current climate vulnerabilities, along with specific adaptive management strategies to increase the resilience of working lands in different regions (Gray and Baldwin, 2021[23]).

Data on disaster impacts – damage and losses in agriculture[11] – are a valuable risk management tool, as knowledge of past events can help identify vulnerabilities, and inform agricultural risk management and disaster assistance policies, and investments to prevent or mitigate future impacts. A lack of data on disaster damage and losses can also constrain hazard analysis and foresighting exercises.

Japan has comprehensive time series data on damage and losses caused by natural hazards in both qualitative and quantitative terms, in part because sector stakeholders – the local authorities, agricultural co-operatives (that is, Japan Agricultural Co-operatives or JA) and farmers – collaborate with the national government to provide and develop the data after a NHID (Shigemitsu and Gray, 2021[20]). In other case study countries, however, data collection and reporting efforts are more fragmented or remain under development. For example, information on disaster losses is available for insured production in several countries, including Italy, Turkey and the United States. In the United States, agricultural impact data are also available to varying extents for some states. For example, the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) Economic Impact Analysis Program regularly reports estimates of the agricultural damage and losses associated with NHID (Gray and Baldwin, 2021[23]).[12] Several case study countries, including Chile and Italy, are in the process of setting up their systems to assess damage and losses caused by disasters, in order to comply with the 2015-2030 Sendai Framework for Risk Reduction and the Sustainable Development Goals.

To be usable and useful to farmers, *information must be tailored to the needs of the sector*, by region and natural hazard. This includes information on climate and natural hazard risks, as well as options to manage those risks. In the United States, farmers and other agricultural stakeholders, such as county extension and local USDA staff, have access to extensive science-based and targeted information and online tools on climate and extreme weather events, and strategies for reducing natural hazard risk. This includes information and tools developed by the USDA Climate Hubs (Box 4.3), universities and government agencies, as well as tools and services offered by the private sector (Gray and Baldwin, 2021[23]). In New Zealand, the Land and Environment Plans promoted by Beef + Lamb NZ translate available information on climate and natural hazard risks into a farm-scale picture of the risks that farmers face (Casalini, Bagherzadeh and Gray, 2021[25]).

Box 4.3. USDA Regional Climate Hubs

The USDA Regional Climate Hubs develop and deliver science-based and region-specific tools and strategies to agricultural producers and other stakeholders, to enable risk-informed decision-making and adaptation to a changing climate and extreme weather events. The Climate Hubs facilitate the co-production of these tools by working collaboratively with USDA agencies, other federal agencies (for example, the National Oceanic and Atmospheric Administration), universities and co-operative extension, state and local governments, and producer interest groups such as the Farm Bureau. This ensures that climate information and tools for building climate resilience are demand-driven, more accessible, and easier for producers to understand and apply to their operations.

Source: Gray and Baldwin (2021[23]).

Chile's national agroclimatic risk information system provides farmers and other agriculture stakeholders with free, real-time information and forecasts for their area, as well as various agroclimatic information bulletins and tools for monitoring, identifying, assessing and communicating agroclimatic risks to stakeholders (Box 4.4) (FAO, 2021[21]).

Box 4.4. Chile's National agroclimatic risk information system

Chile's national agroclimatic risk information system includes a series of interconnected platforms, various agroclimatic information bulletins and tools to monitor, identify, assess and communicate agroclimatic risks to agricultural sector stakeholders.

The system is managed by MINAGRI in collaboration with the Agricultural Research Institute (INIA) and other members of the National Agroclimatic Network (RAN). The overall goal of the RAN is to provide free access to reliable agroclimatic information in a timely manner for informed decision making at all levels. Its core objectives include setting up and maintaining a network of automatic weather stations to provide tailor-made data for agriculture. Farmers and other agriculture stakeholders have free access to real-time information and forecasts from RAN for their area, which is available on MINAGRI's main information web portal "Agromet".

In addition, SEGRA/MINAGRI publishes various monthly agroclimatic e-bulletins '*Coyuntura agroclimática'* and the '*Monitor Agroclimático*'. These bulletins document meteorological changes and their impact on the crop, livestock and forestry subsectors. INIA also publishes national and regional agroclimatic risk analysis bulletins for key fruit species, crops and livestock – *Boletínes Nacional y Regionales de Análisis de Riesgos Agroclimáticos para las Principales Especies Frutales y Cultivos y la Ganadería* – on a biweekly and monthly basis;

Source: FAO (2021[21]).

4.6. An *ex ante* approach to natural disaster risk management

There is a need to shift the focus from coping with NHID in agriculture to integrated and anticipatory disaster risk management based on trends and losses (Chapter 3). An *ex ante* approach means considering the risk landscape over the long term in order to achieve an appropriate balance between *ex ante* measures such as structural and non-structural measures for disaster risk prevention and mitigation, including opportunities for nature-based solutions (OECD, 2020[27]), versus *ex post* disaster assistance. Agricultural DRM policies that focus on coping with the impacts of NHID, rather than mitigating

risk and preparing for future hazards, may undermine the sector's resilience to natural disaster risk in the future (OECD, 2020[2]). Moreover, reducing natural disaster risk and increasing preparedness can be a cost-effective investment in preventing future losses in agriculture, particularly in developing countries (FAO, 2019[28]).

Countries use a combination of structural and non-structural measures to prevent and mitigate natural disaster risks. For example, water infrastructure is prioritised in Italy and Turkey – both at the sectoral and farm levels – to manage the agricultural sector's water needs, including in the context of increasing drought risks (Baldwin and Casalini, 2021[22]; OECD, 2021[24]). In the United States, publicly and privately managed levees and other flood control structures prevent and mitigate flood risks in rural areas (Gray and Baldwin, 2021[23]). However, in all countries, this can lead stakeholders to under-emphasise alternative, more sustainable strategies (for example, adoption of water-saving practices and less water-intensive crops) or under-estimate residual risks (for example, of levee failures), and can encourage development in natural hazard-prone areas.

In some countries, structural measures are complemented by non-structural measures, in order to manage risks more effectively and at a lower cost. For example, in Japan's Fundamental Plan for National Resilience, infrastructure plays a critical role in minimising damage caused by natural hazards, including in agriculture. However, the government's recent reform of agricultural reservoir management took a balanced approach by mixing structural and non-structural measures, namely physical rehabilitation of reservoirs as well as establishing hazard maps and clarifying the responsibilities of reservoir owners and local authorities (Shigemitsu and Gray, 2021[20]). In Namibia, prevention and control of animal diseases is supported through a combination of structural and non-structural approaches. A Veterinary Cordon Fence divides the country into different zones to help prevent, control and manage outbreaks of FMD among cattle that may be infected by wild buffalos that graze along the country's open border with Angola. In addition, a zoning strategy[13] allows Namibia to distinguish distinct animal sub-populations with respect to animal health status, which allows parts of the livestock sector to participate in international trade (FAO, 2021[26]).

Countries also increasingly recognise that *nature-based solutions* can be physically effective and cost-efficient alternatives to grey infrastructure in preventing and mitigating natural disaster risk (OECD, 2020[27]). A range of initiatives are underway in the case study countries, including within agricultural policy frameworks. In the United States, several USDA conservation programmes directly target improved disaster prevention and mitigation, particularly for floods. Three programmes – the Emergency Watershed Protection Program – Floodplain Easements Option (EWPP-FPE), the Agricultural Conservation Easement Program – Agricultural Land Easements (ACEP-ALE), and the Watershed and Flood Prevention Operations (WFPO) programme – provide support for preventative structural and non-structural measures to reduce flood damage (Gray and Baldwin, 2021[23]). In New Zealand, the Ministry for Primary Industries (MPI) programmes also promote strategies to prevent and mitigate the impacts of floods on production, through co-funding and grant schemes for nature-based solutions such as tree planting and soil erosion control (Casalini, Bagherzadeh and Gray, 2021[25]). In Japan, the government is promoting on-farm measures to maximise potential paddy field water storage for flood control (Box 4.5) (Shigemitsu and Gray, 2021[20]).

Box 4.5. Paddy Field Dams in Japan

Rice paddy fields can naturally help to reduce flood risks by retaining and slowing the flow of water, lowering the peak flow of rivers, and increasing groundwater recharge. Farmers can further increase the natural water storage capacity of their paddy fields – and contribute to flood mitigation – by installing a simple runoff control device (an adjustment plate with a hole smaller than a drain pipe) to control the drainage of the paddy field. With this plate, paddy fields serve as dams. Rainwater is temporarily stored in the paddy field during and after heavy rainfall, and the water is slowly drained over time, preventing a rapid rise in water levels in rivers and drainage canals. These initiatives can reduce the flood risks to downstream communities, especially as residential areas and farmland are often located next to each other in Japan.

The Paddy Field Dams offer a physically effective and cost-efficient option to reduce flood risks and mitigate their impact. The maintenance cost is equivalent to JPY 875 (USD 8) for 5 000 m^2 per year, or 30 minutes or less in labour (Niigata Prefecture, 2020[29]). The Science Council of Japan estimates that activities to improve the water storage function of paddy fields, such as the paddy field dam, could increase water storage to almost 19 000 thousand m^3. In contrast, achieving a similar level of water storage with grey infrastructure – such as a flood prevention dam – was estimated to cost around JPY 6.3 billion (USD 58 million) per year (MAFF, 2017[30]).

Source: Shigemitsu and Gray (2021[20]).

Farm-level practices and technologies to reduce natural hazard risks and impacts can also generate productivity and sustainability benefits, even in non-disaster contexts (FAO, 2019[28]; UNISDR, 2015[18]; UNDP, 2012[31]). For example, there is increasing recognition in the United States of the role that healthy soil can play in mitigating flood risks and impacts on-farm, with a number of public and joint public-private initiatives aiming to address constraints to their adoption on farms (Box 4.6) (Gray and Baldwin, 2021[23]). In New Zealand, industry-led initiatives to improve the environmental sustainability of production, such as the 2013 *Sustainable Dairying: Water Accord*, have led to practices that also reduce natural hazard risks (Casalini, Bagherzadeh and Gray, 2021[25]).[14]

Box 4.6. Initiatives to promote soil health in the United States

Various soil health initiatives led by USDA's Natural Resources Conservation Service (NRCS), farmers and other stakeholders aim to promote and support soil health practices – such as cover crops and conservation tillage – by addressing constraints to on-farm adoption, including a lack of evidence on the economic and environmental benefits of those practices and the risks associated with changing farming methods. This includes:

- NRCS's Soil Health Initiative, which offers technical and financial assistance to producers to adopt soil health practices and systems through various conservation programmes, including the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program.
- The Soil Health Partnership (SHP), a farmer-led research network that measures the impacts of implementing soil health practices on working farms. SHP partners with state governments, commodity associations, non-profits, foundations and private companies to promote the adoption of soil health practices.

- The country's nearly 3 000 conservation districts work directly with landowners to conserve and promote healthy soils, and undertake case studies, field days and demonstrations.

These initiatives share a number of strengths: they engage with, and benefit from the support of a diverse range of stakeholders; support on-farm experimentation with adaptation; prioritise communication with producers, including via peer networks; and build the evidence base on the economic and environmental benefits of soil health practices. This helps to address important information constraints to the adoption of soil health practices and lowers the risks to farmers from changing farming practices

Source: Gray and Baldwin (2021[23]).

Publicly-supported risk management tools also help farmers to mitigate the financial impacts of NHID, and can help to discipline and reduce reliance on ad hoc disaster assistance. In many of the case study countries, farmers can obtain subsidised insurance for losses caused by NHID (among other causes of loss). Subsidised insurance is a pillar of Chile's agricultural DRM strategy, and a range of financial instruments are available to support farmers, including smallholder and subsistence farmers (FAO, 2021[21]). In Italy, MiPAAF provides a variety of risk management tools for mitigating the financial impacts of adverse events on the sector under the *National Risk Management Plan*, with subsidised insurance the most widely utilised (Baldwin and Casalini, 2021[22]). In Japan, MAFF is encouraging farmers to subscribe to a commodity insurance programme that provides insurance for yield losses and production equipment damaged by natural hazards; or a revenue insurance programme that compensates farmers for revenue losses, including those caused by NHID, relative to a benchmark based on the previous five years' revenue (Shigemitsu and Gray, 2021[20]).[15] In Turkey, the agricultural insurance pool TARSIM offers multiple subsidised products, including crop insurance that provides coverage for losses caused by hail, storms, whirlwinds, fire, landslides, floods and earthquakes. Losses caused by drought are covered by a district-based drought yield insurance scheme (OECD, 2021[24]).[16] In the United States, the Federal Crop Insurance Program offers subsidised insurance policies for both yield and revenue losses, including losses caused by natural disasters, and Whole-Farm Revenue Protection, which covers all commodities on the farm under one insurance policy. For producers of crops that are not covered by federal crop insurance, the Noninsured Crop Disaster Assistance Program provides a basic level of coverage for when low yields, loss of inventory, or prevented planting occur due to natural disasters (Gray and Baldwin, 2021[23]).

4.7. An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazards

Ex ante disaster preparedness and planning are crucial for effective crisis management – by public and private stakeholders with a role in disaster response, and on farms. Preparedness activities are an important and necessary complement to risk prevention and mitigation efforts, such that when natural hazards inevitably occur and disrupt agricultural activities, stakeholders have the networks, capacities and resources in place to manage a crisis effectively, minimise the disruptions to agricultural activities, and ensure a quicker and more resilient recovery (UNISDR, 2015[18]). Moreover, following a NHID, recovery and reconstruction efforts offer an opportunity for public and private stakeholders to "build back better" by addressing underlying vulnerabilities, and building the capacities needed to manage natural disaster risks in the future (FAO, IFAD and WFP, 2019[32]).

Across the seven case study countries, *various channels build the preparedness capacities*[17] of public and private actors with a role in disaster preparedness, response and recovery, as well as farmers.

In several countries, *formal networks and co-ordinating structures* allow stakeholders to develop relationships and build preparedness capabilities before an event occurs, strengthening disaster response and recovery. In the United States, the Critical Infrastructure Sectors framework connect public and private actors before a hazard occurs, and enhances collaboration and communication between government agencies and owners and operators of food and agriculture critical infrastructure, and with stakeholders in other critical infrastructure sectors. At the state level, networks such as the Extension Disaster Education Network (EDEN) and the Multi-State Partnership for Security in Agriculture build the disaster preparedness and response capabilities of the extension service and other public actors, and minimise the duplication of effort across states (Gray and Baldwin, 2021[23]). In Japan, prefectural governments created a system to 'pair up' prefectures and share experience and resources for responding to large-scale NHID.[18] During crises, Japan Agricultural Co-operatives (JA) leverages its network to send volunteers to affected regions to assist in disaster recovery efforts.[19] In New Zealand, an inter-agency Community Resilience Group was initiated in 2018 to strengthen the capacity of local governments to build community resilience to natural hazards and the effects of climate change (Casalini, Bagherzadeh and Gray, 2021[25]). In Namibia, the DVS co-ordinates and build the capacities of a wide range of stakeholders with a role in animal disease prevention, control and management (FAO, 2021[26]).

Industry and locally-based organisations, such as extension service providers and agricultural co-operatives, are also important and trusted sources of information for farmers. In the United States, co-operative extension agents, Farm Bureaus and local USDA staff are trusted sources of information on disaster preparedness due, to a significant extent, to having local knowledge of issues and established relationships with farming communities. In particular, co-operative extension is an important source of non-formal education and information on natural hazard preparedness, providing research-based information to stakeholders through its connection to the US land-grant colleges and universities (Gray and Baldwin, 2021[23]). In New Zealand, industry groups, such as Beef + Lamb NZ, Dairy NZ and Federated Farmers support farmers with information and programmes that improve their capacities to plan, prepare for, respond to, and recover from, a range of risks (Casalini, Bagherzadeh and Gray, 2021[25]). In Japan, JA provides significant support to help restart farming operations, and maintain members' livelihoods (Shigemitsu and Gray, 2021[20]).

Finally, *agricultural ministries and their locally-based staff* are also important sources of information for farmers on disaster preparedness. In Chile, MINAGRI organises capacity building events and training to raise stakeholders awareness of the various agroclimatic information bulletins and tools available through the national agroclimatic risk information system, as well as how to access and use them (Box 4.4) (FAO, 2021[21]). In New Zealand, MPI has re-entered the extension services space in order to help farmers make decisions that support sustainable land use, and improve farming outcomes and resilience (Casalini, Bagherzadeh and Gray, 2021[25]). In the United States, the USDA Climate Hubs (Box 4.3) provide science-based, and region- and hazard-specific resources on disaster preparedness, including decision-support tools and information on good practices (Gray and Baldwin, 2021[23]).

Disaster response and recovery efforts in the case study countries are also supported by a range of *processes and policies*.

Contingency planning[20] and simulation exercises are prioritised in many of the case study countries. For example, in Namibia there are contingency plans in place for key animal diseases (FMD, BSE, avian influenza) to support a rapid transition from preparedness to action in the event of an outbreak, including by ensuring that equipment, materials, and inputs are available. Real-time or "table-top" simulations are also carried out to maintain staff and community awareness when there are no disease outbreaks (FAO, 2021[26]). In Japan, New Zealand and the United States, farmers are encouraged to develop their own contingency or emergency plans, and provided with guidance on how to do so. Also in Japan, the agricultural sector is also required to develop contingency and response plans for key agricultural facilities, including wholesale markets, slaughterhouses and dairy facilities (Shigemitsu and Gray, 2021[20]).[21] Table-top and simulation exercises are also carried out in other countries. For example, in the United States, the

food and agriculture critical infrastructure sector participates in exercises to test the effectiveness of resilience procedures, with the outcome of each scenario providing feedback on how to enhance the protection of critical infrastructure (Gray and Baldwin, 2021[23]). Finally, *early warning systems* for natural hazards are in place in most of the countries, including for slow onset events such as drought.

In some countries, disaster response is also supported by *decision-support tools and platforms for facilitating disaster response efforts*. In Italy, the Veterinary Information System for Non-Epidemic Emergencies (SIVENE) is a two-way communication tool that provides a unified portal for collecting and transmitting information on conditions at the farm level to authorities from a wide range of stakeholders (Baldwin and Casalini, 2021[22]). In the United States, the National Business Emergency Operations Center (NBEOC) is a virtual platform for two-way information sharing between public and private sector stakeholders. The NBEOC integrates private sector stakeholders into disaster operations and facilitates information sharing between public and private sector actors on existing needs and capabilities (Gray and Baldwin, 2021[23]).

Increasingly, the case study countries are *prioritising business continuity* and the quicker recovery and return to normal farm operations. Italy's approach to disaster response in rural areas prioritises business continuity (Box 4.7) (Baldwin and Casalini, 2021[22]). In Japan, MAFF promotes the early recovery of damaged agricultural land and facilities by allowing reconstruction work to start without first conducting a disaster assessment, if doing so would help restart farming operations in the next cropping cycle (Shigemitsu and Gray, 2021[20]). In Chile, the Agricultural Development Institute (INDAP) provides assistance to smallholders to support production continuity, in the form or financial aid or in-kind support (for example, agricultural inputs, supplementary pastures and infrastructure repair) (FAO, 2021[21]).

Box 4.7. Prioritising business continuity: The Central Italian earthquakes of 2016-17

In 2016 and 2017, a series of earthquakes affected four regions in central Italy, with impacts on the agricultural sector. In response, an interregional technical co-ordination centre (CTI) was established to ensure food safety, business continuity and animal welfare, with the participation of the national Civil Protection Department, the Ministry of Health, MiPAAF, regional veterinary services, regional agricultural services, and veterinary institutes. Through the CTI, actors were able to both co-ordinate activities to support local services, as well as assess impacts using a pre-established checklist that served as a decision-making template to prioritise and decide which emergency measures should be taken.

This co-ordinating structure and approach allowed stakeholders to identify the specific necessities of farming communities and address them within the framework of the existing emergency response system. For example, temporary modular housing units were provided for livestock producers who needed to stay near their animals in order to deliver proper care, while other affected persons were required to relocate to temporary shelters in more centralised locations. Temporary animal shelters were also provided on the basis of the damage assessment, and continuity of milk collection and delivery was ensured by providing drinkable water for the cleaning of milk tanks.

The long-term impact of these interventions is still to be assessed. However, preliminary data collected in the aftermath of the events indicate that no substantial differences were reported in milk deliveries or farm closures compared to the previous year.

Source: Baldwin and Casalini (2021[22]) and Leonardi (2020[33]).

For farmers, financial concerns can be a significant barrier to recovery after a NHID. Farmers can access *ex post disaster assistance* in some form in all of the case study countries, including through disaster assistance programmes established in *ex ante* frameworks; insurance; and *ad hoc* programmes. The

United States has comprehensive disaster assistance policies that provide compensation for losses caused by natural hazards, including crop insurance, Emergency Disaster Loans and support provided through the Supplemental Agricultural Disaster Assistance Programs; cost-shared assistance is also available for farmland rehabilitation.[22] In recent years, farmers have also received support through ad hoc programmes that were implemented in response to hurricanes and wildfires in 2017, and hurricanes, floods, tornadoes, typhoons, volcanic activity, snowstorms and wildfires in 2018 and 2019 (Gray and Baldwin, 2021[23]). In Italy, farmers can subscribe to and receive assistance from a range of *ex ante* risk management programmes, including insurance, an income stabilisation tool, and mutual funds. For adverse events that are not covered by the country's National Risk Management Plan, *ad hoc* assistance is also available through the National Solidarity Fund (FSN) for damage to production, structures or infrastructure (Baldwin and Casalini, 2021[22]). In Japan, farmers are provided support to facilitate a quick recovery through *ad hoc* programmes that are announced for most disasters, including to restore damaged production (for example, farmland, orchards and rice paddy fields), agricultural machinery and facilities (Shigemitsu and Gray, 2021[20]). In Namibia, drought relief includes transport subsidies for farmers willing to move their livestock to areas where there is grazing, and subsidies for grazing leases (FAO, 2021[26]). In Turkey, disaster assistance includes credit subsidies, direct payments, technical assistance and support to repair equipment (OECD, 2021[24]). In contrast, in New Zealand most support is directed towards funding the Rural Support Trusts to provide psychosocial support, and co-ordination and information services in affected communities (Box 4.8). However, farmers can also access assistance that is available under the CDEM system to support society-wide recovery, and sector-specific support may be provided for medium and large-scale events, including to access advisory services for reducing exposure and vulnerability to future risks (Casalini, Bagherzadeh and Gray, 2021[25]).

Box 4.8. New Zealand's Rural Support Trusts

A voluntary network for psychosocial support in rural areas

A unique feature of the New Zealand approach to disaster risk management is the emphasis placed on mental wellbeing as an enabler of resilience, and the role of the Rural Support Trusts (RSTs) in supporting rural communities from a psychosocial perspective.

The RSTs are autonomous and not-for-profit networks that operate locally. RSTs directly assist farmers, growers and their families who experience a climatic, financial or personal adverse event to more effectively meet and overcome these challenges. The role of an RST facilitator (mostly serving on a voluntary basis) is to 'empower' affected parties to deal with problems rather than to provide specific advice.

RSTs receive some baseline funding from MPI but also operate thanks to donations. During or after an identified adverse event due to climatic or biosecurity reasons, RSTs in affected regions may receive additional funding from MPI, which they can use: to co-ordinate an initial needs assessment and the response to the event; to provide information and assistance to impacted groups; to arrange for mentors from rural backgrounds to talk over problems; and to provide stress management services and support social healing. In the case of a medium- or large-scale event, MPI actively works with the relevant RST(s) as a key on-ground resource supporting rural communities. The RSTs deliver many of MPI's recovery measures to those in need, and often work closely with the relevant regional CDEM groups by assisting and supporting their activities in rural areas during and following an emergency

Source: Casalini, Bagherzadeh and Gray (2021[25]).

4.8. Remaining challenges

The case studies on Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States have shown that governments, farmers and other stakeholders are using innovative policy measures, governance arrangements and on-farm strategies to increase the agricultural sector's resilience to natural hazards. In particular, four good practices stand out.

- Farmers increasingly have access to *science-based and targeted information and decision-support tools* on climate and extreme weather events, and options and strategies for reducing and adapting to those risks, which are tailored to the needs of the sector, and by region and natural hazard. These tools, which are being developed by both public and private actors, encourage farmers and other stakeholders to consider the risk landscape over the long term by helping them to understand the risks that they face from natural hazards, and support risk-informed decision-making on farm. In some countries, these tools are co-produced with farmers and other stakeholders to ensure their usability and usefulness on farm.
- Countries are *implementing physically effective and cost-efficient nature-based solutions* to prevent and mitigate natural hazard risks and impacts. Agriculture is a significant land user in all seven case study countries, and risk reduction practices in the sector can prevent and mitigate the risks and impacts of NHID, including to non-farming activities, assets and properties. This includes solutions that leverage the potential of agricultural land to reduce specific natural hazard risks, such as the risk of flooding, but also on-farm practices that prevent and mitigate the impacts of NHID such as floods and droughts, and generate productivity and sustainability benefits even in non-disaster contexts, such as by improving soil health and enhancing the health and diversity of ecosystems.
- Agricultural sector stakeholders are also *collaborating and building relationships to better prepare for and respond to NHID via formal networks* of public and private stakeholders. Wider agro-food sector stakeholders – the private sector, farm and industry organisations, and indeed, farmers themselves – are an important source of information, resources, capabilities and expertise for disaster preparedness, response and recovery activities. These networks offer an opportunity for stakeholders to develop relationships and build capabilities before a disaster, improving the effectiveness of disaster preparedness and response – on farm, and for the wider agro-food sector.
- Finally, countries are *prioritising contingency planning and simulation exercises* to help enhance the preparedness of all relevant stakeholders to respond to NHID. These exercises ensure that DRM frameworks, measures and stakeholders remain flexible and have the capacity to respond to unanticipated events, and can help to identify and manage potential cascading effects.

While good progress has been made, recent and projected trends in natural hazard risks and their impacts on agriculture underscore the need to do more to build the sector's resilience to NHID. Across the seven case study countries, policy frameworks and stakeholders emphasise approaches and policies for coping with and responding to NHID, with relatively less attention given to practices for preventing and mitigating natural hazard risks, or for ensuring a more resilient recovery – including through adapting and transforming farm operations (Chapter 3).

Specifically, governments and agricultural sector stakeholders need to shift from an approach that emphasises coping with the impacts of NHID, to being better prepared *ex ante* to prevent, mitigate and recover from them, and to adapt and transform in order to be better placed to manage future natural hazards; that is, to move from a risk coping to a resilience approach. This approach entails a shift from *ex post* government disaster assistance to building the capacity of stakeholders to manage risks. Frameworks that strengthen the ability of farmers and other stakeholders to prepare and plan for natural hazards; to absorb, respond to and recover from their impacts; and to more successfully adapt and transform in response to the risk of future NHID, are essential to build a more resilient agricultural sector.

4.9. Recommendations

Applying a resilience approach requires stakeholders to prepare for natural hazards and implement strategies to reduce the risks and impacts, but also to learn from disasters in order to increase resilience for future shocks and recover more quickly the next time. This means helping stakeholders understand the risks that they face from natural hazards and their responsibilities for managing those risks; and supporting their capacity to manage risk, and to adapt and transform to be better positioned to face future risks. To this end, this report proposes three main areas for action.

Get the policy incentives right

Building a more resilient agricultural sector requires consistent and coherent policy signals, both in disaster assistance policies and indeed in agricultural policy frameworks more broadly.

A common policy challenge lies in *how to provide disaster assistance* without discouraging a more resilient recovery and ongoing efforts on farm to prepare for and mitigate natural hazard risks and impacts. For example, the expectation of *ad hoc* disaster assistance, which is used in most of the case study countries, can reduce farmers' incentives to invest in risk prevention and mitigation, and encourage farmers to take on more risk. Instead, triggering criteria and types and level of government support should be clearly defined in advance, and use of *ad hoc* support should be minimised, in order to provide farmers with a clear incentive to invest *ex ante* in risk prevention and mitigation measures, and preparedness capacities (OECD, 2009[4]). Moreover, while short-term considerations are a priority for farmers following a NHID, rebuilding offers an important opportunity to address underlying gaps in resilience and build the capacities needed to manage natural hazards in the future (FAO, IFAD and WFP, 2019[32]). For this reason, disaster assistance should encourage farmers to "build back better" during recovery by providing guidance on and targeting support towards on-farm options to reduce natural hazard exposure and vulnerability.

Beyond disaster assistance policies, incentives and signals from the wider agricultural policy environment play an important role in motivating farmers to prepare for, prevent and mitigate natural hazard risks – and indeed, to adapt and transform in response to future climate and natural hazard risks (OECD, 2009[4]; Ignaciuk, 2015[34]). Agricultural support policies can affect farm-level behaviour, such as by providing a financial buffer (for example, direct payments), shielding farmers from the true cost of natural hazard risk (for example, publicly-supported risk management tools), or by reducing the cost or perceived riskiness of changing farming practices (for example, technical or financial assistance for risk-reducing practices). Such policies can provide useful incentives to adopt new practices or encourage take up of risk management tools, but unless carefully calibrated can reduce the cost of, and incentives to address, risk (OECD, 2021[35]). For this reason, there is also a need to review wider agricultural policy frameworks for their effects on farm-level incentives to mitigate, prevent and prepare for natural hazard risks in the long term, and for opportunities to better integrate resilience considerations.

Target policy investment towards developing a resilience toolkit for farmers

While clear and consistent policy signals are necessary to encourage farmers and other agricultural sector stakeholders to take responsibility for building their resilience to NHID, it is crucial that farmers have the capacity to act on those incentives – including the necessary skills, information and tools.

Governments have an important role where gaps exist in stakeholders' capacities (OECD, 2020[2]). At the farm level, capacity gaps can arise because of the inexperience or age of farmers, or a low level of skills, education or capacity for using available information or tools. There is an opportunity to provide targeted training and extension services, and technical assistance, that help farmers develop their entrepreneurial and risk management skills, and to adapt and transform in response to uncertainty and a changing risk environment.

Information gaps can also constrain risk-informed decision-making by farmers, including limited awareness of their exposure and vulnerability to natural hazards, or of their options for adapting to natural hazard and climate risks. Targeted and science-based information that is tailored to the needs of farmers, by region and by type of natural hazard is important for raising awareness and for risk-informed decision-making. This information need not come from the public sector – indeed, in the case study countries, private actors are active in developing innovations and digital tools. However, it is important that tools are co-produced with researchers, and with farmers and other end users to ensure their usability and usefulness.

An important information gap is accurate information about risk and disaster impacts. In particular, data on agricultural damage and losses caused by NHID are crucial for understanding vulnerability to NHID, and to inform cost-effective resilience-enhancing investments, by governments and on-farm. Yet in many countries, data on agricultural damage and losses caused by NHID are fragmented or not widely available. For this reason, governments should consistently and systematically assess agricultural damage and losses in the wake of NHID, and ensure that this information is available and accessible to all stakeholders (Chapter 3).

