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ADDRESSING AGRICULTURE, FORESTRY AND FISHERIES IN NATIONAL ADAPTATION PLANS

[Supplementary guidelines]

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APRIL 2017

This document has been prepared to supplement the UNFCCC National Adaptation Plan Technical Guidelines.

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Foreword

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Climate action in the agricultural sectors has never been more important than today. Crops, livestock, forestry, fisheries and aquaculture provide direct livelihoods to over 1.3 billion people and their dependants, produce food for our growing population and support national economies. However, climate change is already modifying and degrading productive capacities and the natural resource base and ecosystems on which they rely. It threatens to undermine all dimensions of food security, not only productive capacity: climate change can limit the stability and potential growth in the incomes, especially of the poorest, and thereby reduce their ability to purchase nutritious food; it increases risk of market disruptions; it affects supply and storage systems; climate change has even been found to adversely impact the nutritional content of some foods. At the same time, boosting food production by 60 percent to feed an anticipated world population of 9 billion people by 2050 challenges the long term goal of achieving carbon neutrality by the same year. Farmers, fishers and foresters are already adjusting to these changing conditions and pressures. They need support that helps them sustainably build the resilience of food systems and ecosystems to shocks and strengthen their adaptive capacity to cope with increased variability and slow onset changes in order to succeed in their efforts of securing food security and nutrition.

The Paris Agreement on climate change aims to set the world on course for a healthier, safer, more prosperous future with its twin goals of limiting average temperature increase to "well below 2°C" compared to pre–industrial times while "ensuring an adequate adaptation response in the context of the global temperature goal". It recognizes "the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change", a message that resonates particularly in developing countries' national climate plans: 93 percent of developing countries included adaptation in the agricultural sectors in their Intended Nationally Determined Contributions (INDCs).

National Adaptation Plans (NAPs) are considered to be a core vehicle to deliver on adaptation priorities, and towards achieving countries' Nationally Determined Contributions (NDCs). The NAPs process was established under the Cancun Adaptation Framework in 2010, enabling Parties to the UNFCCC to identify medium– and long–term adaptation needs and to develop and implement strategies and programmes to address them. NAPs can build upon the National Adaptation Programmes of Action (NAPAs), established in 2001, to tackle least developed countries' urgent and immediate needs to adapt to climate change.

This document, *Addressing agriculture, forestry and fisheries in National Adaptation Plans – Supplementary guidelines (NAP–Ag Guidelines)*, responds to a call issued in 2013 by the Least Developed Countries Expert Group (LEG) of the UNFCCC, inviting international actors to "come forward in drafting supplementary sectorial guidelines to the *NAP Technical Guidelines*". The *NAP–Ag Guidelines* therefore specifically aim to support:

- National planners and decision–makers working on climate change in developing countries to better understand the need and opportunities for adaptation in the agricultural sectors.

- Authorities and experts within the agricultural sectors who are already contributing to climate change adaptation and NAP formulation.

These guidelines were developed over the past two years in a consultative process involving 15 countries and 20 international agencies, including the Rome–Based Agencies and the CGIAR System, as well as the UNFCCC and the LEG. The *NAP–Ag Guidelines* are informed by the joint UNDP–FAO programme, *Integrating Agriculture in National Adaptation Plans*, which aims to address climate change adaptation concerns related to the agricultural sectors in 11 partner countries' national planning and budgeting processes. Notwithstanding the unique individuality of each country, important lessons can be drawn from existing experience. Such insights have enriched the *NAP–Ag Guidelines* with experiences from the ground.

To facilitate integration with adaptation planning across different economic sectors, the *NAP–Ag Guidelines* follow the same four elements that structure the UNFCCC NAP Technical Guidelines: laying the groundwork and addressing gaps; preparatory elements; implementation strategies; and reporting, monitoring and review. Within each element, various possible steps related to the agricultural sectors are outlined. As every country pursues its individual, nationally driven process to address climate change, the planning elements and steps described here offer guidance, and are not prescriptive.

In parallel with their adaptation planning, countries are gearing up to deliver on the mitigation commitments of their NDCs as well as the global development framework provided by new Sustainable Development Goals (SDGs).

Looking ahead to 2050, countries have furthermore been requested to develop zero emission pathways. In this complex landscape of interrelated policy planning and implementation, establishing clear and simple systematic linkages across NAPs and related processes will be the key to success. The international community is scaling up its support in this regard.

An important enabling step in terms of resourcing was taken in June 2016, when the Board of the Green Climate Fund created a dedicated funding window under its Readiness and Preparatory Support Programme of up to USD 3 million per country "*for the formulation of National Adaptation Plans (NAPs) and/or other adaptation planning processes*". The Global Environment Facility and bilateral donors are also making funding available for countries to advance in the formulation and implementation of NAPs.

To provide the necessary technical support to countries undertaking this process, FAO in 2017 adopted a corporate *Strategy on Climate Change*, which aims to comprehensively address climate change and sustainable development. FAO is committed to continue integrating food security and nutrition considerations within the international discourse on climate change.