Finally, governments can also invest in key public goods and services that build agricultural sector resilience to risk under a wide range of future scenarios and contribute to agricultural productivity and sustainability, even in the absence of a shock (OECD, 2020[2]). This includes appropriate investments in structural and non-structural measures for reducing disaster risks, supporting implementation of nature-based solutions on farms that leverage the potential of agricultural land to reduce specific natural hazard risks, as well as policy support for adaptation on farm.

Engage with trusted stakeholders to motivate farm-level change

Finally, the above efforts are unlikely to be successful if breakdowns in the “last mile” between research outputs and farmers mean that information on natural hazard risks, and new innovations in risk mitigating investments and management practices do not reach some groups of farmers. This can mean that some farmers lack the information and tools to make risk-informed decisions and reduce the impacts of NHID on their operations.

To address remaining disincentives and barriers, policymakers should engage closely with trusted, locally-based stakeholders, including farm and industry organisations, agricultural co-operatives, and local extension agents. Building on their relationships with farmers, locally-based stakeholders can help to clarify farmers’ roles and responsibilities for DRM, promote the benefits of prevention, mitigation and preparedness to reduce exposure to natural hazard risk, as well as improve understanding of farm-level constraints to adopting practices that improve farm resilience. For example, beginning or older farmers, or farmers who are less well-integrated into commercial value chains may need additional resources or efforts to reach similar levels of preparedness as more experienced farmers. In this respect, industry organisations, agricultural co-operatives and extension agents can play an important intermediary role by connecting farmers with this information.

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Notes

[1] According to UNDRR (formerly UNISDR), a hazard is a "dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". Hazards of natural origin arise from a variety of sources, including: geological (e.g. earthquakes), climatological (e.g. droughts), meteorological (e.g. storms), biological (e.g. animal diseases, insect infestations or epidemics) and hydrological (e.g. floods) sources (UNISDR and CRED, 2015[39]; UNISDR, 2016[40]). Hazards become disasters when they cause great damage, destruction and human suffering.

[2] UNISDR (2016[40]) defines disaster risk management as the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

[3] See Baldwin and Casalini (2021[22]), Shigemitsu and Gray (2021[20]), Casalini, Bagherzadeh and Gray (2021[25]), Gray and Baldwin (2021[25]), and FAO (2021[21]; 2021[26]) for the full case studies.

[4] OECD Holistic Approach to Risk Management for Resilience in Agriculture (OECD, 2009[4]; OECD, 2011[36]; OECD, 2020[2]); Sendai Framework for Disaster Risk Reduction (UNISDR, 2015[18]); OECD Recommendation on the Governance of Critical Risks (OECD, 2014[37]); and the Joint Framework for Strengthening resilience for food security and nutrition of the Rome-based Agencies (FAO, IFAD and WFP, 2019[32]).

[5] Building back better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR, 2015[41]).

[6] Including production agriculture, forestry and fisheries, the food and beverage industry, retail food service and dining.

[7] Including agriculture, forestry and fisheries, agricultural material supply, food manufacturing, food related distribution and merchandising, and food service.

[8] To some extent, this reflects the fact national frameworks for governing disaster risks prioritise the protection of life and property. While NHID of significance to agriculture can be economically devastating.

for farmers in developed economies, they rarely threaten human life, and as such do not typically invite an emergency response from local, regional or national authorities.

[9] These include the Federal Crop Insurance Program, the Noninsured Crop Disaster Assistance Program, the Emergency Disaster Loans programme, and the Supplemental Agricultural Disaster Assistance Programs.

[10] SIGRIAN serves as the national reference repository for data on irrigation networks, water use, and groundwater abstraction at a water user level, while DANIA is a decision support tool for planning investments aimed at reducing risks in agriculture.

[11] "Damage" refers to the total or partial destruction of physical assets and infrastructure in disaster-affected areas, expressed as replacement or repair costs. "Losses" refer to the changes in economic flows or revenues arising from the disaster (FAO, 2016[38]).

[12] UF/IFAS developed an online survey tool to harmonise and facilitate the collection of data on disaster impacts, and addresses challenges UF/IFAS extension agents faced in collecting information in the field, as well as those faced by UF/IFAS faculty in using these data to determine the overall economic impacts associated with NHID. In 2020, UF/IFAS also used the online survey tool to assess the financial impact of COVID-19 on Florida's agricultural and marine industries.

[13] As prescribed by the World Organisation for Animal Health (OIE).

[14] The 2013 *Sustainable Dairying: Water Accord* is a national, industry-led voluntary programme that established a set of good management practices to improve the environmental performance of dairy farms. This included practices that significantly contribute to preventing and mitigating the impacts of floods, such as riparian planting and fencing dairy cattle off from waterways.

[15] In some cases, MAFF requires farmers to have insurance in order to qualify for *ex post* disaster support (Shigemitsu and Gray, 2021[20]).

[16] Despite its name, the district-based drought yield insurance scheme offers an area-based multi-peril insurance product, which also covers damages from frost, hot wind, heat waves, excessive humidity and excess precipitation. The drought yield insurance is district-based and triggers when yields are below 70% of district average yield, with the gap paid to farmers (OECD, 2021[24]).

[17] Preparedness capacities are the knowledge and capacities of governments, response and recovery organisations, communities and individuals that allow them to anticipate and respond to a likely, imminent or current NHID (UNISDR, 2016[40]).

[18] The prefectural system was particularly helpful in 2018-19 as typhoons and heavy rains in those years landed in areas with less historical exposure to such events. This meant that more experienced and unaffected prefectures could help affected regions by providing reconstruction knowledge and expertise to guide the recovery process (Shigemitsu and Gray, 2021[20]).

[19] Volunteers have played a significant role in some NHID. For example, regional JA, farmers, non-profit organisations and the prefectural and municipal governments co-ordinated more than 6 500 volunteers to

supported clean-up efforts in Nagano Prefecture for the regions apple and peach producers (Shigemitsu and Gray, 2021[20]).

[20] Contingency planning is a management process that analyses disaster risks and establishes arrangements in advance to enable timely, effective and appropriate responses (UNISDR, 2016[40]).

[21] Three-Year Emergency Measures for Disaster Prevention, Mitigation and Building Resilience 2018-2020.

[22] The Emergency Conservation Program (ECP) and the Emergency Watershed Protection (EWP) programme. USDA also uses some existing conservation programmes to assist with rehabilitating land following natural disasters, including EQIP.

5 Building agriculture resilience to climate risks in Chile

This chapter describes Chile's approach to building agricultural resilience to natural hazard-induced disasters, and to climate risks in particular. It outlines two areas of strength: Chile's national agroclimatic risk information system, which consists of a series of interconnected platforms, various agroclimatic information bulletins, tools and initiatives to monitor, identify, assess and communicate the risks; as well as the country's capacity development events and training, which support decision-making by agricultural stakeholders on how to avoid and reduce the adverse impacts of natural hazard-induced disasters. Furthermore, the case study outlines a variety of financial instruments that are available to fund emergency response and recovery activities in the agricultural sector and to transfer risk through the provision of state subsidies for agricultural insurance.

Key messages

- Chile's agriculture sector is significantly impacted by natural hazard-induced disasters, including climate related events. Due to the expected increase in the frequency and severity of these hazards and their adverse impacts on agriculture, appropriate and effective disaster risk reduction measures should be undertaken to help reduce the underlying vulnerabilities and risks to the sector.
- The country's national agroclimatic risk information system includes a series of interconnected platforms, various agroclimatic information bulletins, tools and initiatives to monitor, identify, assess and communicate the risks. In addition, capacity development events and trainings are organised to enhance awareness raising among key stakeholders on the availability, access to, and usage of, these agroclimatic information products. This informs decision-making of agricultural stakeholders to avoid and reduce the adverse impacts of natural hazard-induced disasters.
- A variety of financial instruments are available to fund emergency response and recovery activities in the agriculture sector and to transfer risk through the provision of state subsidies for agricultural insurance. Through the systematic collection, sharing and analysis of data among various agencies, a better understanding can be obtained about the farmers that are regularly affected, the types of events and the kind of assistance they are receiving. This will help to produce information that can inform as well as enhance decision-making about the implementation of disaster risk management strategies and agricultural programmes and policies.

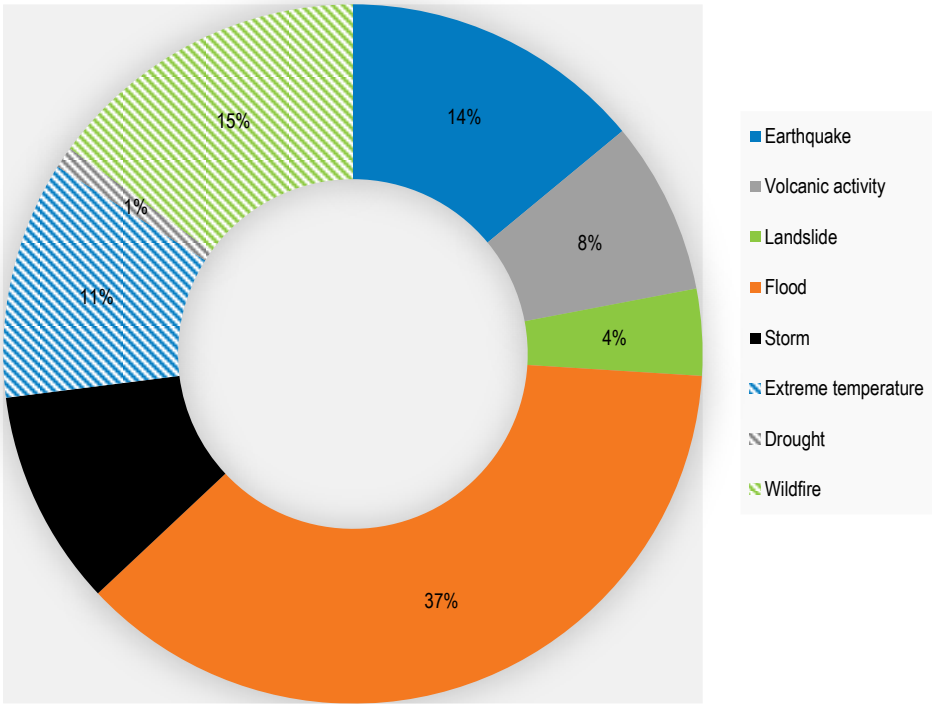
5.1. Background

Natural hazard-induced disasters

Given Chile's location along the Pacific ring of fire, it is one of the most earthquake-prone countries in the world. It is also severely impacted by flooding, followed by wildfires, earthquakes, extreme temperatures, storms, volcanic eruptions, landslides and drought (Figure 5.1).

Earthquakes followed by floods affected more Chileans and inflicted the greatest economic loss between 1985 and 2020 than any other disaster type. During this period, a total of 29 major disasters were recorded in Chile: nine floods, seven forest fires, three polar cold spells, three volcanic events, three earthquakes, two tsunamis, one storm and one landslide. Combined, these affected more than 4 million people and resulted in 853 deaths (EM-DAT, 2019[1]).

Figure 5.1. Frequency per type of disasters in Chile, 1985-2020



Source: EM-DAT (2019[1]).

Impact of natural hazard-induced disasters on agriculture

The 2010 earthquake – the sixth most powerful quake ever recorded – and the tsunami it caused, constitute the most recent rapid-onset disaster to strike Chile and resulted in an estimated economic loss of USD 30 billion, equal to 18% of its national GDP (Economic commission for Latin America and the Caribbean (ECLAC), 2010[2]). The two disasters resulted in the loss of 75% to 90% of Chile's fishery capacity and damaged nearly 300 000 hectares of agricultural land in the Bio Bio and Maule regions (EM-DAT, 2019[1]). Nearly 70% of irrigation capacity was destroyed in the earthquake-damaged region (Burgoine, 2010[3]). It was estimated that the total damage to Chile's crop, livestock and forestry subsectors amounted to 2% or USD 601 million of the country's total damage (FAO, CAS, IICA, 2017[4]).

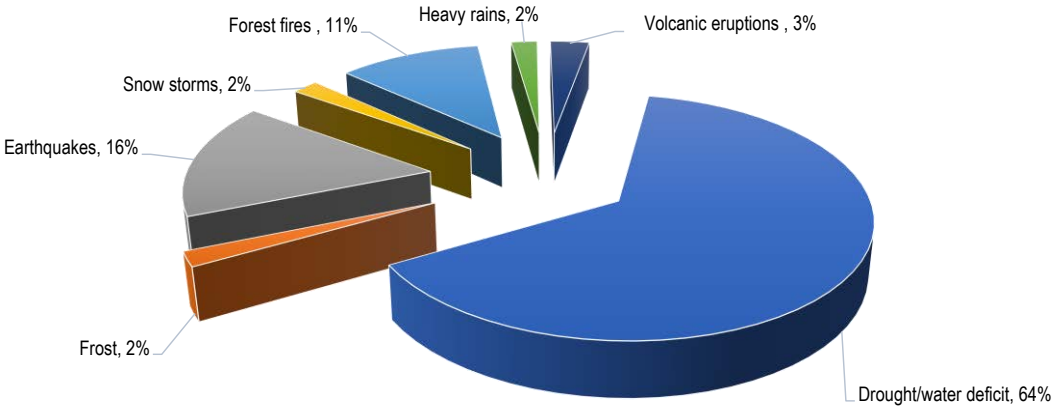
Drought has also substantially affected the agriculture sector, particularly the 'mega drought' of 2010-2015, which is the longest and most extensive drought in Chile's history. A significant proportion of the country (from the Coquimbo to Araucanía regions) experienced a precipitation deficit of 30% during the 2010-2015 period. While its total magnitude is still unknown due to insufficient data on damage and losses, this disaster significantly affected crop, livestock and forestry production. Climate change scenarios indicate that the 2010-2015 situation could become the norm in the near future, resulting in an imbalance between fresh water supply and demand in Chile's southern regions. This would mean that the cultivation of certain crops might need to be shifted to the south, which would in turn lead to less land being sown with grains, such as wheat. This is an important matter for Chile, which has already seen its wheat area decline by half, from 400 000 to 200 000 hectares, over the last 20 years (Center for Climate and Resilience Research (CR)2, 2015[5]).

During 2008-2019, drought has been the most recurrent event, as evidenced by the number of exempt resolutions for which emergencies have been declared by Chile's Ministry of Agriculture (MINAGRI), followed by earthquakes, frosts, fires and heavy rains/flooding (Ministry of Agriculture, 2018[6]). However, due to the slow-onset nature of the event, the same drought can lead to multiple emergency declarations.

Existing databases do not provide sufficient information to group emergency declarations covering a prolonged drought. This is a current challenge as there can be several back-to-back declarations, both from the Ministry of Agriculture (MINAGRI) and the Agricultural Development Institute (INDAP)[1] for a single event (for more information, see Section 5.3).

In addition, analysing public spending on emergency response helps to better understand the economic impact of disasters on Chile's agriculture sector.[2] During the 2008-2017 period, it is estimated that Chile's total agricultural emergency response expenditures amounted to USD 160 million. During this period, the costliest public emergency responses were for drought, followed by earthquakes, forest fires, volcanic eruptions, snowstorms, heavy rains and frosts (Figure 5.2).

Figure 5.2. Chile's agricultural emergency response expenditures by hazard type, 2008-2017



Source: Based on information from MINAGRI (2018).

5.2. Chile's risk governance framework

Chile's National Civil Protection System (SNPC) consists of various technical and sectoral agencies and ministries, regional authorities, technical and academic institutions, as well as organised civil society at the national and territorial levels. SNPC's actions are coordinated by the Ministry of the Interior and Public Security's National Emergency Management Agency's (ONEMI), which is mandated to plan, coordinate and carry out prevention, mitigation, alert, response and rehabilitation activities to safeguard individuals, their property and the environment (Ministry of Interior, 1974[7]). To ensure that the SNPC is operating efficiently and effectively nationwide, ONEMI also created civil protection and emergency operations committees at national, regional, provincial and municipal levels. Representatives from the Ministry of Agriculture (MINAGRI) and other public and private agencies whose mandates contribute to civil protection participate in these committees (Table 5.1).

MINAGRI is responsible for promoting and coordinating the country's crop, livestock and forestry activities within the context of sustainable natural resources management. It has an administrative department titled Agricultural Emergency and Risk Management Section (SEGRA), which has disaster risk management responsibilities, e.g. monitoring and issuing agricultural emergency and risk warnings, conducting studies, generating technical information, providing training opportunities, and designing and implementing emergency response actions. Moreover, it coordinates and provides technical assistance to implement regional agricultural emergency and agroclimatic risk management plans, which have been developed for each region.

Table 5.1. Disaster Risk Management Framework for agriculture in Chile

	Disaster Risk Management	Agriculture Risk Management
Primary responsibility	ONEMI	SEGRA/MINAGRI
Main policy documents	National Civil Protection Plan (2002)* Emergency Operations Plan (2002)* National Emergency Plan (2017)*^ National Disaster Risk Management Policy (2016)* National Disaster Risk Management Strategic Plan 2015-2018 (2016)*^ National Disaster Risk Reduction Policy – National Strategic Plan 2020-2030 (2020*^) National Climate Change Action Plan (2009)*^	National Emergency Plan (2017)*^ National Disaster Risk Management Strategic Plan 2015-2018 (2016)*^
Contributing agencies/ government bodies	Ministries, academic and research institutions, NGOs and others all of them participating in the National DRR Platform	Agro Insurance Committee (Agroseguros) Agricultural Development Institute (INDAP) Agricultural Research Institute (INIA)

Notes:
* The mainstreaming of DRR/M and specific measures into these policies, plans and strategies.
^ The integration and prioritization of agriculture into these policies, plans and strategies.

SEGRA leads the National Agroclimatic Risk Management System, which was established under Chile's 2009 National Climate Change Action Plan (Ministry of Agriculture, 2018[8]). The Ministry of Agriculture is also a member of several of the National Disaster Risk Reduction (DRR) Platform's working groups. For instance, those that focus on: i) institutional strengthening; ii) improving the early warning and monitoring system; iii) enhancing a culture of prevention; iv) promoting insurance; and v) strengthening disaster preparedness for effective response.

Chile has several relevant disaster risk management (DRM) policy frameworks, including for example its 2002 National Civil Protection Plan (Ministry of Interior and Public Security, 2002[9]). This plan is non-binding for the various national, regional, provincial and local agencies involved in the SNPC, but nevertheless provides guidance for their disaster risk management actions and encourages adjustment of their regulatory and institutional frameworks. It has been instrumental for ensuring that civil protection actions are in line with sectoral, institutional and territorial needs. It has incentivised several ministries, including MINAGRI, and public and private institutions to better define their specific DRM roles, responsibilities and actions in line with their overall mandates and expertise.

In 2016, the Government adopted a new National Disaster Risk Management Policy (Ministry of Interior and Public Security, 2018[10]). This cross-sectoral policy serves as a reference framework for public, scientific, academic and civil society organisations and includes DRM goals and strategic priorities that are in alignment with international frameworks, such as Sendai and the 2030 Agenda for Sustainable Development. It provides guidelines for setting up ongoing disaster risk reduction and emergency response processes in Chile, and includes climate change a strategic priority. Agriculture, however, is not considered a priority in the policy, and there are no specific measures included for the sector.

As an instrument to operationalize the National Disaster Risk Management Policy, Chile also adopted in 2016 the National Disaster Risk Management Strategic Plan 2015-2018, which outlines specific actors, programmes, actions, and timeframes involved in it (Ministry of Interior and Public Security, 2018[11]). This plan facilitates the adoption of a disaster risk management approach. It prioritizes actions and promotes the involvement of various sectors at the national and territorial levels in designing and implementing effective disaster-risk reduction initiatives. As a member of the SNPC, MINAGRI was actively engaged in defining the Plan's strategic objectives and activities under four of the five priority pillars: institutional strengthening (pillar 1); strengthening early warning and monitoring systems (pillar 2); promoting a culture of prevention and insurance (pillar 3); and reducing underlying risk factors (pillar 4).

5.3. Resilience successes and opportunities

Chile´s approach to agricultural disasters has evolved over time and it now includes more robust mechanisms and instruments to enhance planning, prevention, mitigation and preparedness for response actions involving the various agriculture agencies and other relevant stakeholders. The following areas of strengths to build agricultural resilience to climate risks are included.

Risk identification, assessment and awareness

National agroclimatic risk information system

Chile's national agroclimatic risk information system includes a series of interconnected platforms, various agroclimatic information bulletins, tools and initiatives to monitor, identify, assess and communicate the risks that are provided by MINAGRI in collaboration with the Agricultural Research Institute (INIA) and other members of the National Agroclimatic Network (RAN). INIA is the main sectoral research institute and conducts monthly agroclimatic risk analyses at national and regional levels. It is also a member of RAN. Farmers and other agriculture stakeholders have free access to real-time information from RAN for their area, which is available on MINAGRI's main information web portal Agromet. In addition to the real-time data, the network provides five-day forecasts related to hazardous events that may threaten the main fruit trees, crops (e.g. rice, wheat, grassland) and livestock (sheep, bovines) in different Chilean regions. As the web portal provides the most relevant information in reliable form and quality, it is an essential resource for farmers to inform their decision-making, particularly for the country's crop and livestock subsectors.

Specifically for drought, there is the online Agroclimatic Risk Observatory Platform,[3] which provides an early warning and monitoring system for drought. It also identifies the areas most affected by drought and helps the users prioritize their response actions. The Platform provides access to free online information,[4] including a data library and maps with information on: i) *El Niño*-Southern Oscillation situation;[5] ii) drought monitoring; iii) historical data from each automatic weather station where available; iv) drought vulnerability maps; and, v) drought warnings.

In addition, various monthly agroclimatic e-bulletins *Coyuntura agroclimática* and the *Monitor Agroclimático* are published by SEGRA/MINAGRI. These bulletins document meteorological changes and their impact on the crops, livestock and forestry subsectors. They also provide information on drought monitoring, *El Niño* monitoring and forecasts, hydrological updates on the flow rates of most major rivers and reservoirs, and updated forest fire information. National and regional agroclimatic risk analysis bulletins for key fruit species, crops and livestock *Boletínes Nacional y Regionales de Análisis de Riesgos Agroclimáticos para las Principales Especies Frutales y Cultivos y la Ganadería* are also published by INIA on a biweekly and monthly basis. These also outline national and regional meteorological data and specific agricultural practices that can help prevent and mitigate the adverse impacts of natural hazard-induced disasters on the main crop, fruit and livestock production activities in each of Chile's diverse regions.

Among the constraints regarding these information services and products is the access by farmers. The data platforms seem to be primarily accessed by users located in the Santiago area, as most of these information services and data platforms require access to internet, registration to an institutional e-mail distribution list and some IT skills to understand, analyse and use the services it offers. Moreover, it is not clear to what extent these agroclimatic information platforms and information products are accessed and used by small-scale family farmers, who are not necessarily regular internet users, but could benefit greatly from the provided information and advice to reduce the adverse impacts of climate-related hazards on agriculture.

Moreover, MINAGRI is organising capacity development events and trainings to enhance the awareness raising among key stakeholders, including meteorologists, agricultural experts and farmers, on the

availability, access to, and usage of, these agroclimatic information products. For instance, this includes the provision of advice on the best use of new or adjusted farming practices in view of actual weather forecasts and seasonal outlooks. This informs the decision-making of agricultural stakeholders to reduce the adverse impacts of natural hazard-induced disasters. One of the challenges is that extension officers are not direct recipients of the trainings, which limits their ability to transfer risk reduction knowledge and information to farmers.

Risk prevention and mitigation

Agricultural insurance

Agro-insurance is a key pillar of Chile's agriculture DRM strategy. Government subsidies are currently provided by the Chilean Economic Development Agency's Agricultural Insurance Committee – Agroseguros,[6] which was established in 2000 to increase awareness of agricultural insurance and establish market conditions (e.g. subsidies) to make it more viable for different types of agricultural products. The total subsidy cannot exceed 80 UF[7] (USD 2 880) per policy and 120 UF (USD 4 320) per type of crop and livestock for the beneficiary farmer. Every type of producers in the crop, livestock and forestry subsectors (large-, medium-, small-sized companies, microenterprises and small producers) is eligible for this agricultural insurance state subsidy. Most of the insurance products purchased are for garden vegetables and grains, followed by industrial crops, and then fruits and livestock, although insurance coverage of the latter two has increased substantially over the last few years.

In addition, INDAP's Agricultural Insurance Support Programme (PACSA) is available to assist smallholder and subsistence farmers in purchasing an agriculture insurance policy. PACSA will complement the Agroseguros subsidy up to 95% of the net premium cost unsubsidized by Agroseguros. The maximum net co-payment farmers may receive is 5% for annual crops, 10% for fruit trees, 5% for bovines, 5% for sheep and 5% for apiculture.

Combined, MINAGRI and INDAP allocated a total of roughly USD 10.2 million to subsidize agricultural insurance in 2019. Individual beneficiaries included microenterprises (56%), small businesses (31%), medium-sized enterprises (8%) and large companies (5%) (Vega, 2020[12]). While all types of agricultural producers may participate in the programme, smaller and less-resilient farmers benefit the most. However, the exact number of beneficiaries is currently unknown because only the total number of policies that are subsidized are documented and one single beneficiary can receive subsidies under several policies.

Disaster response, recovery, rehabilitation and reconstruction

MINAGRI and INDAP's special emergency line of funding for agriculture

Different financial instruments are available to support agricultural producers in Chile. Among others, MINAGRI's Undersecretariat maintains a special budget line for 'agricultural emergencies' through the symbolic allocation of USD 20 until an emergency is actually declared by ministerial decree. Once an agricultural emergency has been declared, MINAGRI's Undersecretariat can increase this budget line by transferring resources from its other budget lines. However, this resource re-allocation may affect other actions and development programmes, given that they may no longer have access to the full amount of originally allocated funds. Moreover, this approach allows for a flexible allocation of funding, but it is reactive and not based on risk analysis that would be part of proactive disaster risk management planning.

For many years, INDAP conducted the same emergency funding approach as MINAGRI, i.e. allocating a symbolic amount to agricultural emergencies and increasing it as needed. However, since 2016, this initial emergency allocation was significantly increased and between 2016-2019 reached on average USD 2.1 million per year. However, due to the lack of a specific budget allocation strategy that is based on risk

analysis or past emergency expenditures, INDAP has been faced with a continuous transfer of financial resources from its development programmes to annually increase its initial emergency fund allocation. Contrary to MINAGRI's emergency funding, INDAP's assistance specifically targets smallholders. One of the main challenges is related to adequately determining the annual emergency resources by both agencies, as damage and loss information is currently not shared across institutions. Although both of the agencies' financial instruments are responsive in nature, they do provide important safety nets and support to farmers' recovery activities after a disaster has occurred.

5.4. Strengthening risk management in Chile

While extensive progress has been achieved over the years regarding disaster risk management in Chile's agriculture sector, a number of recommendations can be proposed to help ensure that disaster risk management in agriculture is included as a cross-sectoral approach across MINAGRI's programmes, among others:

- *Enhance the involvement of agro services in disaster risk management*: Agro services of the public and public-private institutions, including for example Agroseguros, INDAP and INIA, could play a larger role in advising MINAGRI on how best interventions can be applied to prevent and mitigate the impact of natural hazard-induced disasters. In this regard, disaster risk management roles and responsibilities should be better defined and further enhanced with the aim of achieving greater coordination among the services. To successfully carry out its responsibilities as technical secretary of the Ministerial Technical Advisory Committee for Agricultural Emergencies and Risk Management, SEGRA/MINAGRI must be assigned the human, technical and financial resources it needs to continue strengthening the capacities of Chile's various agro services and provide the technical support they need to apply explicit DRR criteria in their analysis, planning and programme implementation. The role of SEGRA/MINAGRI remains fundamental to ensure multi-sectoral and multi-stakeholder coordination and collaboration at all levels to build the sector's resilience to natural hazard-induced disasters.
- *Increase the dissemination and use of agroclimatic information platforms and products*: Chile could increase the number and type of users of existing agroclimatic platforms and products, especially by ensuring that information is provided in simple and accessible formats to small-scale farmers. Options to enhance the outreach of existing products include: i) automatic subscriptions to information products on RAN member websites (INIA has already implemented this for its agroclimatic bulletins); ii) establish mutual links on the websites and products of the RAN members; iii) turn Agromet's web portal into a gateway to access the agroclimatic information products available within the RAN framework; iv) increase awareness of these agroclimatic platforms and capacity to use them among potential users; v) build user feedback mechanisms into the platforms so that they can be continually upgraded; vi) develop and distribute simple complementary offline products; vii) use WhatsApp and SMS to expand outreach in areas with less connectivity and internet usage; vi) advocate for increased digital infrastructure in rural agricultural areas to improve access to internet and online services; and vii) track and integrate new information products and tools developed by other stakeholders such as the Ministry of Environment that could support agriculture disaster and climate risk management.
- *Train extensionists on agriculture disaster risk management*: Chile could effectively promote resilient agriculture practices through its well-established extension services. This could be achieved by providing regular disaster risk management training for agriculture extensionists. Currently, training sessions target mostly government staff, whilst extensionists are external consultants. It is highly important that the capacities of extensionists related to DRM are strengthened, as it is them who raise awareness of good practices and technologies and transfer

the knowledge to farmers to implement them to reduce the adverse impacts of natural hazard-induced disasters on agriculture.

- *Improve access to, and analysis of, existing data to inform disaster risk management strategies*: Available data could be used to generate more detailed analyses if information would be better shared and integrated across institutions, which would help to better understand, among others, the farmers that are regularly affected, the type of events, and the type of assistance they are receiving (including subsidized insurance). This would significantly enhance decision-making about agriculture programmes and policies, as well as inform a financial strategy for disaster risk management in agriculture. As the sectoral lead on DRM, SEGRA/MINAGRI is well positioned to manage the integration of databases and improve the level of analysis. In addition, the role of academia and the private sector is highly important with regard to data collection, analysis and sharing, and MINAGRI could foster increased collaboration with these actors.
- *Develop a financial strategy for disaster risk management in the agriculture sector*: Various financial instruments are available to support agriculture emergency response and recovery, and to transfer farmers' risks via insurance. These include e.g. allocating funds for emergency support and subsidizing agricultural insurance. Given that it is not clear to what extent there is complementarity between the different budget resources provided by MINAGRI, INDAP and Agroseguros, a financial disaster risk management strategy for the crop, livestock and forestry subsectors could help to determine the allocation of funds and take into account the complementarity and advantages of the various financial instruments. Therefore, it is advisable that Chile assess the extent to which emergency allocations and agricultural insurance subsidy programmes cover disaster-related risks, especially for vulnerable farmers, and the extent they contribute to building their resilience, in order to ensure the sustainability of the financial strategy. This would also help to define, prioritise and allocate financial resources to support disaster prevention, mitigation and preparedness for response actions, including for example risk and vulnerability assessments, which aim to reduce the adverse impacts of disasters on the agriculture sector.

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Notes

[1] INDAP focuses on family farming and related organisations, among others, it co-finances technical assistance and services to this type of farm. It also contributes to follow up actions after agricultural emergencies by providing trainings on agroclimatic risk management to farmers and agricultural extensionists and by developing disaster risk reduction programmes.

[2] MINAGRI has made progress in setting up a system to assess damages and losses caused by disasters in different sectors, in order to comply with the 2015-2030 Sendai Framework for Risk Reduction and the Sustainable Development Goals.

[3] The Agroclimatic Risk Observatory Platform is accessible via http://www.climatedatalibrary.cl/IMP-DGIR/maproom/.

[4] The data library and maps can be accessed via http://www.climatedatalibrary.cl/.

[5] During *El Niño*-Southern Oscillation episodes, the normal patterns of tropical precipitation and atmospheric circulation are disrupted, hence triggering extreme climate events around the globe: droughts, floods and affecting the intensity and frequency of hurricanes. Agriculture is one of the main sectors that can be severely affected by the *El Niño* phenomenon (Food and Agriculture Organization of the United Nations, 2014[13]).

[6] See for more information on Agroseguros, see https://www.agroseguros.gob.cl/.

[7] The *unidad de fomento* or UF is a Chilean currency unit indexed to inflation. For reference, the value of the UF on 10 February 2020 was USD 28 352.33 (approximately USD 36).

6 Building agricultural resilience to drought in Italy

Drought has become a particular concern in Italy over the past decade and will continue to threaten the country's agricultural sector under climate change. As a result, better management of water resources and improved agricultural resilience will be required to confront more frequent and severe droughts. This chapter explores recent initiatives that are positioning Italy for improved resilience to droughts and other natural hazards, and identifies opportunities to further strengthen how natural hazard risks are managed by the sector.

Key messages

- Drought has become a particular concern in Italy over the past decade, and will continue to threaten the country's agricultural sector under climate change. Better management of water resources and improved agricultural resilience will be required to confront more frequent and more severe droughts.
- Recent initiatives are positioning Italy for improved resilience to natural hazards. In particular, awareness of the risk environment is increasing, stakeholders are improving data collection on water resources and agricultural damage and loss from natural hazards, policymakers recognise the advantages of moving towards prevention and *ex ante* approaches, and response processes increasingly prioritise business continuity.
- Progress could be further strengthened by developing a holistic, long-term sectoral risk management strategy, ensuring the effectiveness of existing reforms, re-evaluating the trade-offs between spending on risk coping tools versus increasing investments in risk prevention and preparedness, and taking baseline farmer demographics and capacities into account in policy design.

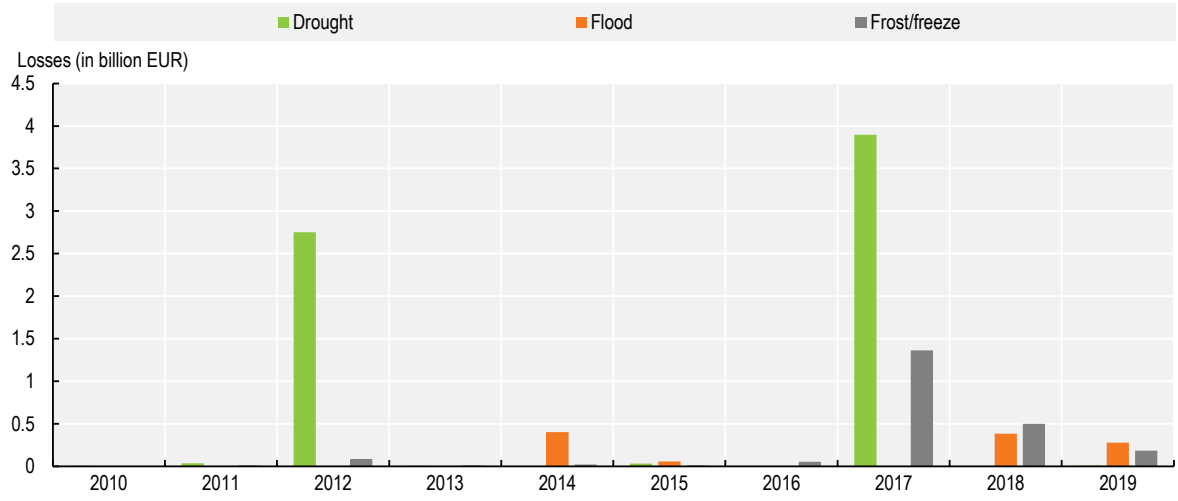
6.1. Italy's agricultural sector faces the challenge of building its resilience to more frequent drought and water scarcity events

Italy is exposed to many natural hazards, which can have significant impacts on the agricultural sector.[1] In particular, drought, the focus of this case study, is an increasing challenge for Italy's agricultural sector, posing a problem for the country's major export industries, as well as smaller farmers. Droughts have become more frequent and costly in Italy over the past two decades, and are increasingly affecting new areas of the country (Figure 6.1) (AGEA, 2020[1]; CPD, 2018[2]). Moreover, climate change projections indicate that droughts are likely to become more frequent and severe in the future. On top of weather and climate conditions, water shortages are also exacerbated by the state of the country's water distribution network and management, although recent advances in water governance and infrastructure investments are addressing these needs.

Building the agricultural sector's resilience to drought will require effective short-term hazard management improvements, including improved management of increasingly unpredictable water resources, but also investments that will improve the sector's capacity to manage or adapt to these types of events in the long-term. Among other challenges, the government must find the most effective balance between investing in preparedness and prevention versus hazard response; more effectively manage water resources amongst competing uses; and incentivise improved farm-level capacity to manage drought and adapt to changing conditions. In doing so, stakeholders have an opportunity to reconceptualise how they perceive risk management in agriculture and ensure that policies are better-oriented toward the sector's long-term sustainability rather than solely the capacity to cope with single hazard events.

Moreover, to ensure that these efforts are effective, they must be carried out taking into account the needs, capacities and objectives of the country's farmers. Italian farms tend to be small and managed by older farmers, and a significant share of farmers are not well-integrated into commercial value chains (OECD, 2020[3]). Accordingly, these farmers may be less inclined toward innovation or have limited drive to invest in building the resilience, productivity and long-term sustainability of their farms.

Figure 6.1. Losses to agriculture in Italy from three hazards



Note: Values represent the sum of indemnified insurance losses and loss declarations reported to the National Solidarity Fund.
Source: ISMEA (2020), "Perdite economiche per evento" Dataset.

6.2. Drought governance in Italy falls across several policy frameworks

The Italian agricultural sector's approach to managing natural hazards involves activities under a variety of governance frameworks – emergency management, agricultural risk management, agricultural policy and water governance – each with their own guiding policy documents and set of responsible actors. Different activities under each framework contribute to natural hazard risk management by helping producers to plan and prepare for, absorb the impact of, and recover from drought, as well as provide the incentives and plans for adapting and transforming in response to these events (Table 6.1).

Table 6.1. Disaster risk management governance in Italian agriculture

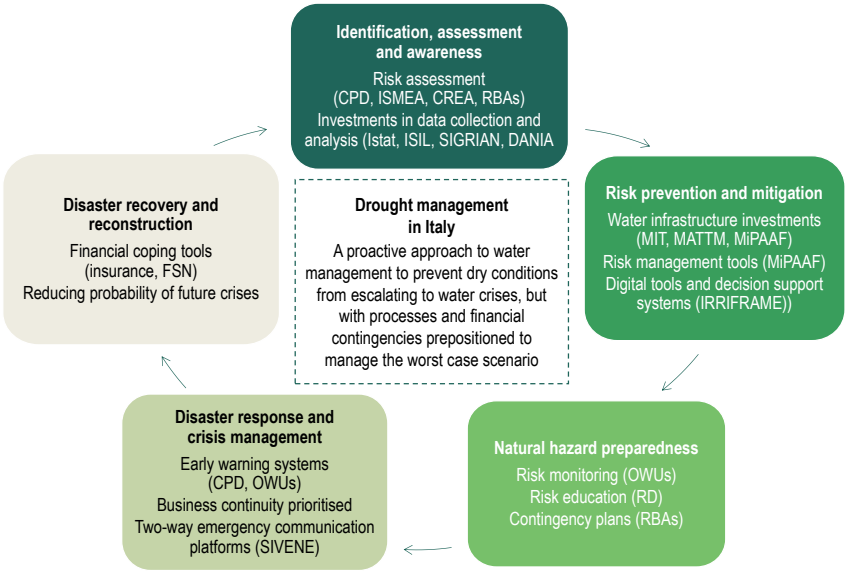
	Key governance frameworks				
	Disaster risk management	Agricultural risk management	Agricultural policy		Water governance
Primary responsibility	Civil protection (local, regional, national)	MiPAAF	National level: MiPAAF	Local level: Region	MATTM (coordinating role); River Basin Authorities; Regions
Main policy documents	Civil Protection Code	National Risk Management Plan	EU Common Agricultural Policy Pillar I National Rural Development Plan (Pillar II) Regional RDPs (Pillar II)		EU Water Framework Directive; EU Groundwater Directive; EU Floods Directive (and related national regulations)
Contributing Agencies/ government bodies	Other Ministries and agencies, as relevant IUVENE	ISMEA AGEA	ISMEA AGEA CREA		OWUs MiPAAF, MIT, CPD, CREA, ISPRA

Disaster risk management is under the charge of the Civil Protection Department (CPD), whose primary focus is the safety and well-being of humans, animals and property in emergency situations. A specific agricultural risk management framework is the responsibility of the Ministry of Agricultural, Food and Forestry Policies (MiPAAF), and includes the portfolio of subsidised insurance policies and *ex post* assistance under the National Solidarity Fund. Other agricultural policies include programmes that help farmers to prevent or mitigate their natural hazard risk – mostly through rural development programming funded through the Common Agricultural Policy's Pillar II, but also through national funds. Finally, water management frameworks have substantial implications for farmers who must share water with other users. Water governance in Italy has made important advances with the institution of the EU Water Framework Directive (WFD) under the coordination of the Ministry for Environment, Land and Sea Protection (MATTM), but opportunities remain. For example, there is a territorial mismatch between administrative and hydrological boundaries, as River Basin District Authorities (RBAs) are the primary planning authorities, but Regions are the main authorities issuing water abstraction licenses (WALs).

6.3. Italy's agricultural disaster risk management system includes innovative approaches and good practices

While each of the governance frameworks has its own target objectives, actors and processes, farmers and sector stakeholders make their decisions taking into account the entire policy environment. Accordingly, activities under the four frameworks at each stage of the disaster risk management (DRM) cycle (risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction) are considered holistically to better understand conditions, good practices, challenges and opportunities for Italy's agricultural sector with respect to natural hazard risk management. In the context of drought, Italy's DRM system focuses on mitigating impacts by improving water management – in particular, collecting and making use of more and better data, supporting improved farm-level management decisions, and increasing and better targeting investments in infrastructure (Figure 6.2).

Figure 6.2. Drought risk management in Italy across the DRM cycle



Risk identification, assessment and awareness

Managing natural hazard risk begins with an understanding of the risk environment, to encourage investments in risk prevention and to ensure that policies are in place for hazard management before an adverse event occurs. In Italy, CPD has carried out a National Risk Assessment covering major natural hazards, although the assessment contains little on the specific impacts to the agricultural sector (CPD, 2018[2]). RBAs have also carried out water and drought management plans which assess current conditions and define medium-to-long-term action plans. A longer-term vulnerability assessment in the context of climate change was undertaken during the development of the National Adaptation Strategy (MATTM, 2015[4]). Other work with a specific view toward understanding natural hazard risk for agriculture has been carried out by the Italian Institute of Services for the Agricultural Food Market (ISMEA) and the public Research Center for Agricultural Policies and Bioeconomy of the Council for Agricultural Research and Economics (CREA-PB), including defining specific drought indicators that can be used to support policy decisions (CREA-PB, 2020[5]; Zaccarini Bonelli and Lasorsa, 2020[6]).

Italian stakeholders recognise the importance of using data to inform better risk management decision-making, and several initiatives are emerging to develop data sources that could demonstrate the costs and benefits of *ex ante* interventions, including:

- The Italian statistical agency (Istat**)** is working on a methodology to report on agricultural losses due to hazardous events, which will be useful to inform new policies and investments.
- The linked National Information System for Agriculture Water Management (SIGRIAN) and National Database of Investment for Irrigation and Environment (DANIA) – both managed by CREA-PB. SIGRIAN serves as the national reference repository for data on irrigation networks, water use, and groundwater abstraction at water user level, while DANIA is a decision support tool for planning risk reducing investments in irrigation and water management infrastructure for agriculture. Among other uses, these databases can be used to support economic evaluations of proposed interventions to help avoid losses due to natural hazards (Zucaro et al., 2017[7]; Ferrigno, 2020[8]).
- The Lombardy Irrigation Systems Survey (ISIL) project (Gandolfi, Olivotti and Roverato, 2019[9]).

Box 6.1. Lombardy Irrigation Systems Survey (ISIL) project

Italy's Lombardy region is one of the most intensively irrigated areas in Europe, and climate change is altering the region's water supply. To improve the knowledge base on how water in the region's network is currently used, the ISIL project compiled a comprehensive survey of Lombardy's canals in a collaboration between the Italian Water Boards Association (ANBI), regional authorities, and academics. The data was organised into a geospatial database, which, combined with other data, allows simulations to be carried out to analyse how changes in water management would affect the entire system. The database has demonstrated the importance of feedbacks and consideration of groundwater recharge, and that better data and water management capacity can generate substantial benefits.

Risk prevention and mitigation

Ex ante investments in measures to prevent or mitigate natural disaster risk can reduce the cost of disaster response and recovery by addressing underlying vulnerabilities and mitigating impacts. Government policies and programmes can also encourage stakeholders to identify disaster risks to their own assets and address gaps in their resilience levels. Risk prevention and mitigation efforts in Italy related to drought

management focus on water resource planning and water usage efficiency, but also include policies, initiatives and research to help mitigate the impacts of natural hazards on farms, such as efforts to improve soil health and support the uptake of financial risk mitigation tools.

- *Water resource planning:* These include a variety of initiatives, such as construction of major water-related infrastructure, investments in greater water use efficiency, improvements to WAL planning, moving towards applying full cost recovery in agricultural water use, and using participatory governance models (in the form of permanent observatories on water use, or OWUs) to monitor water availability and use and recommend appropriate actions to mitigate negative impacts (Mariani et al., 2020[10]; Manganiello, 2020[11]).
- *Other initiatives to prevent or mitigate the impacts of drought, including research:* Various soil health and other farm risk prevention initiatives are funded through rural development. A variety of public and private actors also carry out research that looks to improve prevention or mitigation of drought.
- *Financial mitigation tools:* Various tools are available under the National Risk Management Plan, but subsidised insurance policies delivered by private companies are the most widely-utilised tool (ISMEA, 2020[12]).
- *Digital tools increasingly available:* New digital tools and decision support systems are helping farmers to mitigate the impact of adverse events and optimise their decision-making, including the IRRIFRAME real-time irrigation decision support software (Battilani, 2020[13]).

Box 6.2. IRRIFRAME

IRRIFRAME helps farmers maximise water productivity by providing tailored, free advice to farmers for irrigation at field scale in 16 Italian regions. The system sets irrigation schedules based on a daily water balance model and considers economic costs and returns for 50 crops. The software also provides a real-time planning resource for water managers, as farmers confirm their irrigation volumes in the software, and then that data is aggregated and integrated into WUA water management systems. IRRIFRAME resulted in estimated water withdrawal savings of 350 million m3 per year in 2017.

Risk preparedness

Disaster preparedness and planning are crucial for effective crisis management – by public and private stakeholders with a role in disaster response, and on farms. Risk preparedness efforts for drought are heavily focused on risk monitoring systems, but risk education and planning also play a role. Risk monitoring is generally housed within CPD, who undertake a number of forecast and surveillance activities. At the same time, the RBA-centred OWUs carry out periodic assessments of a variety of water-related indicators in a collaborative setting that includes government authorities and water users.

Risk education activities are carried out under rural development. Nine regions devote financial resources to knowledge transfer, information actions, and advisory services specific to farm risk prevention and management. While some innovative programming was identified (including the Acqua Campus irrigation technology experimentation and demonstration site in Emilia Romagna), because these activities occur in the context of regional rural development plans, activities are at present fragmented.

Contingency planning also supports preparedness. These are in place in Italy for RBAs thanks to requirements of the WFD, and the National Climate Change Adaptation Strategy has renewed focus on the importance of long-term planning to confront likely future conditions.

Box 6.3. Permanent observatories on water use

In 2016, MATTM established seven observatories on water use (OWUs) – one for each river basin district – to strengthen coordination between relevant government institutions, research bodies, irrigation consortia, water utilities and associations of utilities in managing common surface water resources. OWUs act as a control room for the management of water resources in times of drought and water scarcity. They also develop technical tools to support the planning of water balances at basin scale. The OWUs facilitate the development of common strategies to ensure that all users have adequate water availability during stress situations, based on the principle of solidarity. Through their activity, which focuses on suggesting the most appropriate measures for mitigating the impacts of drought, the OWUs support participatory approaches to defining actions for prevention and mitigation, working closely with utilities and industry associations responsible for water use.

Disaster response and crisis management

Effective crisis management and response hinge on all actors knowing their responsibilities in the event of an emergency and communicating effectively, with the public sector taking a leadership role when the private sector is unable to cope. When a natural hazard occurs, Italy's emergency response frameworks are engaged. These begin with early warning systems, including notices issued through CPD or, in the case of drought, alerts issued by OWUs for individual RBAs. After a natural hazard has struck, response efforts through CPD (particularly in rural areas) have prioritised business continuity, recognising that helping producers return to "normal" business operations as soon as possible greatly speeds recovery.

Box 6.4. Prioritising business continuity: The Central Italian earthquakes of 2016-17

In 2016 and 2017, a series of earthquakes affected four regions in central Italy, with impacts on the agricultural sector. In response, an interregional technical co-ordination centre was established to ensure food safety, business continuity and animal welfare. This co-ordinating structure and approach allowed stakeholders to identify the specific needs of farming communities within the framework of the existing emergency response system, such as by providing temporary housing for livestock producers and ensuring continuity of milk collection and delivery with drinkable water for the cleaning of milk tanks. Preliminary data indicate that no substantial differences were reported in milk deliveries or farm closures in affected areas as compared to the previous year.

Response is also aided by innovative tools or practices, such as the SIVENE tool – a new sector-specific platform developed by national veterinary authorities for emergencies impacting animal health. The tool allows for two-way communication between stakeholders and responders, which helps to target response efforts (Possenti et al., 2020[14]).

Box 6.5. Using the SIVENE tool to improve response to veterinary emergencies

The Veterinary Information System for Non-Epidemic Emergencies (SIVENE) is a tool to facilitate emergency response. It collects, manages and visualises data related to animal health to support emergency management, incorporating various layers of geospatial data. SIVENE helps emergency responders identify where and what type of assistance is needed. It provides a unified portal that allows information on conditions at the farm level to be systematically collected and transmitted to competent authorities. SIVENE can be used for awareness raising purposes, to inform models and damage scenarios, and for risk mapping beyond veterinary institutions. In the future, SIVENE will be integrated into the National Information Platform managed by CPD.

In drought situations, OWUs use information on the level of water scarcity to inform their own management processes and actions. Irrigation agencies can restrict water withdrawals by farmers if their own allocations are reduced, but water prices play only a limited role in adjusting farmer behaviour during droughts, as they are typically set annually – thus limiting their effectiveness in signalling water availability.

Recovery, rehabilitation and reconstruction

Following a natural disaster, recovery and reconstruction efforts offer an opportunity for public and private stakeholders to "build back better"[2] by addressing underlying gaps in resilience, and building the capacities needed to manage natural hazards in the future. This requires all stakeholders – including producers – to learn from natural disasters in order to adjust DRM frameworks and measures with a view towards long-term resilience. Recovery and reconstruction activities for natural hazards range from large projects like repairing damaged infrastructure, to programmes that support the financial recovery of farmers. Financial coping tools like insurance indemnities or payouts from the FSN have helped farmers to absorb the impact of these events, but these tools have their drawbacks to the extent that they reduce incentives to undertake risk mitigation. Few farmers are currently insured, and most of these are not insured against drought. Regarding the FSN, payouts occur at a significant delay to the event and are contingent upon funding availability, making them unpredictable. In response to the limitations of available tools, Italy has advanced a proposal on a new mandatory mutual fund to help farmers better cope with the financial impact of catastrophic events.

Box 6.6. Proposing a mandatory mutual fund against catastrophic adversities

The MeteoCAT fund is a risk management tool proposed by MiPAAF in the context of the next CAP. The programme would be set up as a mandatory mutual fund: producer contributions to the fund would be subsidised by up to 70% through risk management instruments under Pillar II, while farmers would be responsible for contributing the remaining 30% by redirecting a small percentage (up to 5%) of their direct payment entitlements under Pillar I. The mutual fund would cover the three events responsible for most agricultural damages and losses in Italy – drought, flood and frost. Payouts would be triggered using a two-stage process – first, the event would trigger a pre-defined index threshold in a givengeographical area, and then farms within that area would be eligible to submit a claim if their damage exceeds 20% of the farmer's historical average production. Concurrently with the introduction of the MeteoCAT fund, the FSN compensation tool would be ended, such that Italy would no longer have a mechanism for ad hoc assistance and all risk management tools would be defined *ex ante*.

Post-event evaluation and assessment help stakeholders better prepare for future events. These may take place within RBAs in the context of the OWUs, but it is not clear if or how these assessments have led to improved future processes.

6.4. Resilience successes and opportunities

In line with the four principles for resilience to natural hazard-induced disasters in agriculture, Italy's systems for natural hazard risk management – and drought management in particular – demonstrate a number of recent positive developments and good practices, as well as some challenges that provide opportunities for future improvement.

An inclusive, holistic and multi-hazards approach to natural hazard risk governance for resilience

- Agricultural risk management takes an all-hazards approach, but could benefit from a holistic long-term vision integrating the relevant governance frameworks. While the system incorporates inclusive processes and considers all hazards, it lacks a risk management framework with a long-term perspective that links together the different components of risk management in a cohesive way. There appear to be few concrete initiatives recognising that investing in risk prevention could be the most cost-effective approach to reduce *ex post* expenditures on response and recovery. At the same time, drought management is one of the few areas where preventative investments are prioritised.
- Risk governance in Italian agriculture could benefit from more explicit thresholds that define when natural hazards are too big for farmers to cope with. The criteria for when a government response will be triggered are poorly defined, providing no clear incentive for regions, provinces, or farmers to invest in risk reduction because of the likelihood that ad hoc public disaster assistance may be provided. Farmer responsibility to prevent, prepare for, and respond to risk is also unclear, as there is at present only limited interaction between agricultural stakeholders and emergency management authorities in the absence of a crisis.

A shared understanding of risk based on the identification, assessment and communication of hazards, vulnerability and resilience capacities

- *Italian actors are heavily investing in generating better data to inform planning and investment decisions related to agricultural risk management.* Italy has well-developed general public expertise in risk identification, assessment and communication, particularly when it comes to natural hazards that could result in the loss of life. A co-ordinated and systematic methodology to estimate the impact of adverse events specifically on agricultural production is being developed, which will lead to better information on which to base resource allocation decisions, including investments to strengthen on-farm resilience capacities and the development of preventative infrastructure. This data will complement other existing data collection efforts for water and disaster risk management, including SIRGRIAN, DANIA, ISIL and SIVENE.
- *There is an opportunity to ensure relevant data reaches farmers.* Weather alerts and information systems could provide more explicit implications of the forecast events on critical farm management decisions, including through digital tools. An analysis of existing digital tools could help identify where additional development of further technologies may be needed. Stakeholders should also note that more targeted risk outreach programmes may be needed for older farmers and farmers that are not well-integrated into value chains.

An ex ante approach to natural hazard-induced disaster risk management

- *Improving availability of water resources to mitigate the impact of drought is a priority.* Italy is making substantial investments in improving water infrastructure and improving data systems to inform water-related decision-making. But such improvements must be accompanied by strong water governance that prevents unsustainable use of water resources. While Italy allocates water using licenses, the system is inflexible, not allowing for trading, adjustment, or prioritisation as a means of responding to or mitigating drought impacts. Other more cost-effective strategies that could save water include investment in knowledge of water systems, improved management capacity, or planting less water-intensive crops.
- Risk management tools have been reoriented to prioritise tools that are defined *ex ante* rather than rely on *ex post* assistance. Current government support of risk management tools is largely devoted to *ex ante* instruments (such as subsidised crop insurance) instead of *ex post* initiatives (ISMEA, 2018[15]). Nonetheless, few producers subscribe to these tools.
- Other policy initiatives support *ex ante* risk management strategies, but government stakeholders should note that the whole policy environment affects farm-level incentives to invest. Other public goods and programmes help producers to prepare, plan for, absorb, respond, recover from, and more successfully adapt or transform in response to hazards. These are typically funded through rural development expenditures, and include knowledge generation and technical assistance. At the same time, the whole policy environment – including direct payments under Pillar 1 – have an impact on farm-level incentives to take proactive risk management measures.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazard-induced disasters

- *Business continuity is a priority for natural hazard response.* The prioritisation of business continuity in hazard response ensures that producers and their animals are not only safe, but also recover more quickly from adverse events by preventing cascading economic impacts.
- *Focus on "building back better" could be greater*. Drought recovery typically has little in the way of "building back," but current structures, such as the OWUs that focus on addressing developing crises, could be more proactively leveraged to improve the long-term management of water resources in order to prevent future crises.

6.5. Strengthening risk management in Italy

While Italy's disaster risk management systems for agricultural resilience exhibit a number of good practices, there are some concrete actions that would strengthen management of natural hazard risks for the sector.

- *Develop a holistic, long-term sectoral risk management strategy*: Such a strategy should explicitly recognise the need for investments in risk prevention and sectoral adaptation, and would enhance the capacity of the Italian agricultural sector to absorb, adapt and transform in response to natural hazards.
- *Ensure effectiveness of existing reforms:* Continued monitoring (and where necessary, adjustment) of recent policy initiatives is needed to ensure that they are achieving their aims. Additional investments in data analysis and improved management capacity to act on this data may be warranted.

- *Re-evaluate the current balance in favour of spending on risk coping tools to increase investments in risk prevention and preparedness*: Substantial resources continue to be directed toward risk coping tools that are not well-linked to other risk-mitigating activities and may actually weaken resilience to certain risks. Trade-offs and linkages should be explored, as spending on prevention typically results in future cost savings.
- *Take farmer demographics and capacities into account in policy design:* Policies and tools must recognise that some groups of farmers may need additional resources or efforts to reach similar levels of preparedness as others.

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Notes

[1] This chapter is based on Baldwin and Casalini (2021[19]).

[2] Building back better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR, 2015[16]).

7 Building agricultural resilience to typhoons and heavy rain in Japan

Agricultural producers in Japan have significant experience in managing the risk of natural hazard-induced disasters (NHID), but recent large-scale typhoons and heavy rain events have highlighted the importance of increasing the sector's resilience to NHID. The chapter explores current good practices that already build the resilience of Japan's agricultural sector to typhoons and heavy rain – and NHID more broadly – at each stage of the disaster risk management cycle, and identifies further opportunities that would better position the sector to prepare for, mitigate and manage the risks of more frequent and intense typhoons and heavy rains.

Key messages

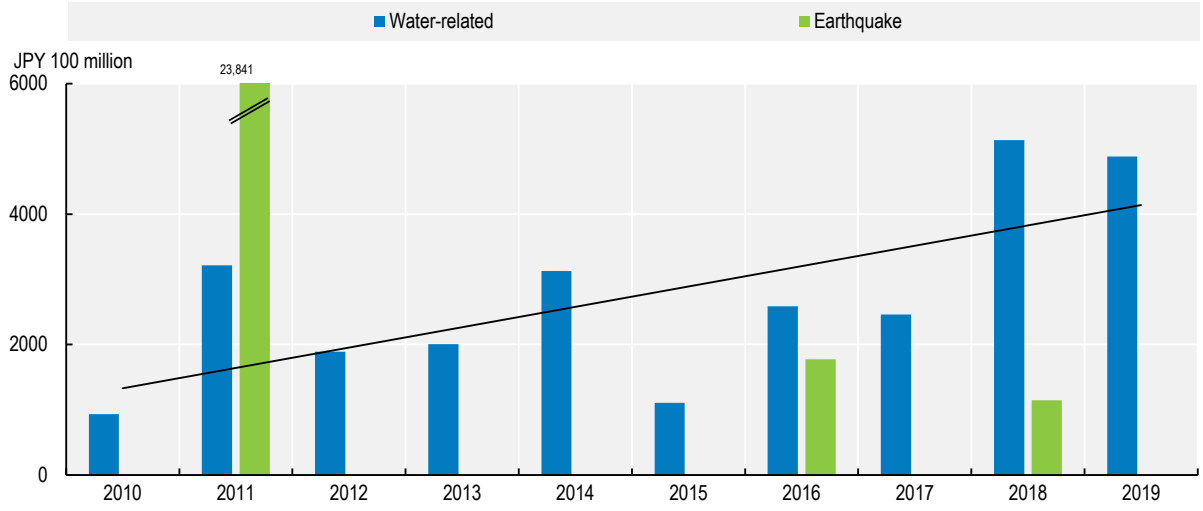
- Large-scale typhoons and heavy rain events have become a particular concern for Japan and will continue to threaten the country's agricultural sector under climate change. Given ageing and depopulation in rural areas, better management of disaster risks and improved agricultural resilience will be required to confront more frequent and more severe typhoons and heavy rain.
- Japan's Disaster risk management (DRM) frameworks are comprehensive and well-structured yet flexible and responsive to evolving hazard risks. Japan also explicitly recognise the imperative of improving the agricultural sector's resilience. A variety of structural and non-structural measures target improved risk prevention and mitigation, and rapid recovery and *ex post* provision support producers return to farming as quickly as possible.
- DRM in agriculture must reflect the challenge of more frequent and intense typhoons and heavy rains in the context of ageing and depopulation in rural areas. Government-led disaster risk reduction efforts should be complemented by greater efforts from farmers and other stakeholders. This could be encouraged by clarifying farmer's responsibilities and incorporating agricultural co-operatives networks into *ex ante* DRM activities. Defining the triggering criteria and types and level of government support would also provide farmers with a clearer incentive to invest *ex ante* activities.