As we build the food systems that will feed the future, decisive climate action will be our defining challenge. Rural or urban, farmer or policy–maker, producer or consumer – we are all stewards of the natural resources and systems that sustain us. United in action, we can become resilient.

René Castro Salazar

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Any omissions of contributors to this guide are unintentional.

If you seek more information related to the guidebook or would like to provide feedback, please contact: FAO–NAPs@fao.org

Abbreviations and acronyms

BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
CBD	Convention on Biological Diversity
CCAFS	CGIAR Research Programme on Climate Change, Agriculture and Food Security
CIFOR	Center for International Forestry Research
COP	Conference of Parties
CSA	Climate–smart agriculture
CSO	Civil society organization
DRM	Disaster risk management
DRR	Disaster risk reduction
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GCF	Green Climate Fund
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German International Cooperation Agency)
HLPE	High Level Panel on Food Security and Nutrition
ICI	International Climate Initiative
IFAD	International Fund for Agriculture Development
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change

IUCN	International Union for Conservation of Nature
LDC	Least Developed Country
LAPA	Local Adaptation Plans of Action
LEG	Least Developed Countries Expert Group
MOSAICC	Modelling System for Agricultural Impacts of Climate Change
NAIP	National Agriculture Investment Plan
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NDC	Nationally Determined Contribution
NGO	Non–governmental organization
OECD	Organisation for Economic Co–operation and Development
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDG	Sustainable Development Goals
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization
WMO	World Meteorological Organization

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Introduction

Many developing countries consider adaptation as their main priority because of significant impacts climate change is expected to have on national development, sustainability and security.

The *Addressing agriculture, forestry and fisheries in National Adaptation Plans – Supplementary guidelines* (referred to hereafter as the *NAP–Ag Guidelines*) accompany the United Nations Framework Convention on Climate Change (UNFCCC) National Adaptation Plan (NAP) Technical Guidelines prepared by the Least Developed Countries Expert Group (LEG) of the UNFCCC, by providing specific guidance for the agricultural sectors. The term 'agriculture sectors' used throughout the document refers to crop–based farming systems and livestock systems, including rangelands and pasturelands; forestry;[1] and fisheries. The fisheries sector includes capture fisheries (fish caught from wild stocks in marine, coastal, off–shore and freshwater ecosystems) and aquaculture (the breeding, rearing and harvesting of plants and animals in all types of aquatic environments).

The Guidelines aim to support developing countries in:

- reducing vulnerability of the agriculture sectors to the impacts of climate change by building adaptive capacities and resilience;
- addressing agriculture in the formulation and implementation of NAPs; and
- enhancing the integration of adaptation in agricultural development policies, programmes and plans.

Chapter One provides background information on NAP formulation and implementation processes.

Chapter Two focuses on technical issues related to climate change, food security, nutrition and the agriculture sectors and gives an overview of the impact of climate change on the agriculture sectors and food security. Key issues are covered in this chapter and in Annex 1, and suggestions are provided for further technical information.

DEMOCRATIC REPUBLIC OF CONGO
A farmer winnowing rice to separate it from remaining pieces of straw while laying it out to dry in the sun outside his home.
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1 In this document, forests are defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under crop or livestock production or urban land use (FAO, 2010).

Chapter Three introduces approaches, preparatory measures and institutional arrangements for adaptation planning in the agriculture sectors.

Chapter Four includes step–by–step guidance for agriculture adaptation planning, aligning the elements and steps closely with the development of the broader NAPs. The aim is to make the planning process simple, clear and easy to implement. The fourth chapter also includes links to resources and examples to support adaptation planning, implementation, monitoring and evaluation. A glossary provides definitions of some specific climate change terms.

BOX 1.

Food security

In this document, the concept of food security is critically important. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). This widely accepted definition points to the following four dimensions of food security:

Availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).

Access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).

Utilization: Utilization of food through adequate diet, clean water, sanitation and healthcare to reach a state of nutritional well–being where all physiological needs are met.

Stability: To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability therefore refers to the availability, access and utilization dimensions of food security.

1.1 Overview of NAPs and their link to Nationally Determined Contributions

The NAP process was established under the UNFCCC in 2010 as part of the Cancun Adaptation Framework. The process enables Parties to the UNFCCC to formulate and implement NAPs as a means of identifying medium– and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process that follows a country-driven, gender–sensitive, participatory and fully transparent approach. NAPs are also now linked to funding sources from the Green Climate Fund (GCF) Readiness and Preparatory Support

Programme, established by the GCF Board in June 2016, and which provides country support for up to US$3 million for the "formulation of NAPs and/or other adaptation planning processes".

Climate change is a particular risk to developing countries, which often lack the capacities to respond to current climate variability and adapt to changing climatic conditions. A NAP is a process to address risks and capacity gaps in medium– to long–term climate change adaptation planning and implementation in developing countries. The objectives of NAPs were defined by COP–17 as follows: "to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience", and "to facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate" (UNFCCC, 2012a).