7.1. Japan's agricultural sector faces the challenge of building its resilience to more frequent typhoon and heavy rains in the context of ageing and depopulation in rural areas

Japan is exposed to many natural hazards, which can have significant impacts on agriculture. Given the high frequency with which natural hazards occur in Japan, the nation has ample experience with reconstructing and thriving after these events. However, the scale of recent typhoons – the most frequent natural hazard in Japan – and heavy rain events, the focus of this case study,[1] has been unprecedented, causing a major setback to the agricultural sector (Figure 7.1). Typhoons and heavy rain are expected to intensify and occur more frequently as a result of climate change, increasing flood and landslide risks. Effective risk management for large-scale typhoons and heavy rain events is therefore ever more important for Japan's agricultural sector.

On top of the climate conditions, the agricultural workforce has declined by almost half since 2015 to 2.1 million in Japan, with an accelerated pace of decline in the last decade (OECD, 2019[1]). The average age of farmers in Japan is 67 years, and more than 80% of farmers are over 60 years old (OECD, 2020[2]). Ageing and depopulation continues in rural areas, suggesting that the sector will be more vulnerable to natural hazard-induced disasters (NHID) in the future. Building the agricultural sector's resilience to typhoons and heavy rain then requires policies that balance safeguarding farmers' livelihoods with providing incentives for on-farm strategies that increase preparedness, prevent and mitigate risks, and support a more resilient recovery. To ensure that efforts become effective, they must be carried out taking into account the needs, capacities and objectives of the country's farmers.

Figure 7.1. Damage and losses to Japan's agricultural sector as a result of water-related events and earthquakes and, 2010-19



Note: As of April 2020. The data includes damage and losses of agriculture, forestry and fisheries.
Source: Author, based on MAFF (2020[3]).

7.2. Several national governance frameworks supports managing typhoons and heavy rain risks

Disaster Risk Management (DRM) is a high priority in Japan, with the aim of ensuring basic security and quality of life against both natural- and human-induced hazards. Japan's national DRM governance is highly structured and institutionalised. Two national frameworks, or "pillars", advance Japan's DRM activities. The first pillar, the *Disaster Countermeasures Basic Act* and mandated *Basic Disaster Management Plan* are all-hazard frameworks (Figure 7.2). They define the roles and responsibilities of actors for each step of DRM cycle, and describe sequence of countermeasures for identified disasters. The second pillar of Japanese disaster governance, the *Basic Act for National Resilience* [2] and its related frameworks, reorient the country toward *ex ante* disaster preparedness in order to withstand large-scale natural disasters (Figure 7.3). Both pillars focus on structural and non-structural measures to build resilience.

The Japanese agricultural sector's approach to managing natural hazards involves activities that are programmed based upon the directions of these national frameworks. The Ministry of Agriculture, Forestry and Fisheries (MAFF) is responsible for specific agricultural risk management programmes. Japan's ten-year agricultural policy agenda, the *Basic Plan for Food, Agriculture and Rural Areas*, revised in March 2020, emphasises preparedness and recovery from large-scale NHID. Other policy frameworks such as the *Basic Policies for Economic and Fiscal Management and Structural Reform*, the *National Climate Change Adaptation Plan*, and the *Climate Change Adaptation Plan* of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) also directly and indirectly influence the agricultural sector's DRM activities and capacities.

Figure 7.2. Disaster risk management governance in Japan

The structure of the Disaster Countermeasures Basic Act

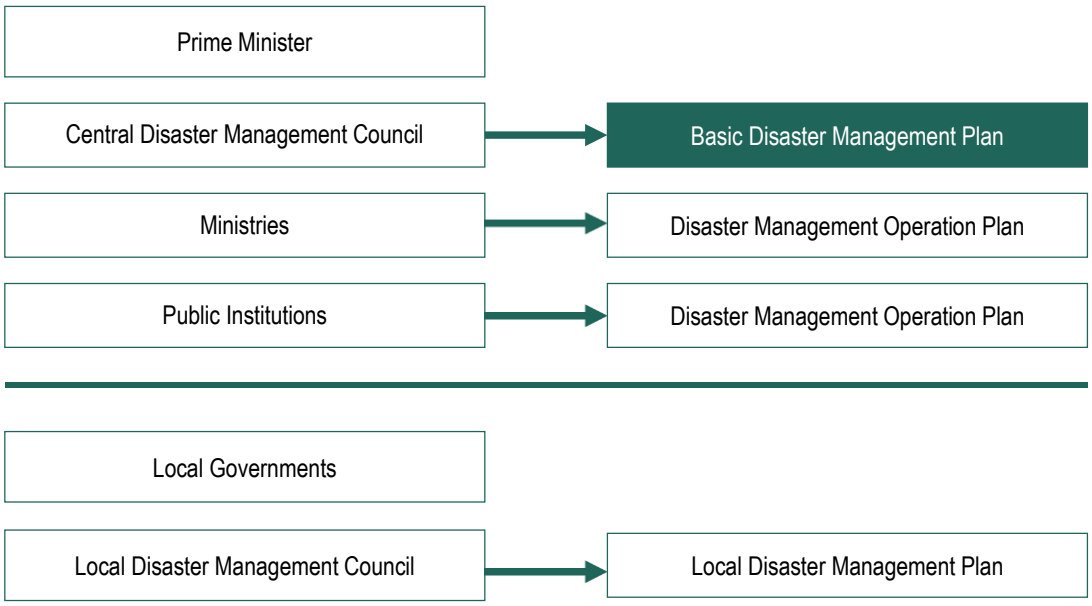
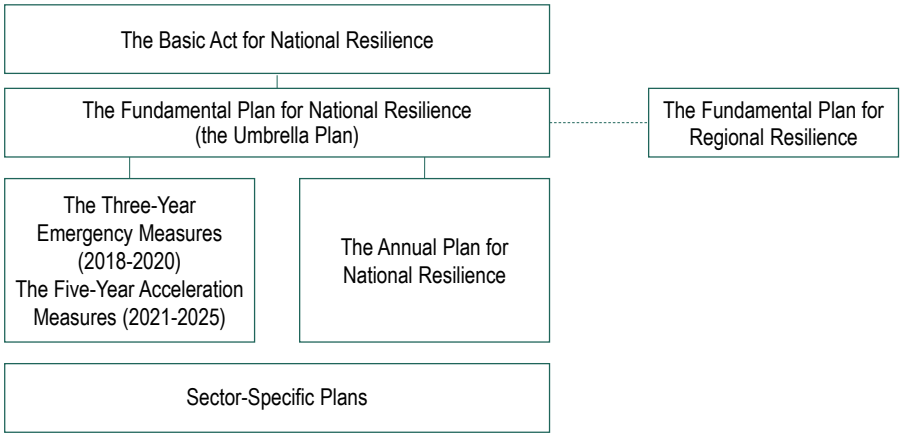


Figure 7.3. The organisational structure of national resilience building policies in Japan



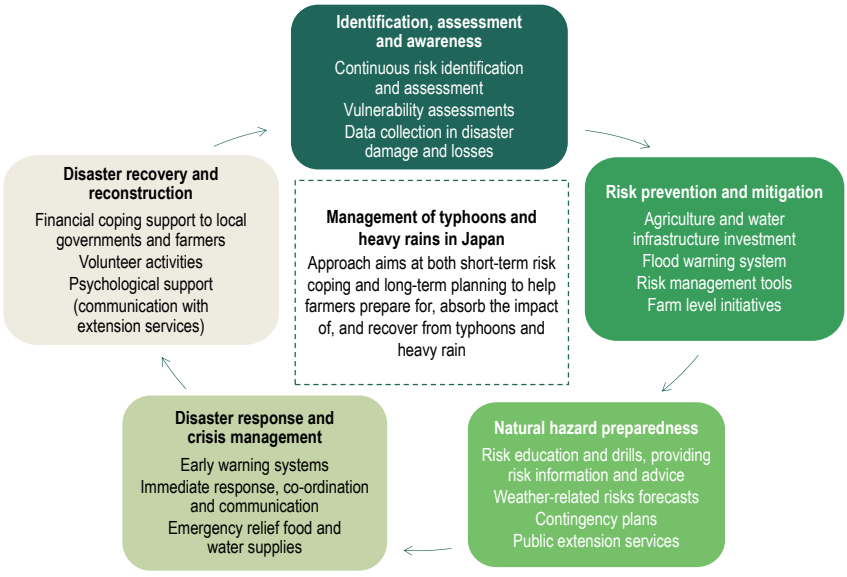
Source: Authors, based on Cabinet Secretariat (2019[4]).

7.3. Japan's disaster risk management system

Farmers and other stakeholders make their DRM decisions taking into account the entire policy environment. Accordingly, activities under the national DRM governance frameworks at each stage of the risk management cycle (risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction) are considered holistically to better understand conditions, good practices, challenges and opportunities for the Japanese agricultural sector with respect to natural hazard risk management. In the context of typhoons and heavy rain events, the management of natural hazard risks in the agricultural sector in Japan includes emergency

responses for immediate and catastrophic events, and agricultural policies aimed at both short-term risk coping and long-term planning to help farmers plan and prepare for, absorb the impact of and recover from typhoons and heavy rain. This is undertaken both through specific DRM, agricultural, and infrastructure policies (Figure 7.4). It involves activities across actors at local and national levels.

Figure 7.4. Typhoon and heavy rain risk management in Japan across the DRM cycle



Risk identification and assessment

Risk identification is the critical first step for more effective disaster preparedness, risk reduction, response and recovery measures (OECD, 2020[5]). In Japan, the Basic Disaster Management Plan (the umbrella DRM plan) identifies storms and floods (stemming from typhoons and heavy rains) among the threats that pose a threat to national security. Japan aims to continuously identify risks and assess its disaster response, and any issues that arise during disasters are analysed and addressed through amendments to existing legal provisions, policies and guidelines. The Central Disaster Management Council reviews the plan every year to reflect any newly identified risks and more effective measures,[3] contributing to sustained enhancement of resilience over the long-term (Figure 7.2).

A regular vulnerability assessment is conducted through the framework of the Basic Act for National Resilience. Moreover, given increasing occurrence of natural hazards, the government carried out "emergency risk assessments and inspections" on 132 infrastructure facilities and systems that are critical to Japan, including on high-risk agricultural infrastructure and facilities, with the aim of identifying areas particularly vulnerable to large scale NHID and formulating *ex ante* measures to address them (*Three-Year Emergency Measures for Disaster Prevention, Mitigation and Building Resilience 2018-2020*). The assessment and inspection revealed the extent to which many facilities were vulnerable to natural hazards, motivating a number of remediation actions. Vulnerability to typhoons and heavy rains poses a critical risk to agricultural reservoirs, yet some are deteriorating and improperly maintained due in part to ageing and depopulation in rural areas. A taskforce in 2018 assessed measures to prevent further damages in areas downstream from agricultural reservoirs (Box 7.1).

Disaster damage and loss[4] data are a critical input into planning current and future disaster preparedness activities. Since 1964, Japan has collected quantitative and qualitative information on agricultural damage and losses caused by natural disasters, with the data collection usually undertaken by municipalities through on-site visits, and shared with the public. Information collection and reporting begins immediately

after natural hazards occur. Agricultural co-operatives (JA) also assess damage experienced by their members to determine if support is needed (Box 7.2).

Box 7.1. Risk assessments on agricultural reservoirs

A number of small-scale agricultural reservoirs in the mountainous regions collapsed following heavy rain in 2018, thereby exacerbating flood damages in the downstream areas during and after the rain. In response, emergency inspections of agricultural reservoirs took place during the summer of 2018, in co-operation with prefectures and municipalities. Based on this inspection, MAFF identified 1 540 agricultural reservoirs that required emergency measures, out of a total of 88 133 agricultural reservoirs that were identified as having the potential to damage houses and public facilities in downstream areas. Following these risk identification exercises, prefectures and municipalities implemented temporary measures such as lowering water levels and removing sediment. In addition, MAFF also initiated a taskforce composed of policymakers, specialists, researchers from the National Agriculture and Food Research Organization (NARO), and impacted prefectures to further identify effective measures for preventing further damages, focusing on identifying and assessing the current conditions of agricultural reservoirs.

Box 7.2. Collecting data on farm damage and losses following a natural disaster

Both national and local governments are important actors for collecting information on farm damage and losses caused by natural hazard-induced disasters in Japan. Based on the Disaster Countermeasures Basic Act,[1] prefectures – usually in co-operation with municipalities – investigate on-farm damage and losses and create a damage report, which is provided to MAFF and becomes the basis for planning and implementing national disaster responses and emergency measures, including allocating support and funding to local governments. The reporting includes four phases: disaster occurrence notification, preliminary damage report, damage overview report, and damage confirmation report. Besides this reporting system, damage to farmland and agricultural facilities, including irrigation infrastructure, is reported to the government separately. Japan gives weight to on-site visits for assessing agricultural damage and losses as this allows damage to be captured more precisely (e.g. satellite imagery cannot detect precise damage and some damage and losses may take a while to become apparent). The data collection efforts rely heavily on the experience of municipality staff, making sharing technical knowledge crucial, e.g. through training.

1. Article 51(1).
Source: MAFF (2019[6]).

Risk prevention and mitigation

Ex ante investments in measures to prevent or mitigate natural disaster risk can reduce the cost of disaster response and recovery, by addressing underlying vulnerabilities and reducing natural hazard exposure. Government policies and programmes can also encourage stakeholders to identify disaster risks to their own assets, address gaps in their resilience levels. In Japan, the risks identified in the national DRM frameworks are the focus of agricultural prevention and mitigation measures for natural hazard risks. Risk prevention and mitigation efforts related typhoon and heavy rain include structural and non-structural measures. Efforts also include policy initiatives to help mitigate the impacts of natural hazards on rural communities and support the uptake of financial risk mitigation tools.

- *Three-Year Emergency Response Measures, Five-Year Acceleration Measures:* The government set a wide range of targets for the agricultural sector for risk prevention and mitigation to avoid future damage given increasing occurrence of natural hazards, including maintaining infrastructure systems such as irrigation facilities and reservoirs; strengthening dams; erosion control; and ensuring power supplies, as well as the creation of damage prevention plans.
- *Act on Agricultural Reservoir Management and Conservation:*[5] Based on the risk assessments carried out on agricultural reservoirs, the Act clarifies the responsibility of reservoir owners and local authorities to manage local agricultural reservoirs. Under the act, NARO developed a database that includes real time data and projects water levels, spill, and inundation areas in case of agricultural reservoir failures, and facilitates the rapid sharing of disaster information (NARO, 2020[7]). The act also requires municipalities to develop hazard maps with the name and location of designated agricultural reservoirs that may impact residential areas if they collapse, and make those maps publically available so that the municipalities can provide local residents with the information necessary for making evacuation decisions.
- *Flood warning system*: the *Flood Control Act* [6] and the *Sediment Disaster Prevention Act*[7] cover rivers subject to Japan's flood warning system and water-level notifications. Municipalities are encouraged to prepare flood hazard maps indicating areas likely to be damaged, along with evacuation routes and sites, and disseminate these maps among their communities. These maps are not specifically for the agricultural sector, but farmers may use the maps for land-use decisions and evacuations.
- *Farm-level initiatives*: Traditional prevention and mitigation activities used in rural communities for flood and landslide are nature-based solutions, such as maintaining forests to prevent soil erosion, planting pine trees along the coast to mitigate wind and sand blow, and planting bamboo trees along riverbanks to reduce flooding, while rice paddy fields can be effective in retaining rainwater, mitigating flood risk (Box 7.3).
- *Insurance*: MAFF offers subsidised natural hazard insurance for commodity yield losses and production equipment, and revenue insurance that compensates farmers for revenue losses relative to a benchmark based on the previous five years' revenue. In some cases, the government requires farmers to have insurance in order to qualify for *ex post* disaster support. Insurance take-up is highest for field crops and cattle (MAFF, 2020[8]).

Box 7.3. Paddy field dams

Rice paddy fields can naturally help to reduce flood risks by retaining and slowing the flow of water. But farmers can further increase the natural water storage capacity of their paddy fields by installing a simple runoff control device. With this, rainwater is temporarily stored in the paddy field during and after heavy rainfall, and the water is slowly drained over time, preventing a rapid rise in water levels in rivers and drainage canals. These initiatives can reduce the flood risks to downstream communities. Now supported by the Five-Year Acceleration Measures, the government aims to increase the areas of paddy field dams through using payments for non-commodity outputs (multi-functionality) (Cabinet Secretariat, 2021[9]).

Risk preparedness and awareness

Ex ante disaster preparedness and planning are crucial for effective crisis management – by public and private stakeholders with a role in disaster response, and on farms. In general, risk preparedness in Japan is co-ordinated systematically across the country. For example, National Disaster Prevention Day is observed every year with educational events and drills conducted nationally to prepare for when a major

natural hazard strikes. The Japan Meteorological Agency (JMA) gathers, reports and forecasts weather data and also monitors weather-related risks (JMA, 2020[10]). These forecasts are broadcast widely, helping to keep all citizens informed about conditions before typhoons and heavy rain arrive.

MAFF issues technical guidance for farmers based on JMA's weather information to help prevent on farm damage (MAFF, 2020[11]). Further, MAFF's newly created natural hazard information page on its website and smartphone application provide farmers preparation information (MAFF, 2020[12]). The government also encourage the agricultural sector to establish contingency plans (Cabinet Secretariat, 2019[13]; MAFF, 2021[14]; MAFF, 2021[15]). On horticultural facilities, a wider risk awareness campaign is conducted during Disaster Resilient Horticulture Months (MAFF, 2018[16]). JA and prefectures have also prepared material on building horticultural facilities that are more resilient to typhoons and heavy rain.

Japan's farmers also have access to public extension services to solve challenges specific to the region. Advisors provide support on diverse topics, including on adoption of new technologies and good practices through on-site consultation and small group activities. However, it is not clear if advisors provide advice on how to prepare for typhoons and heavy rain.

Disaster response and crisis management

Effective crisis management and response hinge on all actors knowing their responsibilities in the event of an emergency and communicating effectively, with the public sector taking a leadership role when the private sector is unable to cope. In crisis situations in Japan, public sector actors play an active role from risk notification to disaster response and co-ordination. JMA issues warnings and advisories, which are usually region-based as well as flood forecasts and landslide warnings, helping farmers take action ahead of typhoons and heavy rains. Crisis governance involves a well-defined and yet flexible distribution of responsibilities. Municipal governments have the primary role for responding to natural disasters. However, if the scale of a disaster is large enough, the national government implements emergency measures immediately under the structured DRM system, by first setting up an emergency response team composed of senior-level officials from each ministry and agency that participates in the Crisis Management Centre of the Prime Minister's Office.

MAFF also aims to minimise the vulnerability of farming communities during a crisis. To ensure an effective response against typhoons and heavy rain, MAFF co-ordinates the disaster response for the agricultural and agro-food sectors, with priority to collecting information from the affected areas to identify the needed assistance. Farmers communicate with municipalities, prefectures or JA regarding the damage sustained, strengthening the links between the ministry, local authorities, and farmers. MAFF is also responsible for providing emergency relief food and water supplies to affected regions during a NHID, since the preservation of life is a priority.

Recovery and reconstruction

Following a NHID, recovery and reconstruction efforts also offer an opportunity for public and private stakeholders to "build back better"[8] by addressing underlying gaps in resilience, and building the capacities needed to manage natural hazards in the future (FAO, IFAD, WFP, 2019[17]). This requires all stakeholders – including producers – to learn from NHID in order to adjust DRM frameworks, policy measures and on-farm strategies with a view towards long-term resilience (OECD, 2014[18]; OECD, 2020[5]). In addition to all-sector support packages provided by the government to ensure a smooth recovery after a NHID, for disasters designated as "extremely severe", the government provides support to reduce the financial burden on municipal governments and to facilitate more rapid recovery and reconstruction efforts. The government now announce the prospects for a designation as early as a week after the termination of a NHID, allowing affected local governments to start recovery projects promptly without concerns over financial uncertainties.

MAFF emphasises the need for swiftness of recovery and reconstruction. MAFF safeguards and rebuilds agricultural and rural livelihoods as quickly as possible by implementing its own ad hoc support programmes to facilitate continuation of farming operations. Recovery and reconstruction measures for the agricultural sector can include infrastructure reconstruction, repair or replacement of production equipment, asset recovery and rebuilding of farmer livelihoods, and support programmes are adjusted to suit the conditions of each disaster. As a result, programme triggers remain flexible (i.e. there are no specific criteria).

Nevertheless, affected areas often struggle to repair infrastructure damage, as activities such as removing mud, debris and driftwood from agricultural fields require substantial physical labour. One feature of Japan's recovery and reconstruction process is that a wide range of actors take part. In particular, volunteer work has become essential to the swift recovery from disasters. Prefectural governments also co-ordinate among themselves to help affected prefectures. For example, the prefectures created a system to pair up prefectures and help the partner prefecture recover from a large-scale NHID.

JA focuses its efforts on the recovery and reconstruction phase of DRM cycle. The bulk of JA's post-disaster efforts are focused on restarting farming operations and maintaining members' livelihoods. JA Zenchu, headquarters of JAs sets up the central emergency task force to co-ordinate recovery efforts, including communicating with the government on damage and the assistance needed. JA Bank (the financial section of JA) provides special loans for rebuilding houses and livelihoods. JA Kyosai (the insurance section of JA) is committed to providing prompt pay-outs, including through the simplification of procedures to members in affected communities and by extending the date of premium payment.

In the time of a disaster, agricultural extension services can also support recovery by working side-by-side with farmers (Cathey et al., 2007[19]; Boteler, 2007[20]). Agricultural extension advisors conduct on-site visits to evaluate the damages and loss and assess conditions in farming communities, including the extent of damage to land, infrastructure, machinery and cultivated products. This two-way interaction also helps alleviate farmers' psychological distress and the sense of isolation stemming from income and agricultural asset loss.

7.4. Resilience successes and opportunities

In line with the four principles for resilience to natural hazard-induced disasters in agriculture, Japan's systems for natural hazard risk management – and typhoons and heavy rain management in particular – demonstrate a number of positive developments and good practices, as well as some challenges that provide opportunities for future improvement.

An inclusive, holistic and multi-hazards approach to natural hazard risk governance for resilience

- Disaster risk management frameworks in Japan are comprehensive and explicitly recognise the need to improve the agricultural sector's resilience to large-scale natural hazards, confirming the government's clear commitment to this objective. The agricultural sector is fully integrated into overarching frameworks for governing disaster risks, and explicitly stated targets and priorities for managing hazard risks and building resilience in the frameworks facilitate investments and the implementation of an array of agricultural DRM and resilience building programmes.
- Japan's disaster risk governance is flexible, responsive and adapts to evolving hazard risks. Resilience gaps are identified through vulnerability assessments and detailed data on damage and losses. Japan also emphasises improving DRM frameworks. The responsibilities of different ministries and jurisdictions are clearly defined, which leaves little space for areas where

responsibility is unclear within governments and also facilitates co-operation between different national and local jurisdictions.

- However, the roles and responsibilities of agricultural stakeholders at all stages of the DRM cycle could be more clearly defined. Policy frameworks do not define the responsibilities of private actors, including farmers, to prevent, mitigate and prepare for natural hazards. Clarifying the responsibilities of agricultural actors to prevent and mitigate the risks and impacts of natural hazards would also encourage farmers to undertake additional risk management activities, with *ex post* assistance provided only when a particular disaster event is beyond their capacity to manage.

A shared understanding of risk based on the identification, assessment and communication of hazards, vulnerability and resilience capacities

- Risk and vulnerability assessments drive disaster risk reduction activities, but data on agricultural losses could be used more extensively. Japan regularly reviews hazard risks and vulnerabilities when developing and revising DRM frameworks and systems, ensuring responsiveness to a changing risk landscape. Japan has comprehensive data on damage and losses and used mainly for marshalling *ex post* support. By revealing the extent to which natural hazards affect agriculture, these data are also an important input into on-farm decision-making, including on where and how to prioritise investments.
- Effective risk communication with agricultural and rural stakeholders is important to enhance stakeholders' understanding of their specific risk exposure. Detailed and well-advanced warning systems, flood and hazard maps, and regional evacuation plans are all available in Japan. But older farmers may not understand the evolving risks due to the complexity or technicality of information, resulting in unpreparedness. The extension service are also available and there is an opportunity to play more active role in communicating the consequences of NHID risks to farmers and ensuring that constraints raised by farmers are understood and addressed by government officials formulating response plans.

An ex ante approach to natural hazard-induced disaster risk management

- *A combination of structural and non-structural measures target improved risk prevention and mitigation*. Japan is making substantial investments in improving agricultural infrastructure (e.g. rehabilitation of reservoirs; erosion control; installing power supplies) and maintenance systems (e.g. creation of hazard maps, damage prevention plans), but ageing farmers and depopulation in rural areas present a challenge for managing ageing infrastructure. There are opportunities for traditional nature-based prevention and mitigation activities in rural communities for flood and landslide as they can be physically effective and cost-efficient.
- *Risk management tools have been reoriented to priotise tools that are defined ex ante rather than rely on ex post assistance.* However, despite generous premium subsidies and promotion of commodity and revenue insurance programmes, the proportion of farmers subscribing to insurance remains low. Understanding why farmers do not subscribe to insurance would improve programme design rather than rely on further participation using subsidies.
- *Older farmers can have significant experience and the experience of farmers and regions in risk management could be an asset for building resilience more widely, but on-farm efforts could be strengthened*. However, the sector's ageing demography, small farms and off-farm income may also mean that farmers may have a limited drive for modernisation and innovation, and lower capacity to manage risk using new risk management tools or make use of technical information and may not have the incentive to make investments for managing risk in the long term.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazard-induced disasters

- Japan's policies support rapid response and recovery but may discourage farmers from taking steps to reduce their vulnerability to future risks. The swift provision of *ex post* support to facilitate a rapid recovery are a hallmark of Japan's DRM system, which provides comprehensive financial safety nets to help producers return to farming as quickly as possible. A fast response during a crisis is enabled by Japan's well co-ordinated governance arrangement across ministries and agencies, local authorities and public institutions. Building back better is also an integral part of the post disaster reconstruction approaches in Japan. However, given generous support and undefined criteria for when the government provides agricultural disaster assistance, farmers tend to rely on *ex post* government assistance. The policy challenge lies in encouraging farmers to take responsibility for building their resilience, while ensuring that support to help farmers rebuild infrastructure and facilities reflects the principle of building back better.
- *Japan's regions have significant experience with a range of natural hazards*. But extreme weather conditions overwhelm the capacity of many (largely small) municipalities and areas with less experience managing typhoon and heavy rain risks. More efforts to establish networks to share the information and capabilities of more experienced regions is becoming more important.

7.5. Strengthening risk management in Japan

Japan's DRM systems for agriculture offer many examples of good practices for building the sector's resilience to typhoons and heavy rains, but there are opportunities for both public and private stakeholders to further build the resilience of the sector to NHID:

- *Address the implications of the socioeconomic and demographic changes in rural communities in Japan's agricultural DRM policy frameworks*:
  - Such a strategy should acknowledge the current condition of infrastructure and the capacity of rural communities and individual farmers to make improvements, including that some farmers have different objectives and older farmers in particular may need additional support in order to build their resilience capacities and increase their preparedness for natural hazards.
  - More frequent infrastructure evaluations, changes in management processes and reconfigured institutional arrangements should be considered. Also, natural defences such as paddy field dams, which are a cost-effective option for flood risk mitigation should be promoted more. Government should also mobilise the extensive data on damage and losses to inform investments in risk prevention and preparedness by all stakeholders, including farmers.
- *Encourage farmers and other private sector actors to take responsibility for their own DRM*. Resilience-building efforts appear to be driven by government mandates and generous disaster assistance may make farmers over reliant on *ex post* assistance, such that the incentive to adapt or transform in response to the changing risk landscape is blunted. Defining the triggering criteria and types and level of government support in advance would provide farmers with a clearer incentive to invest *ex ante* in preparedness capacities, risk prevention and mitigation measures.
- *Farmers' roles in and responsibilities for DRM could be clarified through comprehensive communication on natural disaster risks to farmers*. Public extension services are particularly well placed for this outreach, as they understand both national policies and local conditions. Proactive engagement with other agricultural stakeholders such as JA and the private sector should be integrated into resilience-building efforts across the DRM cycle to support a more cohesive sectoral response.

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Notes

[1] See Shigemitsu and Gray (2021[24]).

[2] The official name of the Act is Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry.

[3] The latest revision of the Plan, which took place in May 2020 following Typhoons Faxai and Hagibis in 2019, enhanced provision of river and weather information and support for local governments that are not accustomed to dealing with large-scale storms (Cabinet Office, 2020[22]).

[4] "Damage" refers to the total or partial destruction of physical assets and infrastructure in disaster-affected areas, expressed as replacement or repair costs. "Losses" refer to the changes in economic flows or revenues arising from the disaster (FAO, 2016[21]).

[5] Enacted in April 2019 (Act No. 17 of 2018).

[6] Act No. 193 of 1949.

[7] Act No. 57 of 2000.

[8] Building back better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR, 2015[23]).

8 Building agricultural resilience to animal pests and diseases in Namibia

This case study focuses on Namibia's *ex ante* approach for preventing, controlling and managing animal pest and disease outbreaks, which are often exacerbated by climate-related disasters such as floods and droughts. The chapter explores the good practices implemented by Namibia to reduce disaster risks, including: controlling livestock movement through a zoning strategy and movement permits; conducting import risk assessments; disease monitoring and surveillance; an animal identification and traceability system; undertaking annual vaccinations; and contingency plans. By implementing these measures, Namibia more effectively prevents, controls and manages animal disease outbreaks so that people's food security, incomes and livelihoods are secured; and ensures that Namibia's meat is disease free and meets safety standards in export markets; and guarantees public health by preventing the transmission of zoonotic diseases between wildlife and livestock, and then to humans.

Key messages

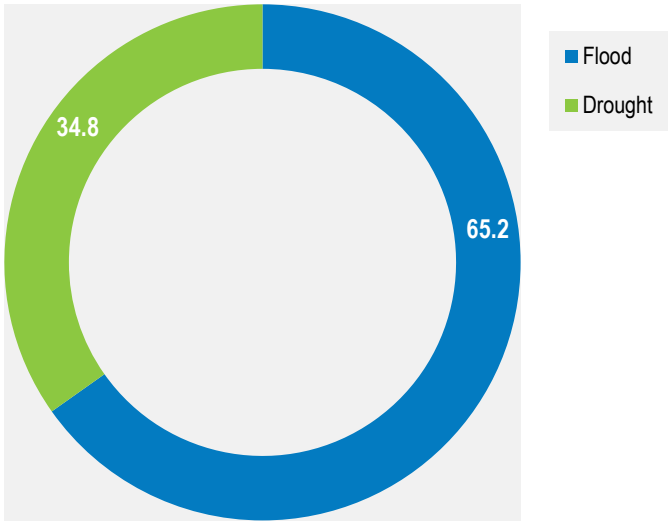
- Namibia's agriculture sector is impacted by natural hazard-induced disasters, such as floods, droughts and veld fires. In particular, the climate related disasters are further exacerbating the outbreak of animal pests and diseases.
- Besides their adverse impacts on ecosystems, fodder and food supply, floods and droughts also negatively impact animal health. These natural hazards-induced disasters often lead to increased animal movements towards higher lying and more fertile areas in the north of the country, and across the border with Angola where wild buffaloes carrying Foot and Mouth Disease, freely mingle with livestock and thus, enhance livestock's risk to infection. Moreover, heavy rains lead to increased humidity levels, which increases vector-borne diseases, such as Rift Valley Fever, while droughts can lead to the reduced availability of fodder and heat stress in livestock, which also enhances the susceptibility to animal related pests and diseases.
- The country has adopted an *ex ante* approach to prevent, control and manage animal diseases through the implementation of good practices such as controlling movement of livestock through a zoning strategy, movement permits, use of an animal identification and traceability system, conducting import risk assessments as well as through disease monitoring and surveillance, undertaking annual vaccinations and contingency plans. Implementing these measures help to prevent, control and manage animal disease outbreaks, which is essential for people's food security, incomes and livelihoods as well as to ensure that Namibia's meat is disease free and meets safety standards to be traded in international markets and to guarantee public health so that zoonotic diseases are not transferred between wildlife and livestock and then to humans

8.1. Background

Natural hazards-induced disasters

Namibia is adversely affected by natural hazards, such as floods, droughts and veld fires, among others. According to the international disaster database from the Centre for Research on the Epidemiology of Disasters, during the 1982-2019 period, a total of 23 disasters were recorded, of which nine droughts and 14 floods that affected over 350 000 people and caused USD 195 million in total damages. Among these, the major disasters that affected over half a million people included the 2011 flood as well as the droughts of 2013-2014 and 2015-2016, which impacted 780 000 and 580 000 people respectively. The year 2019 was the driest in 90 years and significantly affected the livestock sector and people's livelihoods. In terms of the frequency of natural disasters, floods have occurred 65.2% more frequently compared to droughts during the 1990-2014 period (Figure 8.1). The mortality of the disasters during the 1990-2014 period is 100% due to floods, while the economic losses are estimated to be 89.5% the result of droughts and 10.5% due to floods (OFDA-CRED, 2020[1]).

Figure 8.1. Frequency of natural hazard-induced disasters in Namibia, 1990-2020



Source: PreventionWeb (2020[2]).

Extreme weather events have increased in frequency and severity in recent years and are expected to intensify as a result of climate change. In particular, a rise in the number of hot days, heat waves and droughts are expected (Ministry of Environment and Tourism, 2010[3]). It is also anticipated that climate change will alter the distribution, incidence and intensity of animal and plant pests and diseases (FAO, 2008[4]).

A key challenge that Namibia is facing, is the co-existence of domestic livestock with the large wildlife population in the fertile area around the northern border with Angola. Certain wildlife, such as wild buffaloes that are grazing there are carrying Foot and Mouth Disease (FMD) and during droughts, due to the unsupervised and open nature of this border area, Namibian farmers may let their cattle graze there, where they congregate and mingle with these buffaloes, which increases their risk to get FMD. Managing these livestock movements is thus crucial to ensure that domestic animals are not infected.

Animal pests and diseases, such as Foot and Mouth Disease, Contagious Pleuropneumonia (CBPP – lung sickness), lumpy skin disease, anthrax, Brucellosis, Rift Valley Fever, pose a major threat to Namibia's livestock sector as an outbreak can negatively impact the entire country's livestock production, productivity and access to export markets and thereby affect and undermine local food security and livelihoods. Livestock production contributes to over two-thirds (67.6%) of Namibia's total agricultural output, of which cattle is the largest contributor (51.7%) (Ministry of Agriculture, Water and Forestry, 2019[5]). Due to the importance of meat and meat products for the country's export earnings, particularly beef that is exported to, among others, South Africa, European Union, United Kingdom, and Asia, ensuring that meat is disease-free is thus crucial to meet international food safety standards. Implementing appropriate, adequate and effective measures to prevent, control and manage disease outbreaks is therefore essential, not only to ensure farmers' incomes and thus food security and livelihoods, but also to ensure public health so that some of these zoonotic diseases are not transferred between wildlife and livestock and then to humans.

Impact of natural hazard-induced disasters and animal pests and diseases on agriculture

The excessive rains and flooding that occurred in February/March 2009 across Angola, Zambia and Namibia, substantially affected seven regions in the northern and eastern central regions of the country. Moreover, these floods aggravated the impacts of the 2007 drought and the 2008 floods, especially on subsistence farmers and resulted in damage and losses to crops and livestock, particularly in the low-lying areas. It was estimated that total damage and losses amounted to USD 136.4 million and USD 78.2 million, respectively, of which nearly 3.5% and 20% were damage and losses to the agriculture sector and approximately 163 000 people required immediate food security assistance (FAO/WFP, 2009[6]).

During the last few years, Namibia has been affected by recurring droughts, caused by erratic and below normal rainfall during the 2013/2014, 2014/2015 and 2015/2016 rainfall seasons, which severely impacted agricultural production in most parts of the country and particularly in the communal areas (Ministry of Agriculture, Water and Forestry, 2017[7]). For instance, according to an assessment conducted in August 2016, the average crop losses for maize were between 73 and 85% in the northern border region with Angola due the impact of this *El Niño* induced drought (FAO, 2016[8]). Moreover, as mentioned earlier, 2019 was the country's driest year in 90 years, which resulted in a 53% decline in the cereal harvest compared to last season's harvest and over 42% below compared to the 20-year average production, while over 59 000 head of cattle died due to inadequate grazing (Ministry of Agriculture, Water and Forestry, 2019[9]; FAO, 2020[10]).

The drought of 2014/2015 also led to farmers in the Northern Communal Areas to move their livestock into Angola in search of water and pastures for grazing, which led to an outbreak of FMD in 2015 after an absence of almost 27 years. Due to the open border between both countries, the Namibian cattle congregated and mingled with the wild buffaloes, some of which carrying FMD. In total, 264 cases at 28 foci were recorded of cattle with signs of FMD. In order to control the outbreak, a total of 600 000 cattle were vaccinated in two rounds, which represented a vaccination coverage of 90.2%. The outbreak was declared over in Namibia in August 2015 and in April 2016 on the Angolan side (OIE, 2016[11]).

The country experienced an outbreak of Rift Valley Fever (RVF) between May to July 2010. RVF is a virus transmitted by mosquitos and primarily affects livestock, such as cattle, sheep, goats and wild ruminants like buffalos. It is considered a zoonotic disease as it has the capacity to infect humans. This outbreak was caused by a strain of RVF virus closely related to virus strains that were responsible for the outbreaks in South Africa during 2009-2010, where over 14 000 cases and the death of 8 000 animals were reported. This large RVF outbreak in South Africa was attributed to heavy rainfall during January-February 2010. In Namibia, it resulted in the mortality of 2 019 sheep and the morbidity of 35 000 sheep and goats. It led to the vaccination of 130 000 sheep and 67 000 goats (DVS, 2011[12]; Monaco et al., 2013[13]).

Among the expected impacts of climate variability and change on agriculture, are the increase of irrigation demands due to rising temperatures, spatial changes in the optimum growing regions for field crops and forestry, reduction in yields of rain-fed crops, including maize, sorghum and millet and the increasing risks of floods and other extreme weather events that will negatively impact crop production. Moreover, the increase in temperatures will adversely affect livestock production and productivity, especially in the southern and central regions. In addition, through the increase in the emergence and outbreak of animal and plant pests and diseases, which may negatively affect, for example, the quantity and quality of feed, heat stress in animals and their susceptibility to livestock related pests and diseases (Republic of Namibia, 2020[14]).

8.2. Namibia's risk governance framework

Namibia's National Disaster Risk Management System (NDRMS) consists of various key institutions, of which the Office of the Prime Minister has the overall responsibility for the operation of the NDRMS and maintains the Directorate for Disaster Risk Management (DDRM). DDRM is mandated to coordinate the disaster risk management activities and provide support to the regional, constituencies, settlement and local authorities disaster risk management (DRM) committees and serves as the Secretariat to the National Disaster Risk Management Committee. It thereby serves all government offices, ministries and agencies at national, regional and municipal level as well as relevant statutory bodies, private sector, communities and other non-state actors who are involved in disaster risk management in the country. Representatives from the Ministry of Agriculture, Water and Land Reform (MAWLR) are included in the DRM committees at all levels (Table 8.1).

Table 8.1. Disaster risk management frameworks for agriculture in Namibia

	Disaster Risk Management	Agriculture Risk Management
Primary responsibility	OPM-DDRM	Ministry of Agriculture, Water and Land Reform
Main policy documents	National Disaster Risk Management Policy (2009)*^ National Disaster Risk Management Plan (2011)*^ National DRM Framework and Action Plan 2017-2021 (2017)*^ National Strategy for Mainstreaming DRR and CCA into Development Planning in Namibia 2017-2021 (2017)*^ National Drought Policy and Strategy (1997)*^ National Drought Relief Response Plan (2013)*^ National Drought Policy draft of 2017*^ National Policy on Climate Change for Namibia (2011)*^ National Climate Change Strategy and Action Plan 2013-2020 (2013)*^ 5th National Development Plan 2017/18-2021/22 (2017)*^ Namibia Vision 2030 (2004)*^	Namibia Agricultural Policy (2015)* Strategic Plan for the Ministry of Agriculture, Water and Forestry 2017/18-2021/22 (2017)*
Contributing agencies, government bodies	Disaster Risk Management Committees at national, regional, local authorities, constituency and settlement levels National Vulnerability Assessment Committee National Focal Persons Forum Namibia Meteorological Service	Namibia National Farmers Union Namibia Agricultural Union Namibia Emerging Commercial Farmers' Union Directorate of Veterinary Services Directorate of Agricultural Engineering and Extension Services Meat Board of Namibia

* The mainstreaming of DRR/M and specific measures into these policies, plans and strategies.
^ The integration and prioritization of agriculture into these policies, plans and strategies.

Namibia has an extensive number of national disaster risk reduction/management (DRR/M) and sectoral policies, plans and strategies, in which agriculture and DRR/M is mainstreamed (Table 8.1). With regard to the prevention, control and management of animal pests and diseases, some of the DRR/M measures, such as the development of improved and well adapted livestock breeds, the implementation of good animal husbandry and health practices – like vaccinations and the control of (transboundary) animal movements and animal disease surveillance – are included in the country's 2015 Agricultural Policy and in the 2017 Strategic Plan for the Ministry of Agriculture, Water and Forestry 2017/18-2021/22. The country is currently finalising its first sector-specific DRM strategy for agriculture led by the MAWLR and is updating its 1997 national drought policy based on lessons learned from the 2018/2019 drought.

8.3. Resilience successes and opportunities related to animal pest and diseases

The following section describes the various DRR good practices that Namibia is implementing to prevent, control and manage animal disease outbreaks, which are significantly influenced by the occurrence of natural hazard-induced disasters. These types of disasters, such as floods and droughts, negatively affect the health of animals through enhancing their susceptibility to livestock diseases. Through the implementation of *ex ante* measures, the resilience of the livestock sector to animal pests and diseases is enhanced in Namibia.

Risk identification, assessment and awareness

Disease monitoring: Passive and active surveillance

Animal disease surveillance is an important activity to assess the occurrence or continued absence of animal diseases in a country. Namibia is implementing both active and passive surveillance strategies to monitor diseases. Passive surveillance includes *inter alia* the treatment of animals at veterinary clinics and on farms, the inspection of animal gatherings, such as auctions, livestock shows and exhibitions, the inspection of imported cattle and those that will be exported, ante and post-mortem inspections at slaughterhouses, farm, and community visits according to an annual farm inspection program and assessment of bi-annual animal health declaration forms by farmers.

Active surveillance programs are in place for FMD, BSE and residues in food. The active detection of a disease involves the collection of blood or tissue samples from suspected animals, which are then screened and tested at the Central Veterinary Laboratory. If this laboratory screening capacity does not exist in the country, arrangements are made to send the samples to regional and international collaborating laboratories for disease confirmation. Surveillance data and laboratory results are provided to the Epidemiology subdivision of the Directorate of Veterinary Services (DVS) for analyses and reporting, which enables evidence-based decision-making with regard to animal disease status and appropriate measures to be undertaken.

Namibia Livestock Identification and Traceability System and movement permits

To support the surveillance of animal diseases, the Namibia Livestock Identification and Traceability System (NamLITS), managed by the DVS, has been established in close partnership with the private sector, farmers' organisations, and the Meat Board of Namibia. The system requires that all cattle over six months of age need to be identified with individual ear tags. The acquisition and sale of ear tags is managed by the Meat Board of Namibia on instruction by the DVS for the FMD free zone, whilst DVS manages the tagging of cattle north of the Veterinary Cordon Fence. The traceability system also covers small ruminants, such as sheep and goats, but these are identified as "lots" belonging to individual farmers from the same holding. Once the animal is tagged, registration forms are submitted to DVS or entered online to link the animal identification with a specific holding.

Movement permits are issued by DVS for the recording of animal movements from one registered holding (e.g. farm, abattoir, auction pen or loading facility) to another. A departure register is completed by the dispatching livestock owner and the departure and arrival registers are completed by the receiving livestock owner, along with the endorsed livestock movement permit, which are then returned to the DVS for the reconciliation of the movement. Livestock movement permits are valid for 14 days. A holding may be blocked from receiving further animals if documents are not promptly returned and farmers may be prosecuted should they be involved in illegal livestock movements.

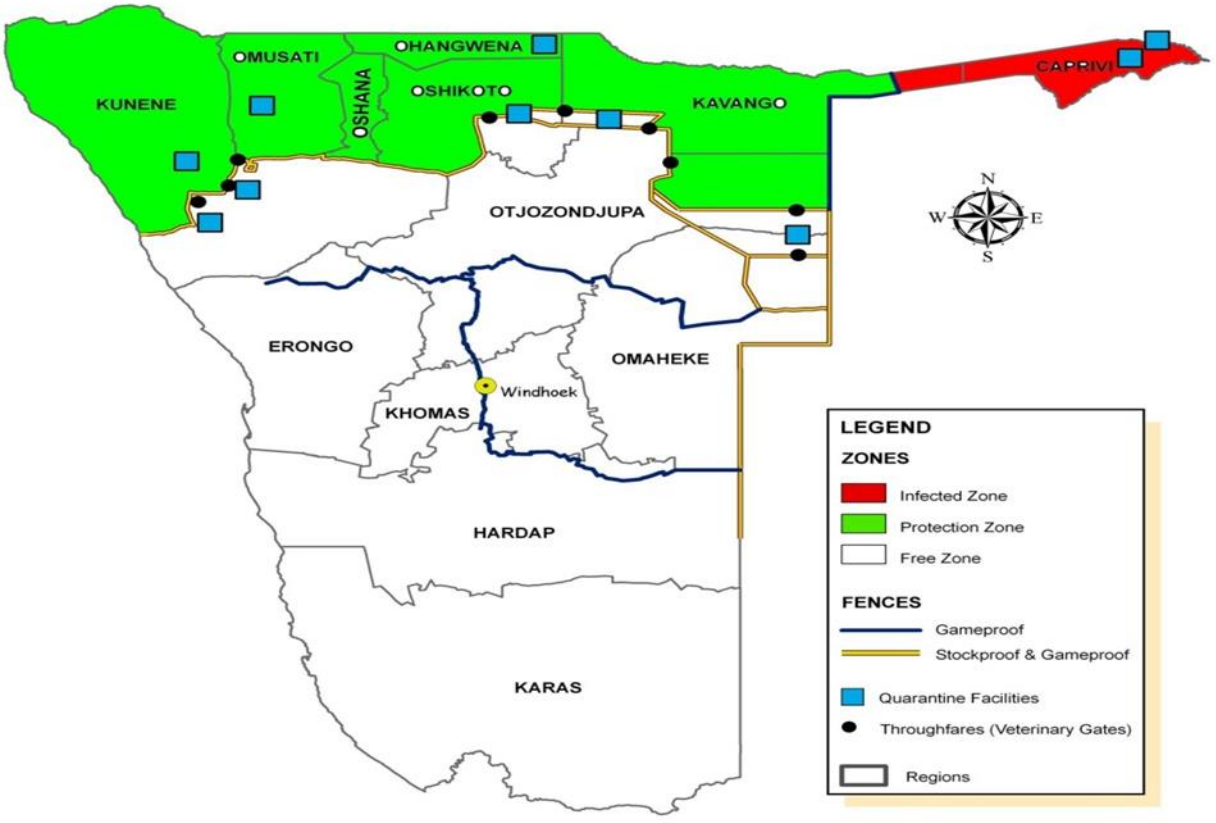
Risk prevention and mitigation

Zoning strategy

Namibia implements zoning strategies as prescribed by the World Organisation for Animal Health (OIE) to maintain distinct animal sub populations in the country with respect to FMD and CBPP. This zoning strategy ensures that some sub populations in the country can benefit from international trade. The country has a Veterinary Cordon Fence (VCF), which is an important feature in the zoning strategy of the country as it divides the country into the "FMD free zone without vaccination" in the south and the "FMD undetermined zone" in the north. The FMD undermined zone is further subdivided into the protection zone and the infected zone, which comprises the entire Caprivi Strip in the north east (Figure 8.2). The "FMD free zone without vaccination" also enjoys OIE-recognised free status from CBPP, Rinderpest, BSE and Peste De Petit Ruminantes – sheep and goat plague.

Figure 8.2. Overview of the different zones in Namibia

With new protection zone



Source: Adapted from Ministry of Agriculture, Water and Forests (2009[15]).

Veterinary Cordon Fence

The Veterinary Cordon Fence was constructed in 1897 and traverses the entire width of the country along the 20th parallel from the Atlantic coast in the west to the border with Botswana in the east. The fence is composed of two separate fences, including an outer 1.2-meter stock proof section to prevent the crossing of domestic animals and a game proof 2.2-meter inner section to prevent wild animals to jump across the

fence. A 9-meter cleared buffer area separates the two fences and there are nine manned and permanent checkpoints along the entire length of the fence to prevent all livestock movement across. In the event of a disease outbreak, these crossings may be closed in order to essentially seal off the FMD free zone from the rest of the country and the African continent. Constant maintenance is undertaken, and the fence is regularly patrolled by the DVS, the police as well as farmers. The latter, due to their proximity to the fences, is able to quickly notify the authorities and be first responders in case of any issues.

FMD free zone

The objective of the FMD-free zone is the early detection and prevention of outbreaks of this animal disease. The FMD free zone is defined by the VCF to the north, the Orange River in the south, the Botswana border to the east and the Atlantic Ocean to the west. It is essentially an enclave on the African continent, as it excludes all contact between domestic and wild animals from other zones or other countries. The north to south movement of livestock, game or livestock products is not allowed across the VCF, but the animals can move in the opposite direction. An FMD free population of 803 African buffaloes is currently present within the confines of the Waterberg Plateau Park (Ministry of Environment, Forestry and Tourism, 2020[16]). These buffaloes are jointly sampled and tested by DVS and the Ministry of Environment, Forestry and Tourism every three years, to reconfirm their FMD-free status. These buffaloes are not allowed to move out of the park, except to be sold to neighbouring countries and no buffalo can be introduced into the park.

Protection zone

The aim of the FMD protection zone is to confine African buffalos in fenced parks. This zone is defined by the VCF in the south, the Kavango River at the Bagani breach in the east, the Atlantic Ocean in the west, and the Angolan border to the north. The fertile area around the Namibia-Angolan border called 'the Cuvelai plains' is used for horticulture production as well as animal grazing by a large diversity of wild and domestic animals. Due to the unsupervised and open nature of the northern border with Angola, livestock can move freely between the two countries as the communities on both sides of the border share close cultural and ethnic ties. However, some of the buffaloes in this area are carrying FMD and during droughts, Namibian farmers may let their cattle graze there, where they congregate and mingle with the buffaloes, which increases their risk to get FMD.

Following the 2015 FMD outbreak, it is evident that the protection zone remains vulnerable given the porous border with Angola and the re-emergence of African buffaloes in that country. The control of this outbreak is an example of the multi-sectoral disaster risk management cooperation as it involved the collaboration from livestock keepers, the police force, DVS, Directorate of Agricultural Engineering and Extension Services, Office of the Prime Minister, Meat Board of Namibia, Meatco, and the Namibia National Farmers Union. Moreover, cross border cooperation was also initiated to coordinate efforts along the border and reduce the spread of the infection. Similarly, the Botswana Vaccine Institute as the supplier of the vaccine, and OIE's regional reference laboratory were closely involved in the diagnosis and provision of the vaccines.

Infected zone

The objective of the infected zone is to maintain a high herd immunity against CBPP and FMD. This zone, which covers the Caprivi strip and includes the eastern part of the Kavango east region and the Zambezi region, is referred to as the infected zone, due to the presence of free roaming buffaloes that are intermingling with cattle. As a result, FMD outbreaks are frequent, particularly in the eastern flood plains when a large number of cattle are trapped on higher lying areas. In order to prevent and control the spread of these diseases, annual mass vaccinations occur three times per year. Outbreaks in this area are mostly due to failure to maintain the vaccination schedule, farmers who are not presenting cattle for vaccination or the mismatch between vaccine and prevailing strains of the virus. To overcome these challenges, close

cooperation is maintained between the producers, veterinary services and the Botswana Vaccine Institute for the supply of vaccines and post-vaccination serosurveillance[1] and vaccine matching.[2]

Annual vaccinations

Annual vaccination of all cattle in the entire country against Anthrax and Brucellosis is mandatory according to the country's Animal Health Act 1 of 2011 and proof of such vaccination needs to be provided to the DVS officials if farmers would like to engage in livestock trade. Moreover, north of the VCF, the government administers the FMD and CBPP vaccine as its control is considered a public good. Vaccination is normally conducted twice a year. Ideally the initial dose must be followed by a booster 30 days apart, however, given the difficult terrain and vast distances that are covered, revaccination occurs on average between 90 and 120 days later. Thus, there is always a concern about the efficiency of vaccination and whether protective immunity is being achieved. The target of such mass vaccination campaigns is to attain 80% vaccine coverage in the animal population. The Act also states that livestock keepers are responsible for the care and preventative vaccination of all their livestock. Thus, livestock raisers may also administer a variety of other vaccines against other diseases, such as black quarter, botulism, Pasteurellosis, and lumpy skin disease as per their annual vaccination programs or on advice of a registered veterinarian.

Disaster preparedness

Contingency planning and simulation exercises

Namibia has contingency plans for FMD, CBPP, BSE and avian influenza, which outline step by step what should be done and by whom during these animal disease outbreaks to ensure the rapid movement from preparedness to action. In addition to this, DVS maintains fully stocked stores in Otjiwarongo, Oshakati and Katima Mulillo, which include items, diagnostic kits, camping material and stationery. These stores are supervised by the chief veterinarians to ensure that the equipment, materials, and inputs are timely replaced and remain ready to be used during an outbreak.

The drafting of the contingency plans involves all relevant stakeholders, and the DVS ensures the routine review of the updating of the contingency plans to the changing prevailing conditions. Real-time or desktop simulations are performed and evaluated to maintain staff and community awareness during times when there are no outbreaks. Currently, there is no defined frequency at which such reviews should take place and reviews are conducted on a needs-basis particularly during and after outbreaks, utilizing feedback from such outbreaks. As a result, the contingency plans for rare or infrequent disease situations are hardly reviewed, simulated or awareness is raised among all relevant stakeholders.

8.4. Strengthening risk management in Namibia

Despite the substantive progress achieved to ensure animal health through the implementation of interventions that help to prevent, control, and manage the outbreak of animal diseases that are exacerbated due to the impact of natural hazard-induced disasters, such as floods and droughts, in Namibia, certain challenges remain that can be addressed. The following recommendations are put forward for consideration:

- *Expansion of NamLITS coverage to include individual identification for sheep, goats, and pigs to support disease surveillance:* NamLITS currently covers cattle as well as small ruminants, but the latter are identified as "lots". Introducing the individual identification for sheep, goats and pigs under the country's livestock identification and traceability system would improve animal disease management, especially for diseases that affect multiple species, such as Rift Valley Fever.

- *Enhance the implementation and enforcement of NamLITS*: enhancing the implementation of the NamLITS north of the VCF, including through applying penalties to offenders, would foster farmers' compliance. More strict enforcement of livestock movement permits and import certification in the northern communal areas would also ensure the early detection and rapid response to prevent and control widespread animal disease outbreaks.
- *Regular revision of animal disease contingency plans and simulation exercises:* conducing regular updates of the animal disease contingency plans that are currently in place and undertaking more frequent simulation exercises, especially in the areas south of the VCF, can help enhance stakeholder's knowledge, awareness, and preparedness to respond to outbreaks in areas where diseases have not been identified for prolonged periods of time. Through the updated contingency plans as well as regular simulations and dry runs, it can be ensured that all relevant stakeholders are aware and have the capacities to carry out their responsibilities during outbreaks. In this regard, it is critical to have updated and logical legal procedures in place that compels stakeholders to act in a predetermined fashion in order to adequately control and manage the outbreak. In this regard, defining a clear hierarchy and roles and responsibilities is key. Roles and responsibilities of stakeholders would also need to be framed under the national legislation. Finally, it could be beneficial to appoint an officer, who would be specifically responsible for contingency planning and outbreak coordination.
- *Encourage regular transboundary cooperation and collaboration with its neighbouring countries:* Namibia could benefit greatly from regular engagement with its neighbouring countries to harmonize animal disease diagnoses, vaccination, and prevention programs. Close regional cooperation on animal disease surveillance and control could foster regional disease freedom.
- *Pursue a gradual northward relocation of the VCF:* implementing robust eradication programs for FMD and CBPP in the northern communal areas is possible through the gradual northward relocation of the VCF. This would allow for the extension of the FMD free zone and allow farmers in the protection zone to also export their beef and mutton to higher value markets (which are currently only accessible to farmers south of the VCF). To address the lack of market opportunities in the NCA with regard to the sale and export of beef, Namibia should promote this commodity-based trade.
- *Secure adequate resources to ensure prevention, control and management of animal disease outbreaks:* Given the importance of the livestock sector in Namibia's economy, it would be important to ensure adequate and continuing funding for the coordination of stakeholders and the prevention, control, and management of animal diseases. Critical activities, such as regular mass vaccination and farm visits, need to be undertaken regularly and its planning and execution could benefit greatly from regular and structured funding sources.

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Notes

[1] Serosurveillance is the detection of vaccine antibodies in the blood after vaccination.

[2] Vaccine matching is comparing the field strain to the vaccine strain.

9 Building agricultural resilience to floods in New Zealand

New Zealand's agricultural sector faces the challenge of building long-term resilience to floods, which are projected to increase due to climate change. This chapter explores the governance arrangements, policy measures and on-farm strategies that currently build the resilience of New Zealand's agricultural sector at each stage of the disaster risk management cycle, and identifies further opportunities that would better position the sector to prepare for, mitigate and manage the risks of floods and other natural hazards.

Key messages

- New Zealand's agricultural sector faces the challenge of building its resilience to storms and floods, which are expected to increase in frequency and intensity due to climate change. Against the background of an agricultural sector that receives only minimal public support, a key question relates to what is an appropriate role for government in strengthening agricultural resilience to floods and other natural hazards.
- The New Zealand policy environment consistently encourages communities and individuals – including farmers – to take responsibility for disaster risk reduction and preparedness, while identifying a more direct role for government in responding to crises and supporting recovery. Key good practices include: an *ex ante* framework to discipline *ex post* assistance to agriculture; incentives for industry groups to develop preparedness resources for farmers; and an emphasis on mental wellbeing following a crisis.
- As the country's policy approach increasingly focuses on resilience and preparedness, there are opportunities to further strengthen the enabling environment for stakeholders to build their resilience capacity to natural hazards, in particular, by: improving data collection, including on impacts from previous events, to support targeted investments in risk prevention and mitigation; and collaborating to develop effective solutions for mitigating the impacts of natural hazards, and to ensure their diffusion in the sector, including through the renewed engagement on extension services.

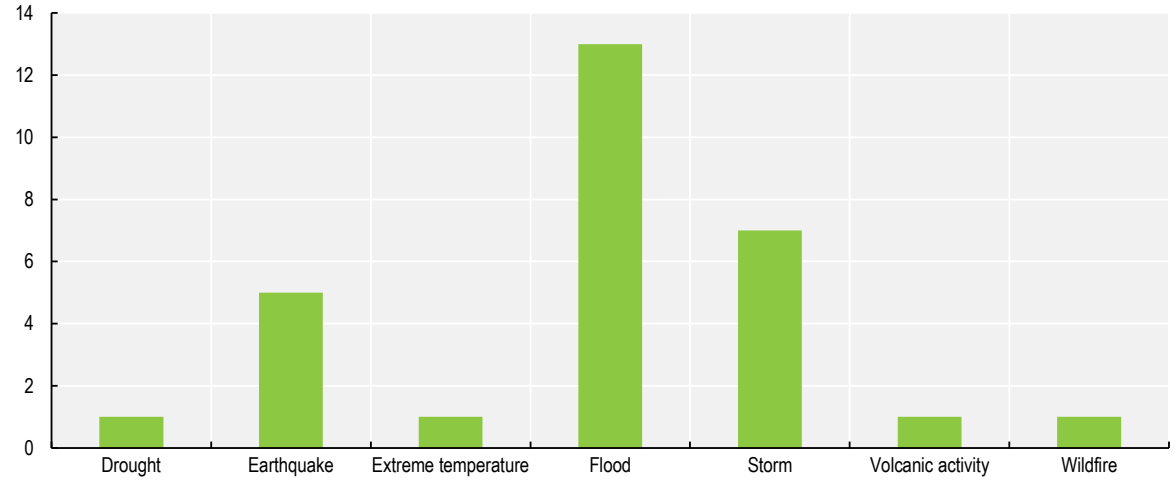
9.1. New Zealand's agricultural sector faces the challenge of building its resilience to more frequent and intense storms and floods

New Zealand's geography and climate expose the country to many natural hazard risks. In particular, floods, the focus of this case study[1], is an increasing challenge for New Zealand's agricultural sector, which is a key contributor to the country's economy. Floods and other weather-related events have become frequent and severe in New Zealand in recent years (Figure 9.1) and climate change is expected to accelerate these trends. According to projected climate change scenarios, government liabilities stemming from storms and floods could increase ten-fold per year from now until 2050 (NZIER, 2020[1]).

The New Zealand Government's policy approach does not foresee specific policy measures for the primary sector compared to other sectors of the economy and policy support for the New Zealand agricultural sector has been the lowest among OECD countries for almost three decades (OECD, 2020[2]). For this reason, producers have significant experience in ensuring the financial viability of their businesses, and in managing natural hazard risk.

Building the agricultural sector's resilience to floods will require effective short-term hazard management strategies, including improved management of increasingly unpredictable weather events, but also investments that will improve the sector's capacity to manage or adapt to these types of events in the long-term. In particular, against the backdrop of an agricultural sector that receives only minimal public support, a key question relates to what is an appropriate role for government in strengthening agricultural resilience to floods and other natural hazards.

Figure 9.1. Natural hazard-induced disaster by type in New Zealand, 2002-2020



Source: CRED (2021[3]).

Over the last decade, the New Zealand government and key agricultural stakeholders have implemented several changes to how they approach natural hazard risk management, improving the capacity of the sector to plan for, cope with, and recover from flood and other adverse events. This flexibility will continue to be important to ensure the resilience of New Zealand's agricultural sector to a shifting risk environment.

9.2. Governance frameworks

In New Zealand, natural hazard risks in agriculture are managed though the combined efforts of public and private actors (Table 9.1). Agriculture receives limited sectoral support from the government, and key disaster risk management frameworks are whole-of-government and all-hazard. As a result of the country's devolved governance model, the primary responsibility for managing natural hazard risk lies with producers, and local and regional authorities. National frameworks focus on ensuring individuals have the tools and ability to understand the risks they face, and the necessary capacities to prevent, mitigate and prepare for natural hazard-induced disasters (NHID). A more direct, but limited, role for government is foreseen in responding to crises and supporting recovery (New Zealand Legislation, 2002[4]; 1991[5]; 1993[6]).

In New Zealand, the Civil Defence and Emergency Management (CDEM) legislative framework sets out the broad frameworks for governing risk across four areas of activity known as the "4 Rs" – reduction, readiness, response and recovery (New Zealand Legislation, 2002[7]; 2015[8]; Director of CDEM, 2015[9]). In particular, a system of "lead" and "supporting" agencies exists for managing different types of hazard. Geological and meteorological hazards, including storm surges and floods, and infrastructure failure, are under the leadership of the National Emergency Management Agency (NEMA), and its regional CDEM Groups, and regional and local authorities. In case of floods, MPI is a supporting agency but rural advisory groups have formed in several regions to provide a platform for communication and co-ordination among public and private stakeholders, including agricultural actors, at the response stage for any type of hazard that affects rural areas.

Table 9.1. Disaster risk management governance in New Zealand agriculture

	Key governance frameworks			
	Disaster risk management	Agricultural risk management	Disaster risk management	Water governance
	Disaster risk management	Agricultural risk management	Agricultural policy	Industry-led arrangements
Primary responsibility	Civil Defence Emergency Management (CDEM) (local, regional, national)	Ministry for Primary Industries (MPI)	MPI	Beef + Lamb NZ, Dairy NZ, Federated Farmers, Zespri, etc.
Key policy documents	Resilience Strategy (10 yrs); National CDEM Plan (5 yrs);	MPI Primary Sector Recovery Policy	Sustainable Land Management and Climate Change; Hill Country Erosion Programme; Productive and Sustainable Land Use package, etc.	Sustainable Dairying: Water Accord; Land and Environment Plans; etc.
Contributing agencies/ government bodies	Other ministries and agencies, as relevant	Rural Support Trusts Ministry of Business, Innovation and Employment (MBIE) Inland Revenue Department of Internal Affairs Regional CDEM Groups Ministry for the Environment	Local governments MBIE Crown Research Institutes	MPI CDEM MBIE

In parallel, the Ministry for Primary Industries (MPI) administers some agriculture-specific funds and frameworks that support on-farm capacity building (MPI, 2020[10]), including through dedicated programmes for Māori communities (Box 9.1), and a framework to provide recovery support to primary producers after an adverse event affects the rural sector. This sectoral assistance is limited and proportional to the magnitude of the event, and often takes the form of psychosocial support for farmers to overcome challenges and speed up recovery (MPI, 2019[11]).

Box 9.1. Engaging with Māori culture to strengthen agricultural resilience

Māori resilience is an important component of the resilience of the New Zealand primary sector. Māori land is particularly susceptible to natural hazards, as it tends to be prone to erosion, exposed to flooding, and have limited access to sources of water. At the same time, certain Māori cultural specificities (for example, that land management is based on traditional knowledge and co-ownership, and Māori may not wish to sell land or relocate) suggest that a tailored approach may be needed to build resilience. In this context, the Māori Agribusiness: Pathway to Increased Productivity and the Māori Agribusiness Extension Programme are targeted government programmes to support Māori landowners achieve their economic, environmental, social and cultural aspirations.

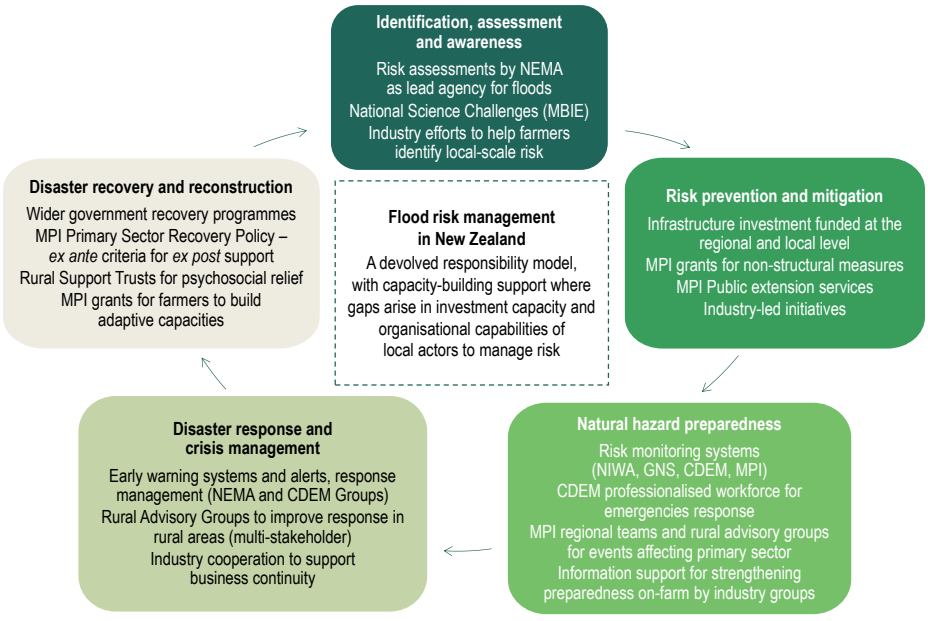
At the same time, Māori knowledge can also contribute to sustainability through regenerative agriculture and 'te teaiao' - a deep relationship of respect and reciprocity with the natural world across generations. In this sense, MPI is developing a framework to leverage traditional Māori knowledge to increase the overall sustainability and resilience of the country's whole agricultural sector.

Against this background, industry groups such as Beef + Lamb NZ and Dairy NZ also play a key role in disaster risk management for New Zealand's agricultural sector, supporting farmers with information and programmes that improve their capacities to plan, prepare for, respond to, and recover from, a range of risks.

9.3. New Zealand's disaster risk management system includes innovative approaches and good practices

Resilience to NHID is an outcome of measures put in place before, during and after an extreme event, such as a flood. Different measures are typically instituted by different actors, with some measures more effective at managing the impacts of specific risks, while other measures contribute to building resilience to a variety of known and unknown risks more broadly (OECD, 2020[12]). In New Zealand, the resilience of the agricultural sector is shaped by the efforts of a range of public and private actors to manage natural hazard risk across society, and specifically for the sector. Accordingly, activities under the four frameworks at each stage of the DRM cycle (risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction) are considered to identify good practices that contribute to building resilience, as well as the opportunities to position the sector to better prevent and mitigate, and prepare for natural hazards, and flood risks in particular (Figure 9.2).

Figure 9.2. Flood risk management in New Zealand across the DRM cycle



Risk identification, assessment, and awareness

Managing natural hazard risk begins with an understanding of the risk environment, to encourage targeted and cost-effective investments in risk prevention and mitigation, and to ensure that policies are in place for hazard management once an adverse event occurs (OECD, 2020[12]). In New Zealand, risk assessments are part of the regular activities of government agencies, regional and local authorities, and research institutions, although none focuses on agriculture specifically. In particular, key risk assessment activities at the include efforts by:

- The National Security System incorporating the Risk Hazard Board, which oversees New Zealand's risks, and assigns risk coordinating agencies (NEMA for floods) to work across systems to identify, assess and manage risks.
- The inter-agency Community Resilience Group, which aims to enhance the use of data in risk assessments at the regional and local authorities' level. Guidelines on risk assessments, soon to be released, detail a comprehensive framework in capacity building for developing datasets to support risk assessments, including elements that are relevant for risk identification in agriculture – for example, collecting data on risks to soil and water quality, livestock and infrastructure (DIA, 2019[13]; LGNZ, 2019[14]).
- The Ministry for the Environment, which has commissioned the first National Climate Change Risk Assessment. This was released in 2020 and will also inform the development of the National Adaptation Plan (Ministry for the Environment, 2020[15]).
- The Ministry of Business Innovation and Employment, which is funding ten-year academic research projects on emerging risks via the National Science Challenges.
- Crown Research Institutes (CRIs), including the National Institute of Water and Atmospheric Research (NIWA) and the Institute of Geological and Nuclear Sciences (GNS), which carry out mapping, modelling, and forecasting activities on a variety of natural hazard risks (Riskscape, 2020[16]; MBIE, 2020[17]).
- The New Zealand Institute of Economic Research (NZIER), which regularly produces reports and analysis of key economic challenges for the New Zealand economy, including those caused by disasters (NZIER, 2020[1]).
- Regional governments, local authorities and regional CDEM groups, which are responsible for floods, and accordingly undertake flood risk assessments, develop risk management plans for their territory, and make that information public online. However, there are significant differences in the financial capacity and organisational capability of local governments to conduct these assessments.

In general, New Zealand farmers are aware of the risks they face from natural hazards, because of the limited availability of public support and their exposure to natural hazards. At the same time, because risk assessment and communication strategies are mostly tailored to the wider public, agricultural industry groups and the rural advisory groups play a critical role in improving farmers' awareness and understanding of the local risk environment. For example, Beef + Lamb NZ's Land and Environment Plans help farmers to improve their operations, including by considering the impact of extreme weather events at the farm level, and developing a plan for managing them (Box 9.2).

Nevertheless, anecdotal feedback highlights a desire among farmers for more science-based information that is consistent across government agencies and industry groups, particularly in the context of the longer-term challenges facing the sector, including those due to climate change (MPI, 2019[18]).

Box 9.2. Beef + Lamb NZ programme for farm-level Land and Environment Plans

Beef + Lamb NZ's Land and Environment Plans help farmers to manage regulatory requirements around water quality and other environmental concerns, while leveraging the opportunities that these offer to improve farm profitability. Workbooks and workshops are available to guide farmers in developing these plans, which often also lead to improved resilience at the farm level.

Within these plans, farmers assess their farm's natural capital assets to understand their vulnerabilities and the opportunities. Through a process of risk assessment, farmers are encouraged to think about

improvement strategies. Some regional councils now require an LEP plan as a way to facilitate regulatory compliance.

Source: Beef + Lamb NZ (2020[19]).

Risk prevention and mitigation

Ex ante investments in measures that prevent or mitigate the risks and adverse impacts of NHID can be a cost-effective strategy in reducing future losses and damages in agriculture (OECD, 2020[12]). In New Zealand, primary responsibility for flood risk prevention and mitigation lies with local governments for water infrastructure and with individual farmers for private farmland. In this regard, public sector activities to prevent and mitigate flood risks include measures to improve water infrastructure performance, and non-structural measures to avoid unnecessary exposure to risk. But capacity building measures provided by MPI and industry groups are also in place to support farmers in adapting and transforming to a changing risk landscape.

Key initiatives to strengthen prevention and mitigation of natural hazard risk for agriculture, and flood risk in particular, include:

- The Three Waters Review on how to improve the regulation of and supply arrangements for drinking water, wastewater and storm water (DIA, 2019[20]; 2019[13]; 2020[21]). Based on this work, the Government is working with local governments to develop a revised funding model for flood protection, while ensuring that they utilise natural infrastructure such as vegetation, ecosystems, permeable surfaces and water storage (DIA, 2020[22]; Beehive, 2020[23]).
- MPI efforts to build capacity for mitigating risks to agriculture at the local and farm business level, through grants to restore ecosystems to buffer the impacts of extreme hazards, in particular to reduce erosion (MPI, 2021[24]). MPI's Sustainable Land Management and Climate Change (SLMACC) research programme also supports researchers and farmers to experiment with on-farm adaptation strategies (MPI, 2021[25]).
- The 2019 *Productive and Sustainable Land Use* package promotes land-use practices to deliver more value and improved environmental outcomes, including through renewed public extension and farm advisory services and training.
- Dairy NZ's 2013 *Sustainable Dairying: Water Accord* establishes good management practices to improve environmental performance on dairy farms, including practices that contribute to preventing and mitigating the impacts of floods, such as riparian planting and fencing dairy cattle off from waterways (Ministry for the Environment, 2020[26]).
- Financial instruments such as the income equalisation tax benefit scheme allow producers to spread fluctuating gross income between years (Inland Revenue, 2021[27]), while agricultural insurance for crop and livestock in New Zealand does not receive any form of government support and uptake is considered to be relatively low.

Risk preparedness

Preparedness to manage natural hazards is crucial for effective crisis management. In New Zealand, the focus is on monitoring, identification and analysis of geological and meteorological hazards and threats, and dissemination of risk information from public and industry sources in relation to specific hazards. In particular, regional councils and some territorial authorities are responsible for monitoring rainfall, lake and river levels, and volumetric flows that are used for predicting and managing floods. However, poor digital connectivity in rural areas can hinder the effective delivery of early warning systems for farmers.

Public-sector preparedness for emergencies in New Zealand is organised across whole-of-government field exercises and training (National Emergency Management Agency, n.d.[28]; DPMC, 2013[29]). The MPI's regional adverse events teams also work throughout the year to build their capacity to respond to adverse events that affect rural areas, strengthening the understanding of risk, and building relationships with potential partners.

Alongside these efforts, industry groups play an important role in strengthening preparedness on-farm. Groups such as Beef + Lamb NZ, Dairy NZ and Federated Farmers have developed information and guidance for on-farm preparedness and emergency planning for floods. They recommend that farmers integrate preventative measures and recovery costs into regular farm budgets, and encourage farmers to develop recovery plans in advance. Information is also available to guide farmers through on-farm crisis management (Dairy NZ, 2020[30]; 2019[31]; Beef + Lamb NZ, 2017[32]). Nevertheless, despite the availability of information to support individual farmers in preparing for adverse events, this is not always supported by the necessary extension activity and may not lead to the necessary change of behaviour and uptake of preparedness practices (Rangitāiki River Scheme Review Panel, 2017[33]; Whakatāne District Local Recovery Manager, 2017[34]). At the same time, industry and MPI also encourage local sharing of information among farmers through community events, workshops, and one-on-one farmer support and referral (MPI, 2021[35]).

Disaster response and crisis management

Effective crisis management and disaster response hinge on all actors knowing their responsibilities in the event of an emergency and communicating effectively, with the public sector taking a leadership role when the private sector is unable to cope (OECD, 2020[12]). During crisis situations in New Zealand, public sector actors play an active role – from providing information about imminent hazards through to co-ordinating the disaster response. In the case of agriculture, industry groups also play key role, including by ensuring that the specific needs of primary producers are addressed and business continuity is prioritised.

In case of floods, the National Emergency Management Agency (NEMA) is the central authority supporting and co-ordinating the response work of regional and local authorities, communities, central government departments and agencies, emergency services, welfare agencies, lifeline utilities, researchers, international agencies, and NGOs. Statutory response objectives include the protection of human life, the protection of assets, and natural and physical resources, the provision of animal welfare, and the continuation or restoration of economic activity (New Zealand Legislation, 2002[7]; New Zealand Legislation, 2015[8]).

Overall, research and stakeholders' feedback suggest that emergency response can still be less effective in rural areas than in urban areas. But in more recent years, rural advisory groups have emerged in several regions, providing a platform for improved coordination between all public and private actors involved in emergency management in rural areas.

Recovery, rehabilitation and reconstruction

Following a NHID, recovery and reconstruction efforts offer an opportunity for public and private stakeholders to "build back better"2 by addressing underlying gaps in resilience, and building the capacities needed to manage natural hazards in the future (FAO, IFAD and WFP, 2019[36]). This requires all stakeholders – including farmers – to learn from natural disasters in order to adjust DRM frameworks, policy measures and on-farm strategies with a view towards long-term resilience.

In New Zealand, disaster recovery in the agricultural sector is based on the understanding that farming is a business like others, and farmers are able to access funding that is available to support society-wide recovery. More specifically, damages are primarily reimbursed by insurance policies, although central government provides financial support though relief payments for individuals affected by an emergency.

The Government may also fund 60% of eligible costs, with local authorities paying the remainder, to rebuild or repair essential infrastructure, river management systems and community assets that are vital for the recovery of the agricultural sector (New Zealand Legislation, 2002[4]).

Nevertheless, MPI may also provide some sector-specific funding in case of adverse events affecting agriculture. The MPI Primary Sector Recovery Policy is a framework to guide assistance decisions after adverse events and discipline *ex post* support to ensure alignment of incentives (Box 9.3; Figure 9.3). Notably, much of the support under MPI Primary Sector Recovery Policy is often directed towards funding the Rural Support Trusts to provide psychosocial support, and co-ordinate information services in affected communities (MPI, 2019[11]).

While the relatively low levels of support provided to farmers after a crisis provides an incentive to farmers to adapt and transform after a disaster has occurred, the government has also been experimenting with recovery funds earmarked towards advisory and other capacity building services for farmers to learn how to better prevent, mitigate and manage natural hazard risk going forward (MPI, 2020[37]; MPI, 2017[38]).

Finally, post-event evaluation and assessment is also a key element in preparation for future crises and to ensure that gaps and vulnerabilities are understood and addressed. In New Zealand, all agencies with responsibilities must monitor and measure progress against their aims. For the post-disaster evaluations that have been undertaken, the country's institutions have a good record of taking corrective actions. While there is no established practice to undertake agriculture-specific reviews of the response performance, mitigation and prevention measures for the sector in terms of land-use planning and building codes, but also crisis management, have progressed thanks to lessons learnt as part of these review processes (MCDEM, 2018[39]).

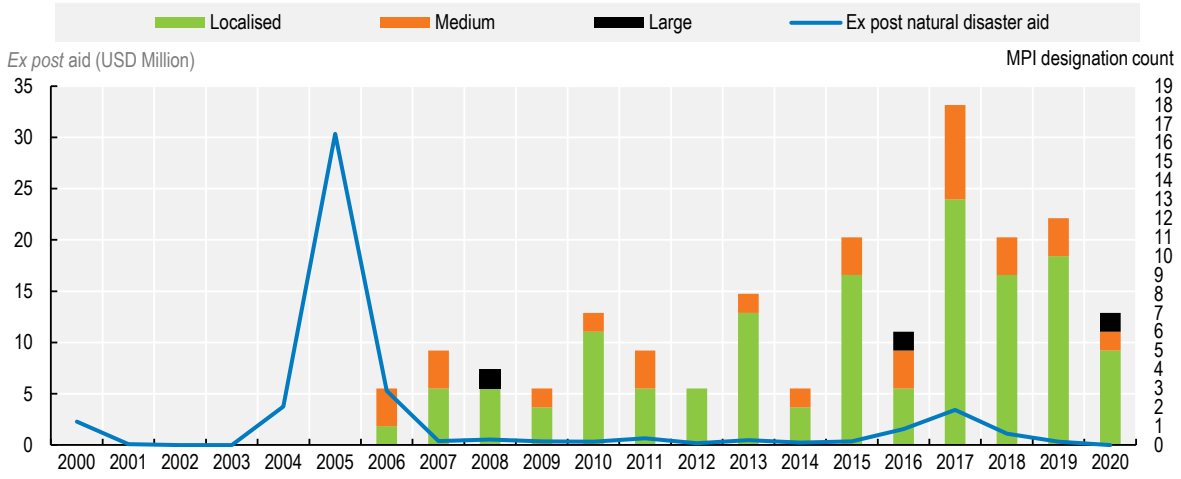
Box 9.3. The Primary Sector Recovery Policy: An *ex ante* framework for *ex post* assistance

The Primary Sector Recovery Policy establishes an *ex ante* framework to guide government decisions on recovery assistance following adverse climatic events and biosecurity incursions impacting farms.

The policy was developed with a view to: avoid the government from making recovery decisions that are precedent-setting; constrain government spending; incentivise risk-reducing actions by relevant stakeholders; and provide stakeholders with confidence that their risk management investments will not be undermined by *ad hoc* government decisions taken under political pressure after a shock. The focus is on the community to avoid assessments of individual cases, and helps the government to decide what recovery help is made available for each event from among a menu of pre-defined options.

Source: MPI (2020[40]).

Figure 9.3. *Ex post* disaster aid for primary producers related to adverse events identified by MPI, 2000-2020



Note: Axis on the left expresses the count of adverse events affecting the rural sector as classified by MPI. Data is not available for the period before 2006, which is when the Primary Sector Recovery Policy was established. Axis on the right expresses *ex post* disaster aid (USD million) for the primary sector. Data for 2020 not available yet.
Source: Author's elaboration, based on data received from MPI, and OECD (2020[2]), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), https://doi.org/10.1787/466c3b98-en;

9.4. Resilience successes and opportunities

In line with the four principles for strengthening resilience to NHID in agriculture, New Zealand's systems for natural hazard risk management – and flood management in particular – demonstrate a number of good practices, as well as some challenges that provide opportunities for future improvement.

An inclusive, holistic and multi-hazards approach to natural hazard risk governance for resilience

- *Disaster risk management frameworks provide consistent incentives to invest in agricultural resilience, but the devolved governance model can be a barrier to implementation*. The New Zealand approach to disaster risk management emphasises devolved responsibility to local communities, businesses and individuals, including farmers, while agricultural policy focuses on providing incentives for farmers to develop their capacity for managing risk, with only limited *ex post* government support in the case of catastrophic events. However, some local communities lack the information, capabilities and financial resources to effectively identify, assess, mitigate and prepare for risk. Nevertheless, the establishment of the Community Resilience Group at national level represents a positive development by providing a forum for assessing resilience gaps and capabilities at the local level, and to start developing solutions to address them.
- *Fragmented disaster risk management frameworks can reduce the effectiveness and efficiency of investments in resilience*. Lead responsibility for managing the risks of different types of hazards falls under different agencies. It will be important to assess if this hazard-specific approach results in either duplication of efforts or gaps across agencies. More broadly, ensuring that the perspective of a wide set of stakeholders is included in the short-term and long-term planning for all types of hazards will be important to ensure that no gaps exist across the disaster risk management cycle.

A shared understanding of risk based on the identification, assessment and communication of hazards, vulnerability and resilience capacities

- *Stakeholders are aware of the risks they face from natural hazards, but there is a need for consistent and tailored information on both immediate and long-term risks*. Government agencies, regional and local authorities, and research institutions undertake risk assessments as part of their regular activities. However, this set up can lead to fragmentation of information and gaps in the relevance and suitability of this information for the agricultural sector. In turn, this may create challenges for farmers and other relevant stakeholders to understand the nature of the risk that agriculture faces, potentially hindering investment in disaster risk prevention and mitigation.
- *Industry groups have taken on a primary role in raising risk awareness among farmers*. Beef + Lamb NZ supports farmers by helping them to make more informed farm management decisions, including in relation to the need to adapt to climate and natural hazard risk.
- *At all levels, better data are needed to improve the possibility of stakeholders to understand the agricultural sector's exposure to natural hazard risk*. Given that a lack of data constrains hazard analyses, stakeholders should further invest in developing high quality datasets on the physical, land use, and other characteristics of the agricultural sector, as well as data on loss and damage from previous NHID, which are a necessary input to improving disaster risk assessment.

An ex ante approach to natural hazard-induced disaster risk management:

- *The New Zealand government is increasing efforts to intervene in the anticipatory phases of risk management, in particular by building farmers' capacities for risk mitigation and adaptation*. With increasing awareness of natural hazard risks and limited public assistance available *ex post*, stakeholders at all levels are adjusting their policy approach and practices towards prevention and mitigation. The government is taking on a larger role where capacities at a local level hinder adequate resilience-enhancing efforts and investments, including through funding.
- *At the farm-level, farmers are adapting their operations to mitigate climate and natural hazard risks.* Farmers are supported both by industry groups and MPI, which promote strategies to prevent and mitigate the impacts of floods on production through co-funding and grant schemes for nature-based solutions such as tree planting and soil erosion control.
- *Renewed public engagement in extension services represents a positive development to ease capacity constraints for faster uptake of resilience-enhancing strategies on-farm.* By re-entering the extension services space, the government has increased its engagement to build capacities to prevent and mitigate the risks and impacts of NHID on farms without undermining its overarching policy approach, but focusing on enhancing the capacity of farmers to adjust to the long-term challenges that they face. This is a positive development, especially as it emphasis on co-production of information and solutions, to maximise their relevance to local contexts and usability.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazard-induced disasters

- *New Zealand emphasises individuals and private actors taking responsibility for managing the risks posed by NHID, but preparedness to flood risk in the agricultural sector is uneven*. Producers have access to information on disaster preparedness, and industry groups have made significant investments in developing information and resources to help farmers to prepare more effectively, including in relation to specific hazards. However, stakeholders consider that producers would benefit from better integrating recovery considerations into their risk management plans.
- *In New Zealand some key good practices arise during recovery, in terms of clearly defined criteria for ex post disaster aid, psychosocial support after a shock, and incentives to 'build back better'*.

The MPI Primary Sector Recovery Policy provides an *ex ante* framework to guide decision-making on *ex post* disaster aid for primary producers, ensuring aligned incentives. New Zealand also recognises that mental wellbeing is an important driver of resilience following a disaster. There is also an increased recognition of the need to "build back better" after a natural disaster with the design of agricultural disaster assistance packages that include advisory services on disaster risk management. This is a key good practice to encourage the sector to transform through the capacity building of farmers, rather than by undermining the incentives for farmers to invest in those improvements themselves.

- *Further opportunities exist to strengthen mechanisms for public and private actors that are involved in disaster response to build their capacities, and to build relationships and devise collaboration strategies before emergencies occur*. Multi-stakeholder scenario planning exercises can be extremely valuable for consolidating linkages while identifying gaps and vulnerabilities in the system.

9.5. Strengthening risk management in New Zealand

New Zealand encourages communities and individuals to take responsibility for managing natural hazard risk, but there is a need to foster an environment that supports their capacity to do so. In particular here is an opportunity for public and private stakeholders to:

- *Improve data collection, including on impacts from previous events, and risk scanning across the country:* this would help decision-makers – including farmers and local authorities – to identify vulnerabilities and make targeted and cost-effective investments in risk prevention and mitigation.
- *Collaborate to develop effective solutions for mitigating the risks and impacts of natural hazards on farm:* such a strategy would ensure their diffusion in agriculture, including by drawing on the renewed engagement on extension services.
- *Improve disaster response and recovery in rural areas by strengthening mechanisms and networks for rural stakeholders cooperation:* collaboration among the MPI, Regional CDEM Groups, and agro-industry groups, would help to build preparedness capacities and relationships before crises occur.

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Notes

[1] Casalini, Bagherzadeh and Gray (2021[41]).

[2] Building Back Better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR and CRED, 2015[42]).

10 Building agricultural resilience to drought in Turkey

Turkey is exposed to multiple natural hazard-induced disasters (NHID) and has experience in managing the associated risks. Among these, drought has significant impacts on Turkey's agricultural sector, and its frequency is expected to increase due to climate change. Turkey has established processes to manage natural hazards affecting agriculture, including drought, with governance and policy frameworks that seek to ensure that the agricultural sector is better prepared for adverse events and can respond effectively when these occur. While these mechanisms contribute to improved resilience, further opportunities exist to improve policy processes, in particular through increased farmer and private sector participation.

Key messages

- Droughts are increasingly observed in many of Turkey's agricultural regions and their frequency and severity are expected to increase due to climate change. As the country's largest water user, the sector's resilience to drought requires action to solve the "water conundrum" of securing access to an increasingly rare and unpredictable resource while, at the same time, easing the demand pressure.
- Government is central to planning for drought and crisis management, including through setting-up drought action plans, and basin-based drought and water management plans. Government also invests in data infrastructure and research.
- Agricultural policies prioritise improving the capacity of the country's farmers to produce and participate in markets through investment and development, including through support for new irrigation infrastructures, through farm programmes that encourage commodity output, including the production of strategic crops, and, more recently, through support for insurance take up. At the same time, in the absence of strong water allocation and enforcement programmes, these measures maintain the demand pressure on the water resource.
- Efforts should now aim to (i) streamline government programmes, including water governance and policies; (ii) strengthen links with farmers and the food industry in the policy process; (iii) facilitate access to information systems on farm damages and losses from natural hazards; and (iv) overcome the skill and knowledge gap<!!Best practice on key box (unnumbered): Essential information – such as key messages, recommendations, findings, calls for action – highlighting the main text. Ideally, no more than one page long.

10.1. Turkey's agricultural sector faces the challenge of building resilience to a range of natural hazards, with droughts increasingly frequent in many agricultural regions

Turkey is exposed to earthquakes, floods, drought, frost and avalanches, as a result of the country's climatic and geographic diversity. Droughts, the focus of this case study, are increasingly common and of particular concern as they have an outsized effect on the livelihoods of farmers and the rural poor, in addition to their impact on the country's market and export oriented value chains. Climate change is expected to increase the frequency and intensity of drought, emphasising the importance of strengthening the sector's resilience to droughts. But improving the resilience of Turkey's agricultural sector is complicated as many of the country's farmers are not integrated into modern value chains, the farming structure is fragmented, there are significant regional income disparities, and the dissemination of technology and innovation is hindered by the generally low-skilled economy (OECD, 2016[1]; 2021[2]). The combination of these factors undermines farm productivity and resilience by limiting access to capital, services and knowledge.

The agricultural sector is the largest water user in Turkey (OECD, 2020[3]). Given the sector's exposure to droughts, water infrastructure such as dams and irrigation are critical for the sector. Agricultural policies emphasise irrigation as a means of increasing and stabilising farm output, and irrigation projects account for more than half of public expenditure on general services for the sector (OECD, 2020[3]). At the same time, illegal groundwater abstractions for agricultural use are a growing problem, particularly when implementing basin-based water management.

The challenge for the agricultural sector is to strike a balance between economic development, and encouraging adaptation that builds the sector's resilience to drought and other natural hazards. There is thus a need to improve the capacity of the country's farmers to produce and participate in markets through investment and development, while ensuring that current investments and expenditures do not exacerbate future water stress conditions.

10.2. Multiple policy frameworks overlap in Turkey's drought governance

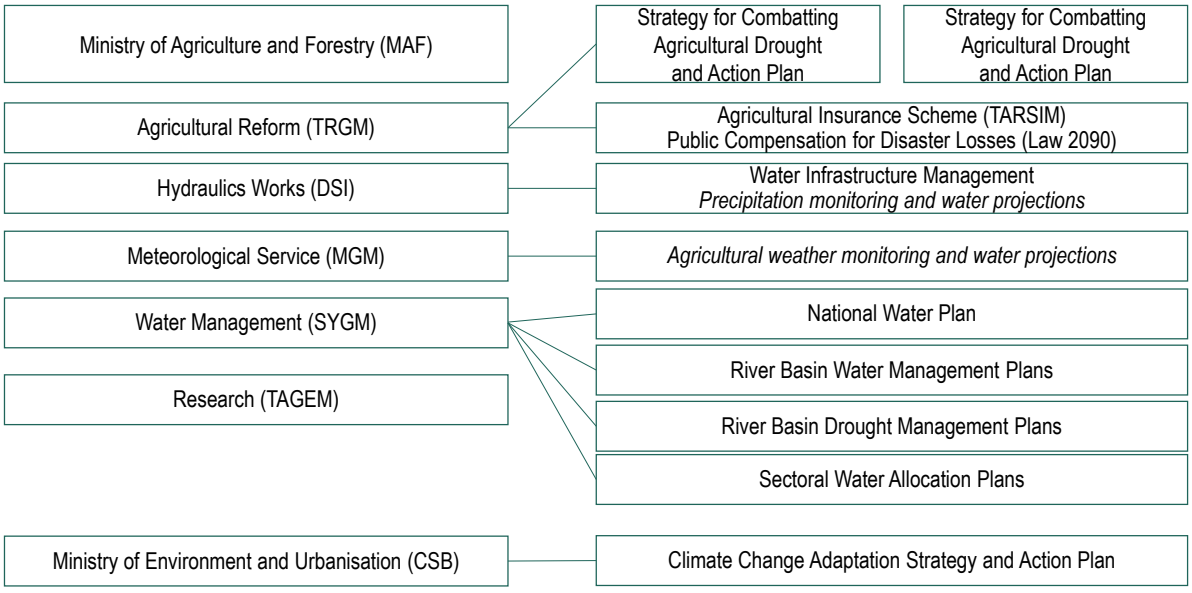
Four governance areas influence how natural hazard risks in the agricultural sector – including drought – are managed in Turkey, including disaster response plans, overall plans for economic development, agricultural policy frameworks (including specific sectoral plans for drought), and water governance frameworks. Disaster response in Turkey covers large-scale and mostly life-threatening critical risks, including floods, landslides, storms, wildfires and earthquakes. The Disaster and Emergency Management Presidency (AFAD) has primary authority for disaster risk reduction, co-ordinating the preparation and implementation of disaster risk reduction plans which include both *ex ante* measures and *ex post* responses (AFAD, 2019[4]).

Turkey's *Eleventh five-yearly Development Plan* (2019-23) sets development targets for all sectors, including for agriculture, as well as targets for strengthening the economy's capacity to adapt to climate change (SBB, 2019[5]). The Development Plan seeks to increase the irrigation rate as a means to increase agricultural production. Turkey's *National Climate Change Action Plan* (2011-2023) also prioritises strengthening the agricultural sector's capacity to adapt to climate change. Specifically, the Action Plan requires agriculture to increase its capacity to act as a carbon sink; limit greenhouse gas (GHG) emissions; and develop its climate information infrastructure to adapt to and combat climate change (CSB, 2010[6]).

Turkey's *Strategy for Combatting Agricultural Drought and Action Plan* (hereafter the "Drought Strategy") aims to minimise the effects of droughts on agriculture by emphasising increased use of irrigation and water resources, and through risk assessment via the monitoring activities of the Agricultural Drought Management Coordination Board (TKYKK) (Figure 2). The Drought Strategy is implemented at the provincial level through *Provincial Agricultural Drought Action Plans*, which bring together local stakeholders under the lead of provincial governors. The action plans facilitate data collection and the implementation of response measures when an early warning is triggered. Turkey's agricultural disaster risk management (DRM) frameworks for droughts, including the Drought Strategy, are mostly under the General Directorates (GD) of the Ministry of Agriculture and Forestry (MAF), as shown in Figure 10.1.

Recent institutional changes have attached directorates for water infrastructure (DSI), water management (SYGM), and meteorology (MGM) to the MAF, and hence strengthened MAF's faculty to oversee critical areas for managing natural hazard and climate-related risks in agriculture. More generally, MAF shapes agricultural policy and oversees its implementation. Agricultural policy influences day-to-day farm management decisions and ultimately on-farm resilience. The current agricultural policy framework encourages commodity output and facilitates access to irrigation through infrastructure investments and a water price structure that does not internalise the full cost of the resource.

Figure 10.1. Disaster risk management governance and frameworks for agricultural droughts in Turkey



Note: Activities related to data and information collection are in italic.

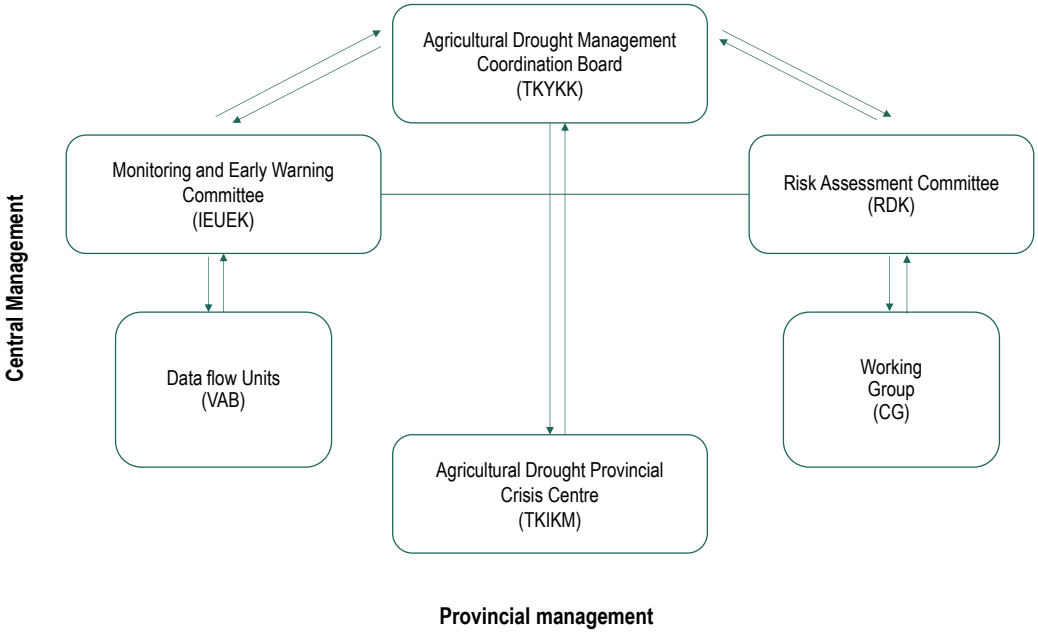
10.3. Agricultural policy shapes Turkey's agricultural disaster risk management systems

While each of the governance frameworks has its own target objectives, farmers and sector stakeholders make their decisions taking into account the entire policy environment. Accordingly, activities at all stages of the risk management cycle (risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction) are considered holistically to better understand conditions, good practices, challenges and opportunities for the Turkish agricultural sector with respect to natural hazard risk management. In the case of drought, Turkey's policy approach has long emphasised water investment and its management.

Risk identification, assessment and awareness

The public sector undertakes many of the risk identification, assessment and awareness activities in Turkey. Risk assessment has been prioritised as an integral component of Turkey's Drought Strategy. Overall drought vulnerability assessments are conducted under *Drought Action Plans* by the Agricultural Drought Management Coordination Board. Awareness of drought risk is particularly high among agricultural agencies, which use an established methodology for analysing and monitoring drought. Agricultural drought management functions, and their linkages across the national and provincial levels, are illustrated in Figure 10.2.

Figure 10.2. Drought risk management in agriculture



Source: National Drought Management Policies (TKYKK, 2013[7]).

The *Climate Change Action Plan* strengthens information systems to support the sector's capacity to adapt to and mitigate the projected effects of climate change (CSB, 2010[6]). The plan identifies information systems that should be prioritised in the context of climate change adaptation in areas of specific relevance to agriculture, including erosion risk maps; land degradation with a soil and land database and inventory; carbon content mapping and monitoring; a land use and land use change database; a water resources database for assessing quality and capacity; and agricultural yields monitoring. The plan emphasises the promotion of sustainable agriculture techniques and soil management, including protecting soil and water resources and sequestering carbon.

Government agencies carry out and support research and development activities to analyse the effects of drought on plant growth. They also provide weather observations, early warning systems, and modelling and projections on weather and climatic events that adversely affect human, plant and animal health. Government agencies also prepare climate change adaptation and mitigation studies and projections that are used as inputs into climate change impact assessments as foreseen in the *Climate Change Action Plan*. However, efforts to anticipate the likely effects of climate change are scattered, while whole-of-economy risk reduction action plans have not yet been developed (OECD, 2019[8]).

Turkey has several data repositories on agricultural damage and losses, including an inventory of insured events and their cost to individual farms. Currently, data on farm losses are limited to use by policy makers and insurers, for loss compensation support or insurance pay-outs, and are not available to private sector stakeholders. The potential exists to improve private sector stakeholders access to farm loss data through available repositories, to increase awareness of the sector's exposure and vulnerability to natural hazards, and inform investments to mitigate those risks (Box 10.1).

Box 10.1. Turkey's Disaster Knowledge Bank (TABB)

The TABB is an online platform providing harmonised evidence on natural and human-induced events going back to 1900 and is available to the public. TABB features an analysis module where individual events are recorded and a library module where disaster related resources are stored in electronic form or their location references. Recorded disaster events can be visualised in tabular form as well as maps. In the absence of economic information, a simple count of agricultural events registered in the TABB database highlights a relatively high frequency of floods and droughts.

Risk prevention and mitigation

Ex ante investments in measures to prevent or mitigate disaster risk can reduce the cost of disaster response and recovery, by addressing underlying vulnerabilities and reducing natural hazard exposure. Government policies and programmes can also encourage stakeholders to identify disaster risks to their own assets, and address gaps in their resilience levels. In Turkey, the risks identified in the agricultural DRM frameworks are the basis of agricultural prevention and mitigation measures for natural hazard risks, including:

- *Disaster Risk Reduction Plans* (TARAP and IRAP). The national Disaster Risk Reduction Plan (TARAP) is pending while the first provincial Disaster Risk Reduction plan (IRAP) is published. The IRAP, published for the Kahramanmaraş Province, prioritises investments in risk mitigation and prevention to protect lives and properties, including to mitigate the effects of climate change on floods and excessive heat. Six other IRAPs are planned for publication in 2021.
- *Surface and groundwater infrastructures*, which are managed by Turkey's central water infrastructures agency (State Hydraulics Works; DSI). The agency is responsible for constructing and maintaining irrigation and drainage infrastructure, with the operation and maintenance of canals gradually being decentralised and transferred to water users' organisations and municipalities. The development of new irrigation infrastructures, with pressurised piped irrigation systems and the installation of centralised water measuring instruments, aims to renew the ageing infrastructure, expand the irrigated area, increase water use efficiency and reduce water loss. However, about 80% of groundwater wells are informal (IBRD, 2016[9]).
- *Sectoral Water Allocation Plans* prepared by the GD Water Management (SYGM) are based on sectoral demands and water needs, but there is no accounting of farmers' water use in the absence of meters, and agricultural needs are estimated based on crop cover area and crop water needs. The allocations are indicative, with no enforcement mechanisms.
- *Agricultural insurance* under TARSIM offers a variety of products to mitigate the financial impacts of natural hazards on agriculture. Insurance subscription is supported by premium subsidies and the portfolio of insurance products was enlarged to include drought insurance while digitally enabled tools accelerate compensation payments (TARSIM, 2020[10]). Among crops insured, the largest coverage is for wheat, but all crops and geographic locations can be insured and there are no exclusions based on dry area farming. Under these conditions, there are few incentives for farmers themselves to adopt prevention and mitigation measures.
- *R&D efforts* to alleviate pressure on water resources and to enhance the sustainable management of water are undertaken by the Turkish Water Institute (SUEN) to provide science-based advice to support planning and formulation of water policies and strategies. The network of public agricultural research centres (TAGEM) carries out research and data collection on drought resistant crop varieties and animal breeds, and effective soil and water management is a priority of the National Strategy on Climate Change (CSB, 2010[11]).

- *Extension services and farmer field schools*, operated by TAGEM, disseminate drought resilient farming practices and contribute to raising farmers' awareness on the effects of climate change. However, farm-level uptake of prevention and mitigation activities is uneven, and the provision of extension services remains critical for sustainable productivity growth.

Risk preparedness

Ex ante disaster preparedness and planning are crucial for effective crisis management – by public and private stakeholders with a role in disaster response, and on farms. Risk preparedness in Turkey is supported by established natural hazard monitoring programmes that inform public agencies about developing risks. These include watershed monitoring, drought monitoring, flood monitoring and monitoring of weather and other risks.

Turkey's DSI collects estimates of irrigation water needs through Irrigation Declarations from all irrigated farms. The declaration provides information on the location, amount of irrigation needed, crop and type of land to be irrigated during the irrigation season, through comparing estimates of irrigation water demand with the existing water resource potential and system capacity.

MGM provides agricultural weather forecasts and monitors weather-related risks, and issues early warnings for adverse weather events that can be used to inform crop-planting and animal husbandry decision-making. However, the extent to which farmers make use of these tools and services, and their take-up rates in the sector, are not clear.

Research into risk preparedness for the agricultural sector in Turkey is carried out in co-operation with international research networks (Box 10.2). In addition, the extension service helps to build farmers' capacity to manage the effects of climate change on the sector.

Box 10.2. Turkey engages in international research networks

Turkey's public research centres (TAGEM) engage in international research networks, including by participating in regional or thematic co-operation and projects. The benefits of international research co-operation are numerous. Projects mutualise and strengthen research capacity, improve access to research outputs and accelerate the dissemination of knowledge and results. They ease access to funds and mobilise individual expertise of each institution to generate knowledge that can be widely disseminated.

Disaster response and crisis management

Effective crisis management and response in the event of an emergency hinge on all actors knowing their responsibilities and communicating effectively, with the public sector taking a leadership role when the private sector is unable to cope. The role of government is central in Turkey in co-ordinating disaster response with AFAD co-ordinating the preparation and implementation of disaster risk reduction plans and interagency co-ordination (AFAD, 2019[4]).

In the event of droughts, early warnings are addressed to local Agricultural Drought Provincial Crisis Centres that manage the local response. They declare the state of emergency and assign response tasks among agencies and provide guidance for planting alternative crops and taking sanitary and phytosanitary measures to avoid pests and diseases, while *ex post* they evaluate and communicate on-farm damages for central government compensation. In the event of product loss or damage to agricultural equipment due to risks that are not covered by the agricultural insurance scheme (TARSIM) or are of an exceptional scale, farmers' losses may be compensated by the government (TRGM).

Recovery, rehabilitation and reconstruction

Following a natural hazard induced disaster, recovery and reconstruction efforts offer an opportunity for public and private stakeholders to "build back better" by addressing underlying gaps in resilience, and building the capacities needed to manage natural hazards in the future. This requires all stakeholders – including producers – to learn from natural hazard induced disasters in order to adjust DRM frameworks, policy measures and on-farm strategies forming long-term resilience.

Recovery and reconstruction activities for natural hazards in Turkey range from large economy-wide projects to repair damaged infrastructure, to programmes that support the financial recovery of farmers. Recovery from drought events largely happens on farms and is predicated on a return to "normal" rainfall levels. Government involvement in on-farm drought recovery in Turkey mostly consists of the provision of inputs, financial compensation, and activities under the Drought Strategy to better prepare the agricultural sector for the next drought. Other government funded instruments supporting recovery and reconstruction include credit subsidies and repayment deferrals, direct payments, technical assistance and support for repairing equipment.

Effective on-farm drought recovery underscores the imperative of longer-term improvement in water resource availability through infrastructure rehabilitation and more efficient farm-level utilisation of available water resources. In general, Turkey's approach puts a strong emphasis on irrigation and support to commodity output. But, most importantly, the sector's use of irrigation reflects the water price structure that does not internalise the full cost of the resource.

Insurance indemnities are typically an effective coping tool, and agricultural insurance programmes in Turkey are improving, for example through efforts to accelerate compensation payments. Government compensation is foreseen for damages to agricultural products or equipment that result from risks that are not insurable. However, the conditions of compensation, including timing and scale, are not announced in advance.

Turkey's Drought Strategy recognises the role of evaluating existing processes as a way to inform and shape future policy developments. But it is not clear if post-event evaluation and assessment of drought events is undertaken, if they involve private sector stakeholders, or, if such assessments have led to improved future preparedness.

10.4. Resilience successes and opportunities

In line with the four principles for resilience to natural hazard-induced disasters in agriculture (Chapter 3), Turkey's systems for natural hazard risk management – and drought management in particular – demonstrate a number of positive developments and good practices, as well as some challenges that provide opportunities for future improvement.

An inclusive, holistic and multi-hazards approach to natural disaster risk governance for resilience

- *An all-hazards approach to natural hazard risk must be implemented in agriculture*. AFAD implements a whole of government response to large scale, and mostly sudden and life-threatening hazards, but does not include droughts. Moreover, agricultural DRM frameworks in Turkey are mainly shaped by agricultural policy. A co-ordinated and integrated approach to prepare for and manage the adverse effects of droughts should be integrated in an inclusive, holistic and multi-hazards approach.
- *Efforts and reforms conducted over the decades have resulted in a multiplicity of frameworks with potential duplication*. Efforts to integrate risk management principles and plans for readiness for

drought into national programmes and joint action plans of the central and provincial governments offer opportunities to further progress towards a more holistic approach by linking together and aligning existing policy components in a cohesive way. Diffuse governance among multiple agencies results in a lack of coherence and consistency and weakens policy outcomes. Turkey should harness the benefits of recent changes in MAF's structure that now include wider policy areas that are all critical for risk management for the agricultural sector.

- *Risk governance in Turkish agriculture would benefit from a more explicit identifications of roles and responsibilities of each actor in natural disaster risk management.* In Turkey, the government formulates and implements agricultural DRM strategies for drought but clear conditions for policy response would enhance farmers' engagement in risk reduction and incentivise farm-level adaptation to hazards that will be exacerbated by climate change. The involvement of stakeholders is still limited to a consultative role and more frequent interactions between local, regional, and national authorities on the one hand, and farmers on the other, would help create a culture of awareness of the risks as well as provide a clearer demarcation of roles and responsibilities. In addition, current policies have a potential to crowd out farmers' own initiatives, as they do not consider their role and responsibility to prevent, prepare for, and respond to risk. The Drought Strategy should delineate clearly the roles and responsibilities of each stakeholder beyond government to ensure that the impacts of droughts are effectively minimised.
- *Eliminating barriers to stakeholder participation in DRM would demonstrate a more inclusive multi-hazard risk reduction approach at the national and the provincial level.* Turkey's Drought Strategy focuses on local level involvement in the agricultural sector, while Agricultural Drought Provincial Crisis Centres are a valuable interface between the national and local government when planning drought response.

A shared understanding of risk based on the identification, assessment and communication of hazards, vulnerability and resilience capacities

- *Investments in strengthening risk identification and assessment are* public goods that raise stakeholder awareness of exposure to risks and inform actions.
- *Drought is a slow-onset hazard and Turkey's National Climate Change Action Plan recognises the importance of monitoring weather conditions*. Analysing agricultural droughts and prioritising data collection and drought monitoring and assessment activities involves multiple actors. It is important that these assessments are accessible to all levels of government and stakeholders, in order to inform the decision making process and actions taken.
- *Ex post information on agricultural economic losses is held in several repositories*, *but not generally available to private sector stakeholders*. Through insurance schemes and MAF's provincial directorates, Turkey assesses agricultural damages and losses as a result of natural hazards. But assessments are not publicly available and none of the public repositories contain critical economic loss data that would enable analysis of their impacts. The information base should be strengthened by including economic variables in repositories, to identify priority policy areas, and tailor and target risk management policies.
- *Turkey has the opportunity to strengthen links with farmers and stakeholders to improve communication about risk*. While the public sector undertakes many of these risk identification and assessment activities, links with the private sector and farmers are weak and stakeholders point to the lack of access to information on their exposure to climate related risks. The role of the government in disseminating relevant data and information is central in enabling evidence-based and risk-informed decisions to strengthen resilience.

An ex ante approach to natural hazard-induced disaster risk management

- *Government agencies recognise the importance of implementing an ex ante approach to disaster risk management*. Public funding supports conventional and modernised irrigation infrastructure which can increase water use efficiency. Public research activities – with regional and international collaboration – on topic such as heat tolerant breeds and crop varieties, smart technologies for irrigation, drought adapted soil management, are examples of ex ante approaches that support on farm risk management practices. Finally, support to agricultural insurance take up can help improve farmers' risk recovery from NHIDs.
- *Turkey invests in structural and non-structural measures to mitigate and prevent drought risks but water policies need be strengthened*. Agriculture is Turkey's largest water user, but most of the country's irrigated lands use potentially inefficient irrigation methods or facilities. Investment in irrigation infrastructure is critical but needs to be accompanied by a strong water allocation and enforcement programme, including the phasing out of informal wells. Implementation of water allocation systems, including water pricing, should also be flexible enough to respond to and mitigate drought impacts.
- *Turkey's public research initiatives on climate change adaptation and on disaster risk help the agricultural sector prepare, plan for, and more successfully adapt and transform in response to droughts and contribute to sector productivity and sustainability*. While research enhances Turkey's adaptation and mitigation measures, there is little evidence on farm level awareness and adaptive practices, aggravated by the generally low-skilled economy, which hinders the dissemination of technology and innovation. Training programmes and capacity building, including access to extension services to ease on-farm take-up of water saving techniques, are necessary to reduce vulnerability to drought.
- *Turkey's reform of agricultural insurance has provided farmers more options for ex-ante risk management tools*. Take up of insurance by farmers is low but growing in response to insurance premium subsidies and a high-tech web-based system. However, *ex post* public compensation criteria should be announced in advance, conditional on insurance take-up, and limited to catastrophic events.
- *Adapting crops to climate and soil conditions can build drought resilience, but farmer uptake of preventative or mitigating measures may be hindered by an agricultural policy that encourages commodity output*. Efficient water use requires a shift away from output-based support towards support conditional on more sustainable and water efficient production methods.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazard-induced disasters:

- Government is at the centre of disaster response and more could be done to ensure farm sector participation, to support on-farm response capacities, and recovery
- Turkey's adaptation and restructuring of its government agencies helped to better respond to emergency situations. The establishment of AFAD by bringing together key agencies for emergency crisis management improved the effectiveness of crisis management and disaster response. Similarly the recent changes in MAF's structure to include wider policy areas that are all critical for risk management in the agricultural sector could be harnessed to increase the sector's resilience to future NHID.
- Droughts have a disproportionate impact on the livelihoods of subsistence farmers and the rural poor, given their limited capacity to manage risk. Effective integration of farmers into networks for disaster risk management can help mitigate their impacts. Farmers' integration in local networks

can help cushion the immediate adverse effects of NHIDs while access to extension services can help longer term capacity building. Both dimensions can be served by the Drought Strategy as it may serve to build capacities and networks that are necessary when disasters occur, by defining stakeholders' roles and responsibilities in advance, as is the case under the AFAD's emergency response. Support trigger criteria should be defined in advance and clearly communicated to farming communities so that farmers can make better DRM decisions.

- *Ex post assessment of drought impacts is an important step in the process for strengthening resilience and building back better*. However, it is not clear that post-disaster assessments are undertaken regularly in Turkey or that they cover not only the impacts of adverse events on the farm business, farmers' livelihoods, and farm facilities, but also assess governance and the functioning of the social systems.

10.5. Strengthening risk management in Turkey

Turkey has established processes to manage natural hazards affecting agriculture, including drought, which contribute to the sector's resilience. Turkey's governance and policy frameworks seek to ensure that the agricultural sector is better prepared for adverse events and can respond effectively when these occur. But there is an opportunity for public and private stakeholders to:

- *Enhance on-farm preparedness and adaptation to drought risks by improving data access and private sector participation in the policy planning process*. *Ex post* information on agricultural economic losses are held in several repositories, but they are not available to private sector stakeholders. Improved access to farm loss data would increase awareness of the sector's exposure and vulnerability to natural hazards, and inform investments to mitigate risks.
- *Invest in training and extension services that are tailored to the needs and capacities of farming population*. It is important to minimise the knowledge gap and accelerate on-farm adoption of more efficient irrigation systems and water saving techniques.
- *Encourage more efficient water management so as to mitigate and prevent drought impacts*. Turkey should strengthen local water allocation regimes and incentivise water saving. Water fees should be used to cover the operation and administration costs of irrigation networks. Investing in the gradual implementation water metering and use-monitoring, including by bringing illegal wells into formality, combined with the provision of water related extension services is an important step in this direction.
- *Closer attention should be paid to the linkages and trade-offs between agricultural policy that supports specific commodity production and sustainable water use.* Commodity payments can incentivise water use and water stress. The transition away from commodity support to the provision of sector-wide services that enhance the sector's capacity to prepare, prevent, absorb and reconstruct are necessary steps in the direction of sustainable productivity growth.

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11 Building agricultural resilience to extreme floods in the United States

Agricultural producers in the United States have significant experience in managing the risk of natural hazard-induced disasters (NHID), but the 2019 Midwestern Floods and Hurricane Florence in 2018 highlighted the importance of increasing resilience to extreme floods. The chapter explores current good practices that already build the resilience of the US agricultural sector to extreme floods – and NHID more broadly – at each stage of the disaster risk management cycle, and identifies further opportunities that would better position the sector to prepare for, mitigate and manage the risks of floods and other natural hazards.

Key messages

- Agricultural producers in the United States have significant experience in managing the risk of natural hazard-induced disasters (NHID), but the 2019 Midwestern Floods and Hurricane Florence in 2018 highlighted the importance of increasing resilience to extreme floods.
- A number of current practices build resilience. Producers can access science-based information on adaptation to climate and weather-related risks, preparedness and recovery. Formal networks build relationships and capabilities before a disaster, improving the effectiveness of disaster preparedness and response. USDA conservation programmes and various soil health initiatives help farmers to mitigate the impacts of floods on production.
- However, most farm support is directed to agricultural risk management policies and disaster assistance that help producers cope with the impacts of NHID. Integrating resilience objectives into these programmes would send a clearer signal to producers about the need to adapt and increase resilience. Policy makers should also engage with trusted stakeholders – including farm organisations and extension agents – to promote the benefits of practices that build resilience to NHID.

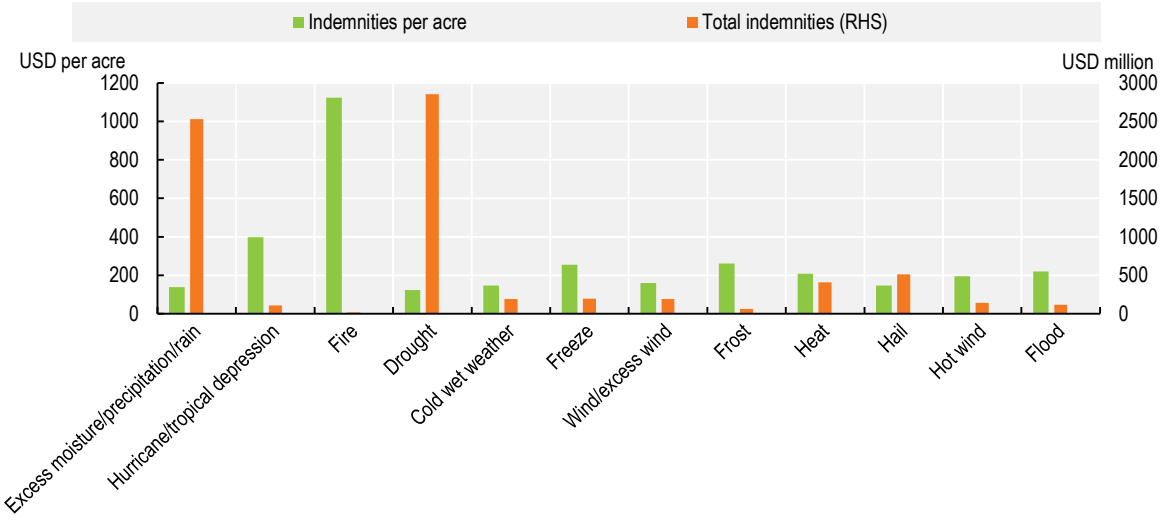
11.1. Recent disasters in the United States have highlighted the importance of building agricultural resilience to extreme floods and other natural hazards

The United States' agricultural sector is exposed to a range of natural hazards, with drought, floods, hurricanes, storms and wildfires causing large losses. Although drought is the main driver of crop insurance indemnity payments and accounts for a large share of disaster assistance over time (Figure 11.1), heavy losses and damage caused by the 2019 Midwestern Floods and Hurricane Florence in 2018 highlighted the importance of increasing resilience to extreme floods, the focus of this case study.[1] Going forward, climate change is expected to increase the frequency and intensity of heavy rainfall events and the risk of floods impacting agriculture.

US producers have significant experience in managing the risks of natural hazard-induced disasters (NHID), and many are frequently exposed to flooding caused by heavy rainfall events and hurricanes. Farm-level capacity for managing that risk is also generally high. US producers are generally well-educated and innovative, adopting new developments in crop and livestock management, including precision agriculture technologies (Lowenberg-DeBoer and Erickson, 2019[1]; Schimmelpfennig, 2016[2]), conservation tillage practices (Claassen et al., 2018[3]), and weather and climate service tools (Haigh et al., 2018[4]), and employ a portfolio of measures to manage risk, including marketing contracts to protect against price fluctuations, production diversification, and off-farm sources of income (Prager et al., 2020[5]).

Nevertheless, more frequent and intense floods present challenges to even experienced farm managers due to the magnitude of the impacts and the cascading effects of multiple events. Building resilience to the risk of extreme floods will require public and private stakeholders to consider the risks that floods pose to the sector over the long term, and place a greater emphasis on what can be done *ex ante* to reduce risk exposure, increase preparedness for floods, and ensure a more resilient recovery.

Figure 11.1. Crop insurance indemnities and indemnities per acre, average for 2010-2020



Source: USDA RMA (2021[6]), *Cause of Loss Historical Data Files*, https://www.rma.usda.gov/SummaryOfBusiness/CauseOfLoss.

11.2. Governance frameworks

Four general governance framework areas influence the US agricultural sector's approach to managing natural disaster risk. These are the US frameworks for all-sector emergency management; governance arrangements for flood risk management; agricultural risk management policies; and other agricultural policies that can affect the sector's capacity to manage floods – specifically, conservation policies. Different activities under each framework contribute to natural hazard risk management by helping producers to plan and prepare for, absorb the impact of, and recover from floods and other NHID, as well as provide the incentives and support for adapting and transforming in response to these events (Table 11.1).

Disaster risk management (DRM) in the United States is based on the principle of preparedness for all hazards. The system for disaster preparedness and response is outlined in the *National Preparedness System* (NPS) and its component planning frameworks, which guide how the whole community builds and sustains the capabilities that are needed to prevent, protect against, mitigate, respond to, and recover from all hazards. The Federal Emergency Management Agency (FEMA) is the co-ordinating agency responsible for disaster preparedness, response and recovery, supported by other federal agencies and departments, together with local, state and tribal governments affected by an incident.

The approach for managing natural hazard risks to critical infrastructure[2] – including in the food and agriculture sector – is outlined in the *National Infrastructure Protection Plan.* This emphasises the importance of public-private partnerships in the food and agriculture sector, given that critical infrastructure is almost entirely under private ownership.

Responsibility for flood risk management is shared across multiple federal, state, and local government agencies, while states and local governments are responsible for land use and development decisions in floodplains. At the national level, the US Army Corps of Engineers (USACE), FEMA and the US Department of Agriculture (USDA) assist states and communities to implement measures to reduce flood damages and improve flood risk management. FEMA is responsible for the National Flood Insurance Program (NFIP), which makes flood insurance available, and also provides funding to states, territories, tribes, and local communities for flood hazard mitigation projects.

Table 11.1. Disaster risk management governance in United States agriculture

		Key governance frameworks		
		Flood risk management	Agricultural policy	Conservation policy
	All-sector emergency management	Flood risk governance	Agricultural risk management	Conservation programmes
Primary responsibility	Federal Emergency Management Agency	Shared across federal, state and local government agencies	US Department of Agriculture (USDA)	USDA
Key policy documents and programmes	*National Preparedness System* and its five *National Planning Frameworks* *National Infrastructure Protection Plan*	FEMA's National Flood Insurance Program; floodplain mapping, and floodplain building and land use requirements US Army Corps of Engineers (USACE) programmes to reduce flood damage & improve flood risk management	Agricultural risk management and disaster assistance programmes in the 2018 Farm Bill including the Federal Crop Insurance Program;[1] Noninsured Crop Disaster Assistance Program; Emergency Disaster Loans; Supplemental Agricultural Disaster Assistance Programs, Emergency Conservation Program and Emergency Watershed Protection	Emergency Watershed Protection Program–Floodplain Easements Option Agricultural Conservation Easement Program–Agricultural Land Easements Watershed and Flood Prevention Operations programme Environmental Quality Incentives Program Conservation Reserve Program
Contributing agencies	Other government agencies; state and local authorities	States and local authorities	USDA Farm Service Agency USDA Natural Resources Conservation Service USDA Risk Management Agency USDA Climate Hubs	USDA Farm Service Agency USDA Natural Resources USDA Climate Hubs

Note: 1. The Federal Crop Insurance Program in its current form was authorised by the Federal Crop Insurance Act of 1980, and modified by subsequent farm bills and other legislation.
Source: Gray and Baldwin (2021[7]).

In the area of agricultural risk management, USDA offers a variety of risk management and disaster assistance programmes to help producers cope with production, financial and physical losses related to or caused by a NHID (Table 11.1). The *Federal Crop Insurance Program*, which is administered by USDA's Risk Management Agency (RMA),[3] offers subsidised insurance policies for both yield and revenue losses, and Whole-Farm Revenue Protection, which covers all commodities on the farm under one insurance policy. USDA's Farm Service Agency (FSA) administers the *Emergency Disaster Loans* programme, which provides low-interest loans to help producers recover from production and physical losses caused by drought, flooding, quarantine, or other NHID. FSA also administers four standing disaster programmes for livestock and trees, bushes, and vineyards (the *Supplemental Agricultural Disaster Assistance Programs*). At various times the United States has also provided *ad hoc* disaster assistance payments to producers.

USDA also has several permanent disaster assistance programmes that help producers to restore damaged farmland and infrastructure following natural disasters. FSA's *Emergency Conservation Program* (ECP) assists landowners to restore agricultural land, including removing debris, restoring fences and conservation structures, and providing water for livestock in drought situations. USDA Natural Resources Conservation Service's (NRCS) *Emergency Watershed Protection* (EWP) programme assists communities to implement emergency recovery measures when a natural disaster causes serious damage to land and infrastructure.

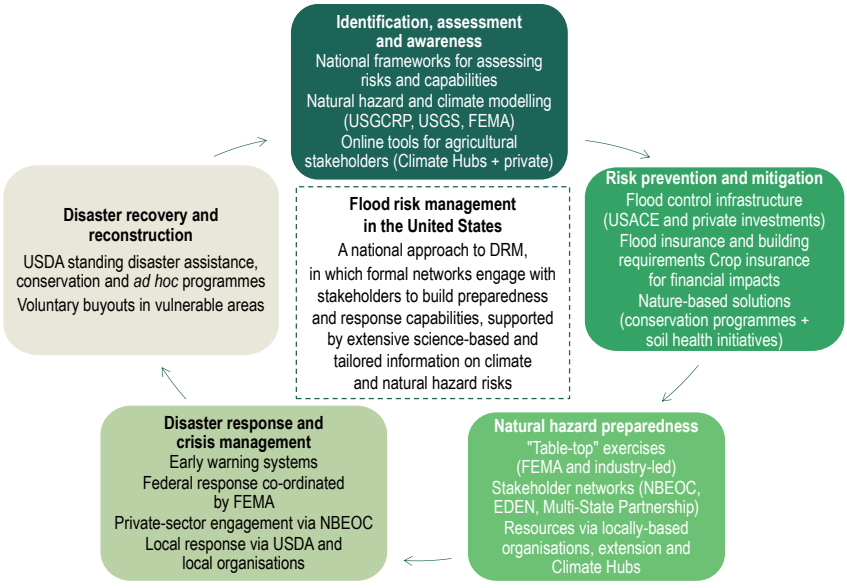
Finally, NRCS also administers conservation programmes that directly target improved disaster prevention and mitigation. These three programmes – the *Emergency Watershed Protection Program – Floodplain*

Easements Option (EWPP-FPE), the *Agricultural Conservation Easement Program – Agricultural Land Easements* (ACEP-ALE), and the *Watershed and Flood Prevention Operations* (WFPO) programme – provide support for preventative structural and non-structural measures to reduce flood damage.[4] FSA and NRCS also administer conservation programmes that can indirectly improve producers' capacity to manage the risk of NHID. For example, NRCS provides technical and financial assistance to producers to implement conservation measures, including land retirement programmes (e.g. the *Conservation Reserve Program* (CRP)) and programmes to encourage adoption of practices to reduce environmental pressures on working land (e.g. the *Environmental Quality Incentives Program* – EQIP).

11.3. The United States' disaster risk management system includes innovative approaches and good practices

Resilience to NHID is an outcome of measures put in place before, during and after an extreme event, such as a flood. Measures undertaken by governments, farmers and other stakeholders at each stage of the DRM cycle play a role in helping the agricultural sector to absorb and recover from the impacts of natural hazards, and to adapt and transform in order to increase resilience to future disaster risks. Accordingly, activities under the four frameworks at each stage of the DRM cycle (risk identification, assessment and awareness; prevention and mitigation; preparedness; response and crisis management; and recovery and reconstruction) are considered to identify good practices that contribute to building resilience, as well as the opportunities to position the sector to better prevent and mitigate, and prepare for natural hazards, and flood risks in particular (Figure 11.2).

Figure 11.2. Flood risk management in the United States across the DRM cycle



Risk identification, assessment and awareness

A shared understanding of natural disaster risks is important to encourage investments in natural disaster risk prevention, mitigation and preparedness by all stakeholders (OECD, 2020[8]). In the United States, initiatives at the national and state levels, including risk assessments, climate and natural hazard modelling, and foresight exercises play an important role in increasing risk awareness. All levels of government undertake all-hazard risk assessments strategically as part of the processes of the NPS. To

do this, communities and governments at the national and state levels can use the National Risk and Capability Assessment tools developed by FEMA to identify hazards, their consequences, and the capabilities needed to manage them (FEMA, 2020[9]).

A number of agencies assess natural hazard- and climate-related risks, including:

- The US Global Change Research Program's National Climate Assessment, which analyses the effects of climate change on regions, sectors, and the natural and built environment, including on agriculture. The Fourth National Climate Assessment provides information on future climate scenarios and their associated risks and impacts, and examples of actions that communities are taking to reduce the risks associated with climate change, increase resilience, and improve livelihoods (USGCRP, 2018[10]).
- The US Geological Survey's Natural Hazards Mission Area conducts research and modelling on risks due to a range of natural hazards, including floods (USGS, 2020[35]).
- FEMA identifies and maps flood hazards and disseminates flood risk information through floodplain maps.

Agricultural sector stakeholders can access more *targeted information on climate and natural hazard risks* through a range of public and private initiatives, including.

- USDA's Regional Climate Hubs develop and deliver region-specific and science-based information and resources to help USDA programme agencies (FSA, NRCS and RMA) and other stakeholders account for climate information in their planning processes (USDA, 2020[10]).
- The Southeast Climate Consortium's *AgroClimate* provides interactive tools and climate information to improve crop management decisions and reduce production risks associated with climate change and variability for south-eastern states (SECC, 2020[11]).
- The *Useful to Usable* project brought together expertise in applied climatology, crop modelling, extension and other disciplines to improve the use and uptake of climate information for agricultural decision making (MRCC, 2017[12]).[5]
- The National Oceanic and Atmospheric Administration's (NOAA) Climate Research Program offers regional climate information to improve decision makers' ability to prepare for and respond to short and long-term climate variability and change (GAO, 2018[13]).

Box 11.1. USDA Regional Climate Hubs

The ten regional Climate Hubs link USDA research and programme agencies in order to develop and deliver science-based, region-specific information and technologies to agricultural producers and other stakeholders to enable climate-informed decision-making and adaptation. The Climate Hubs synthesise research and scientific information; develop science-based tools and strategies for responding to impacts of a changing climate such as drought, extreme weather events; and engage in stakeholder education and outreach, while also providing access to a wide range of decision-support tools for the climate, agriculture and forestry sectors.

Disaster impact data is a valuable risk management tool, as knowledge of past events can help identify vulnerabilities, and inform risk management policies and investments in risk prevention and mitigation. Information on some impacts of NHID on agriculture is available from a range of sources, including:

- USDA's crop insurance database offers an insight into production losses related to NHID, publishing data on US crop insurance pay-outs at the US state and county levels by crop and for more than 20 types of disasters.

- The University of Florida's Economic Impact Analysis Program provides estimates of the agricultural losses and damage associated with NHID in the state (FRED, 2018[14]).

- Given the wide availability of resources to support risk identification and assessment, and the frequent occurrence of various natural hazards in the United States, US producers have a good understanding of the current risk exposure of their operations. However, the extent of their awareness of how this risk environment is changing – and the implications for their operations – is less certain (Chatrchyan et al., 2017[15]; Niles et al., 2019[16]; Prokopy et al., 2015[17]). Commentators have noted that producers consider short-run factors such as market and weather conditions to be more important for farm management and planning.

Box 11.2. University of Florida's Economic Impact Analysis Program

The University of Florida's Economic Impact Analysis Program developed an online survey instrument to assist in the collection of disaster impact information for the state's agricultural sector. The online survey addresses challenges extension agents faced in collecting information in the field, as well as using these data to determine the overall economic impacts associated with natural disasters. The online survey instrument harmonises and improves the timeliness and accuracy of reporting on observed damages caused by natural disasters.

Risk prevention and mitigation

Ex ante investments in measures to prevent or mitigate natural disaster risk can reduce the cost of disaster response and recovery, by addressing underlying vulnerabilities and reducing natural hazard exposure. In the United States, a range of policies and programmes at the federal level aim to prevent and mitigate flood risks with structural measures such as levies.

- *Flood control*: The *USACE* constructs flood control infrastructure and manages levee systems, while NRCS provides technical and financial assistance to support the construction of small levees and dams in rural areas. FEMA programmes offer incentives to communities and individuals to invest in flood risk prevention and mitigation.
- *Flood risk mitigation*: New or substantially improved agricultural structures built on historic floodplains are required to meet FEMA's building requirements, which include elevating or flood proofing to or above the base flood elevation.

Government agencies, producers and other stakeholders also recognise the role of soil health in mitigating the impacts of floods on farms by improving water storage, infiltration and flow, as well as the opportunities for nature-based solutions to mitigate flood risks.

- *Conservation practices*: USDA provides financial and technical assistance to farms to support the adoption of conservation practices on working land and for land retirement. Eligibility for most federal commodity programme payments, including crop insurance premium subsidies, is subject to the recipients having a farm-based conservation plan to protect highly erodible cropland and wetlands.
- *Nature-based solutions*: NRCS funds land use restrictions in floodplains and to restore and enhance floodplains through the EWPP-FPE programme.
- *Soil health initiatives*: Technical and financial support to improve soil health is available from various sources, including NRCS's Soil Health Initiative, the Soil Health Partnership (SHP), and the National Association of Conservation Districts (NACD) Soil Health Champions Network.

Producers can also obtain insurance to mitigate the financial impacts of NHID, including floods. The Federal Crop Insurance Program offers subsidised insurance policies for yield and revenue losses caused by natural hazards, and is highly regarded by public and private stakeholders as the primary policy tool for mitigating natural hazard risks.

Box 11.3. Initiatives to promote soil health

Soil health initiatives led by NRCS, producers and the conservation districts aim to promote and support soil health practices – such as cover crops and conservation tillage – by addressing constraints to on-farm adoption, including a lack of evidence on the economic and environmental benefits of those practices and the risks associated with changing farming methods. Initiatives include: NRCS's Soil Health Initiative, which offers technical and financial assistance to producers to adopt soil health practices and systems through various conservation programmes, including EQIP and the Conservation Stewardship Program (CSP); the Soil Health Partnership (SHP), a farmer-led research network that measures the impacts of implementing soil health practices on working farms; and the country's nearly 3 000 conservation districts, which work directly with landowners to conserve and promote healthy soils, and undertake case studies, field days and demonstrations

Risk preparedness

Disaster preparedness and planning are crucial for effective crisis management. Preparedness activities are an important and necessary complement to risk prevention and mitigation efforts, such that when NHID inevitably occur and disrupt agricultural activities, public and private stakeholders have the networks, capacities and resources in place to manage a crisis effectively, minimise the disruptions to agricultural activities, and ensure a quicker and more resilient recovery (UNISDR, 2015[18]).

DRM in the United States is based on the principle of preparedness for all hazards. Rather than plan for every possible hazard, the NPS is based on capabilities-based planning, namely identifying and building the required capabilities that will help the whole community to prevent, protect against, mitigate, respond to, and recover from multiple hazards. Disaster preparedness is also supported by "table top" exercises at the national and state levels. For example, the Food and Agriculture critical infrastructure sector participates in exercises to test the effectiveness of resilience procedures in the sector (FDA, USDA and DHS, 2015[19]).

US agricultural sector stakeholders value developing *relationships and networks for disaster preparedness* and capacity building before disasters occur. At the national level, the Food and Agriculture critical infrastructure sector enhances collaboration and communication between government agencies, and owners and operators of food and agriculture critical infrastructure, and with stakeholders in other critical infrastructure sectors. Various multi-state consortia are also in place to build preparedness capabilities at the state level, maximise resource sharing, and minimise duplication of effort, including:

- The Multi-State Partnership for Security in Agriculture, a collaboration between state departments of agriculture, state veterinarians, animal health departments, Homeland Security advisors, and emergency management divisions of 15 Midwestern states to support emergency preparedness and response (Multi-State Partnership, 2016[20]).
- The Extension Disaster Education Network (EDEN), a collaborative multi-state effort between USDA's National Institute for Food and Agriculture (NIFA), NOAA, land-grant colleges and universities, and the Cooperative Extension System (CES) across the country. supports local extension agents with research-based education and resources on disaster preparation and

mitigation, and helps them to build relationships with their local and state emergency management (EDEN, 2018[21])

Producers can access *information on natural hazard preparedness* – and on flood and hurricane preparedness in particular – from a range of sources, including USDA and its programme agencies. Region-specific information is available through the USDA Climate Hubs and state departments of agriculture. In particular, locally based organisations, such as co-operative extension agents, Farm Bureaus and local USDA staff are trusted sources of information due to having local knowledge of issues and established relationships with community members.

Disaster response and crisis management

Effective crisis management and disaster response hinge on all actors knowing their responsibilities in the event of an emergency and communicating effectively, with the public sector taking a leadership role when the private sector is unable to cope.

Alerts and real-time information on imminent hazards are provided by several agencies. For example, NOAA develops and issues forecasts, watches and warnings for floods through the National Weather Service (NWS), and for hurricanes through the National Hurricane Center. Information on drought is provided weekly through the US Drought Monitor, a map that shows which parts of the United States are in drought, and the severity of drought conditions.

For disasters requiring federal co-ordination, the immediate response is generally guided by the *National Response Framework* (NRF). While FEMA has primary responsibility for co-ordinating disaster response, USDA is responsible for co-ordinating federal support to provide nutrition assistance; provide technical expertise in support of animal and agricultural emergency management; and ensure the safety and defence of food supply, among other functions. At the local level, USDA programme agencies focus on providing information on disaster assistance programmes to affected producers. USDA is also supported by other organisations, including the Farm Bureau and conservation districts, and local extension agents.

US disaster frameworks also recognise that during disasters, the private sector can contribute resources, capabilities, and expertise in support of disaster response and recovery operations, and help ensure business continuity. Before, during and after disasters, FEMA co-ordinates with the private sector through the National Business Emergency Operations Center (NBEOC),[6] a virtual platform for two-way information sharing between public and private sector stakeholders.

Recovery, rehabilitation and reconstruction

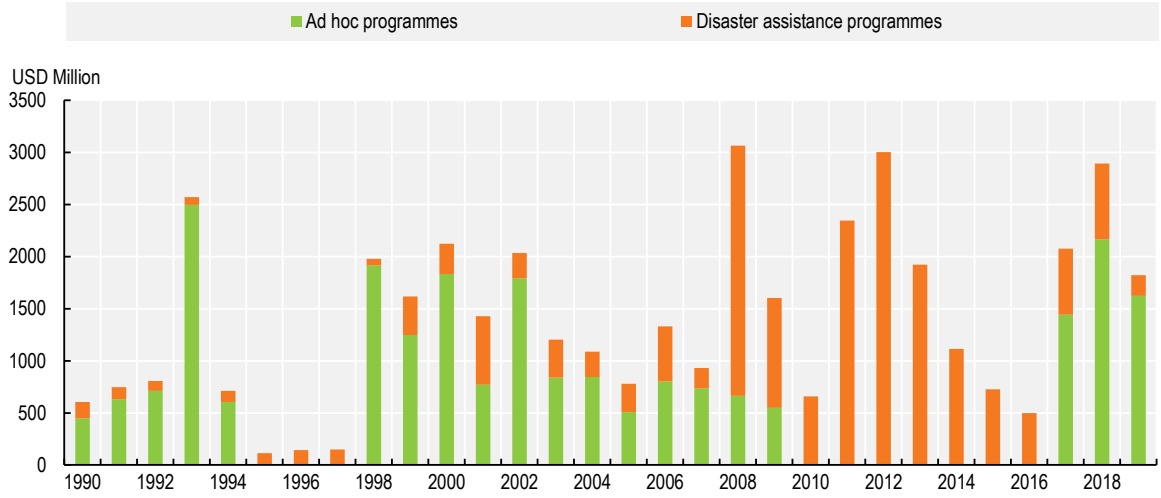
Following a NHID, recovery and reconstruction efforts offer an opportunity for public and private stakeholders to "build back better"[7] by addressing underlying gaps in resilience, and building the capacities needed to manage natural hazards in the future (FAO, IFAD and WFP, 2019[22]). This requires all stakeholders – including producers – to learn from NHID in order to adjust DRM frameworks, policy measures and on-farm strategies with a view towards long-term resilience (OECD, 2014[23]; OECD, 2020[8]).

Recovery from disasters in the United States is guided by the *National Disaster Recovery Framework*, which emphasises pre-disaster recovery planning and preparedness, and outlines co-ordinating structures, roles and responsibilities of different levels of government in short- and long-term recovery efforts. Federal support for recovery is organised around Recovery Support Functions, with federal disaster assistance made available to individuals, state and local governments, and non-government entities, primarily through programmes administered by FEMA.

For many US producers, financial concerns are the most important barrier to – and priority for – recovery after a NHID (Wiener, Álvarez-Berríos and Lindsey, 2020[24]). Producers can access financial support

through a range of federal disaster assistance programmes. Assistance is received most quickly through the Federal Crop Insurance Program, and indemnities can be important for addressing cash flow constraints that impede the restoration of farm operations. *Ad hoc* disaster assistance has also been provided in recent years in response to hurricanes, wildfires, floods, tornadoes, typhoons, volcanic activity, and snowstorms, despite the intention to move away from such programmes (Figure 11.3).[8] Cost-shared assistance for farmland rehabilitation and watershed protection is also available several programmes, including FSA's ECP and NRCS's EWP programme. USDA also uses some existing conservation programmes to assist with rehabilitating land following natural disasters, for example, special EQIP sign-ups for producers in hurricane- or flood-affected areas (Stubbs, 2020[25]).

Figure 11.3 *Ex post* natural disaster assistance to US agriculture, 1990-2020



Notes: *Ad hoc* programmes includes: Cottonseed disaster payments; Dairy disaster payment; Sugar beet disaster payment; Crop disaster payments (*ad hoc*); WHIP Crop disaster payments (*ad hoc*); WHIP+ Crop disaster payments (*ad hoc*); and WHIP+ Milk Loss (*ad hoc*). Disaster assistance programmes includes: Supplemental Revenue Assistance Payments (SURE) Program; Noninsured Crop Disaster Assistance Program; Tree and vineyard disaster payments; Dairy Indemnity Payment Program; Livestock indemnity program (disaster relief); Emergency Assistance for Livestock, Honeybees and Farm-Raised Fish; Emergency assistance loans; Feed assistance.
Source: OECD (2020[26]), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), https://doi.org/10.1787/466c3b98-en.

11.4. Resilience successes and opportunities

In line with the four *Principles for Effective Disaster Risk Management for Resilience* in agriculture (Chapter 3), disaster risk governance and policy measures in the United States offer many examples of good practices for building the agricultural sector's resilience to natural hazards – and for floods in particular – as well as some challenges that provide opportunities for future improvement.

An inclusive, holistic and multi-hazards approach to natural disaster risk governance for resilience

- *Agricultural risk management and disaster assistance policies are comprehensive, but are undermined by ad hoc disaster assistance*. In the event of a NHID, producers have access to a range of programmes that provide compensation for losses, including crop insurance, Emergency Disaster Loans and the Supplemental Agricultural Disaster Assistance Programs. However, the recent return to providing *ad hoc* disaster assistance undermines the *ex ante* framework

established by these policies, and in turn, producers' incentives to adjust their operations in response to evolving natural hazard risks.

- *Resilience objectives could be better integrated into existing farm safety net programmes in the context of the sector's changing exposure to natural hazards under climate change*. This would send a clearer signal to producers about the need to adapt, and to invest in and build capacities for mitigating the risks and impacts of floods and other natural hazards. To some extent, the USDA Climate Hubs are progressing this through their work with USDA agencies, including to better integrate consideration of climate change impacts into farm programmes. However, these links could be strengthened, including by increasing the profile of the Climate Hubs among all stakeholders. It is also important for that stakeholders acknowledge the need for programmes that complement risk coping policies such as crop insurance, and place a greater emphasis on increasing the utility of programmes that promote adaptation

A shared understanding of risk based on the identification, assessment and communication of hazards, vulnerability and resilience capacities

- *Producers and other stakeholders have access to extensive science-based and targeted information and tools for adapting to climate and natural hazard risks*. This information is tailored to the needs of the sector, and by region and by type of natural hazard, and includes information and tools developed by the USDA Climate Hubs, universities and government agencies, as well as tools and services offered by the private sector. This encourages producers and other stakeholders to consider the risk landscape over the long term by helping them to understand the risks that they face from natural hazards, and supports risk-informed decision-making. An important feature of many of these initiatives is that they place significant emphasis on the co-production of information and tools by involving end-users in their development, to enhance their usability and relevance, and on tailoring climate information to meet the needs of producers in specific regions.
- *However, there are opportunities to increase awareness of the risks posed by natural hazards, and the risks of extreme floods in particular*. Efforts to collect data on production losses and damage to farm infrastructure and equipment could be extended, and this information could be made publicly available, in order to help identify vulnerabilities, guide investments in risk prevention and mitigation, and inform revisions to disaster assistance programmes. Trusted non-government organisations, such as the Farm Bureau could also play a larger role in promoting natural hazard risk awareness to improve the preparedness of their stakeholders.

An ex ante approach to natural hazard-induced disaster risk management

- *Conservation programmes and public-private initiatives help to mitigate flood risks and impacts on production*. The various soil health initiatives led by producers (e.g. the SHP), conservation districts and NRCS share a number of strengths, in that they engage with, and benefit from the support of, a diverse range of stakeholders; support on-farm experimentation with adaptation; prioritise communication with producers, including via peer networks; and build the evidence base on the economic and environmental benefits of soil health practices, thereby addressing an important information constraint to their adoption on farm and lowering the risks to farmers from changing farming practices. Nature-based solutions to mitigate flood risks and impacts receive technical and financial support through USDA's conservation programmes.
- *However, stakeholders under-emphasise ex ante measures to prevent and mitigate natural hazard risks*. The Climate Hubs face significant constraints in terms of funding and staffing levels, despite their key role in delivering science-based services and tools on climate and natural hazard adaptation, and demand for their programmes and products (Croft et al., 2020[27]; Elliot, 2020[28]). Disaster assistance programmes in the 2018 Farm Bill – the key policy framework for the sector –

prioritise support that helps producers to cope with the impacts of natural disasters such as floods despite the importance of helping the sector adapt or transform in the wake of flood events. Most of these programmes also lack guidance on – or any requirement to take – actions to reduce natural hazard exposure and vulnerability.

- Agricultural risk management policies may also discourage producers from adapting their enterprises to prevent and mitigate the risks posed by floods and other natural hazards in the long term. For example, crop insurance is the primary policy tool for mitigating natural hazard risk for many public and private stakeholders, and the programme has important strengths. However, subsidies (around 60% of the premium on average) mean that producer-paid premiums do not reflect the true risk premium, which could affect farming decisions and induce maladaptive practices.

An approach emphasising preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazard-induced disasters

- *Formal networks build disaster preparedness and response capacities.* At the national level, the Critical Infrastructure Sectors framework and NBEOC are valued by agricultural stakeholders for connecting public and private actors before a hazard occurs, and for their role in improving the effectiveness of disaster response and supporting business continuity. At the state level, networks such as EDEN and the Multi-State Partnership also build disaster preparedness and response capabilities, and minimise duplication of effort across states.
- *However, more could be done to support a resilient recovery by incorporating the principle of "building back better" after a NHID into existing disaster assistance programmes*. This includes providing guidance on on-farm options to reduce natural hazard exposure and vulnerability, securing funding for conservation programmes that support farmland rehabilitation and future flood risk mitigation, and removing constraints that limit how flexibly funding can be used.

11.5. Strengthening flood risk management for agriculture in the United States

Disaster risk governance, policy measures and on-farm strategies in the United States offer many examples of good practices for building the agricultural sector's resilience to NHID, but there are some concrete actions that would better position the sector to prevent, mitigate, prepare for and manage the risks of floods and other natural hazards.

- *Policies should provide clear signals for producers to manage risks and develop their capacity to plan for, absorb, recover from, and more successfully adapt to natural hazard risk*: Risk management programmes could be reviewed for their effects on farm-level incentives to prevent and mitigate risk in the long term, and for opportunities to integrate resilience considerations. USDA conservation programmes could also be leveraged to improve *ex ante* natural hazard risk management and support a more resilient recovery.
- *Raise the profile of programmes and tools that support adaptation to climate and natural hazard risks*: Tools and programmes that support adaptation to climate and natural hazard risks receive relatively less support than risk coping tools, with many subject to funding limitations and other constraints that limit use, despite high demand for these resources. Raising the profile of these programmes and strengthening the links with risk coping tools could improve outcomes.
- *Policy makers should engage more closely with trusted stakeholders to promote on-farm efforts to build resilience*: Industry organisations and locally-based stakeholders such as the Farm Bureau, county extension service and conservation districts are important and trusted sources of

information for the US agricultural sector. Policymakers should engage closely with these trusted stakeholders to promote the benefits of prevention and mitigation to reduce exposure to natural hazard risk, as well as to better understand farm-level constraints to adopting practices that improve farm resilience.

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Notes

[1] See Gray and Baldwin (2021[7]).

[2] Critical infrastructure is defined as the assets, systems, and networks that underpin American Society.

[3] RMA administers the federal crop insurance programme in partnership with private insurance companies, which share a percentage of the risk of loss or the opportunity for gain associated with each policy. The delivery costs of private insurance companies are also subsidised.

[4] A floodplain or flowage easement is a right granted by a landowner to allow the land to be temporarily inundated.

[5] The *Useful to Usable* project is a collaboration between USDA's National Institute for Food and Agriculture (NIFA), nine Midwestern universities, NOAA's Regional Climate Centres, and the National Drought Mitigation Center.

[6] Participation in the NBEOC is voluntary and open to all organisations with significant and multistate geographical footprints in the private sector.

[7] Building back better is defined as using the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment (UNISDR, 2015[18]).

[8] The authorisation of the Supplemental Agricultural Disaster Assistance Programs in the 2008 and 2014 Farm Bills, as well as expanded crop insurance over time – both in terms of commodity coverage and higher premium subsidies – and the availability of NAP policies, were intended to reduce the need for *ad hoc* disaster assistance (Stubbs, 2020[25]).

Building Agricultural Resilience to Natural Hazard-induced Disasters

INSIGHTS FROM COUNTRY CASE STUDIES

Natural hazard-induced disasters (NHID), such as floods, droughts, severe storms, and animal pests and diseases have significant, widespread and long-lasting impacts on agricultural sectors around the world. With climate change set to amplify many of these impacts, a "business-as-usual" approach to disaster risk management in agriculture cannot continue if we are to meet the challenges of agricultural productivity and sustainability growth, and sustainable development. Drawing from seven case studies – Chile, Italy, Japan, Namibia, New Zealand, Turkey and the United States – this joint OECD-FAO report argues for a new approach to building resilience to NHID in agriculture. It explores the policy measures, governance arrangements, on-farm strategies and other initiatives that countries are using to increase agricultural resilience to NHID, highlighting emerging good practices. It offers concrete recommendations on what more needs to be done to shift from coping with the impacts of disasters, to an ex ante approach that focuses on preventing and mitigating the impacts of disasters, helping the sector be better prepared to respond to disasters, and to adapt and transform in order to be better positioned for future disasters.

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