The Paris Agreement, which came into force in 2016, has created historic momentum for making climate change a prime focus area in the development agenda. It also recognizes "the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change." Countries are looking at ways of meeting the commitments they set out in their Nationally Determined Contributions (NDCs). A majority of developing countries have chosen to include an adaptation component in their NDC. Developing countries are, in parallel, aligning their long–term national development priorities and zero–emission pathways with the framework of the Sustainable Development Goals (SDGs). Hence, it is essential to establish systematic links between NAPs and key planning processes, such as NDCs and the 2030 Development Agenda and its SDGs.

The process to formulate and implement NAPs benefits from the experiences of National Adaptation Programmes of Action (NAPAs), a process initiated in 2001, which focused on urgent and immediate adaptation needs, i.e. those for which further delay could increase vulnerability or lead to increased costs at a later stage in the Least Developed Countries (LDCs). The implementation of projects in NAPA priority areas is ongoing, with financing from different sources, including the GEF's Least Developed Countries Fund, the Special Climate Change Fund and the Adaptation Fund.

At country level, the national adaptation planning should evolve out of existing adaptation and resilience–building process, often within a wider climate change response that may include disaster risk reduction (DRR), disaster risk management (DRM), climate change mitigation planning and climate finance. National contributions, actions, plans and priorities were addressed by priorities in their INDC to the UNFCCC and pledged in the Paris Climate Agreement in 2015. By July 2016, 190 Parties had submitted 161 INDCs.[2] Of these, 134 INDCs included concrete information on areas and/or actions for adaptation (FAO, 2016a).

Many developing countries consider adaptation as their main priority because of the significant impacts climate change is expected to have on national development, sustainability and security. Parties referred to virtually every economic sector in the adaptation component of their INDCs. Notably, almost 93 percent of the countries that stressed the need for adaptation in their INDC included the agriculture sectors. Of these countries, 97 percent referred to crops and livestock, 89 percent to forests, and 64 percent to fisheries and aquaculture. Furthermore, 84 percent of these countries referred to DRM (FAO, 2016a).

The INDC submitted by each Party become its NDC on ratification of the Paris Agreement, unless the Party submits a revised NDC. The Parties are expected to communicate updates of their NDC every five years starting in 2023. Parties may also adjust their existing NDC at any time with a view to enhancing their level of ambition (UNFCCC, 2016). The process of formulating and implementing NAPs will help countries to further identify and address key adaptation issues, gaps, priorities and resource requirements. For this reason a NAP is an instrument that is well suited to support the formulation, updating and implementation of the NDCs (GIZ, 2016a). The alignment of prioritized adaptation actions from NDCs and NAPs can be enhanced by coordinating the processes and the activities of the different stakeholders, and

2 The European Commission submitted one joint INDC for its 28 member states.

establishing links to relevant climate financing mechanisms (e.g. GCF) and national development and investment plans.

In their INDCs, several Parties also indicated that climate–smart agriculture (CSA) could be an effective approach for meeting national climate change challenges because of the adaptation-mitigation co–benefits the approach provides. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible. Given that adaptation actions need to consider potential co–benefits, CSA can provide options in the NAP formulation and implementation processes. Examples of adaptation co–benefits include increased agricultural productivity and potential climate change mitigation co–benefits (e.g. carbon sequestration in soils through a shift to more sustainable grazing management). In moving toward CSA, countries need to assess carefully the potential synergies and trade–offs between increased efficiency in the use of resources and greater resilience. The CSA approach can contribute to this goal by making sure that adaptation measures are not proposed in isolation and do not neglect potential co–benefits (FAO, 2016b).

1.2 Overview of NAP technical guidelines

The UNFCCC NAP Technical Guidelines (UNFCCC, 2012a) prepared by the LEG provide advice on establishing a national planning process, identifying and addressing capacity gaps, preparing NAPs, and establishing a monitoring and evaluation system. They contain a 'checklist' of approaches, actions, tools and activities that countries may find useful in undertaking adaptation planning. They also function as a coherent package for any country that wants to complete all the steps in the process.

Because the UNFCCC NAP Technical Guidelines are not specific to any sector, the UNFCCC invited agencies and partners to submit sector–specific supplementary technical guidelines to support developing countries in preparing their NAPs (UNFCCC, 2013). In response, several agencies have supplemented the UNFCCC NAP Technical Guidelines with sectoral guidance notes and other materials that offer in–depth coverage of sectors, subsectors or cross–cutting topics. Supplements relevant to the agriculture sectors, as well as food security and nutrition include those that deal with biodiversity, ecosystems, genetic resources, climate services, health and water. For detailed technical guidance on these topics, readers are advised to consult these publications.[3]

FAO's first response to the UNFCCC invitation has been the preparation of *Voluntary Guidelines for the Integration of Genetic Diversity in the NAP process* (FAO, 2015a). The *NAP–Ag Guidelines* represent FAO's second contribution to help countries address issues related to agriculture in NAP development. FAO is also finalizing supplementary NAP guidelines that focus specifically on fisheries and aquaculture.

In consultation with UNFCCC, the LEG, other agencies and country representatives, FAO has prepared these *NAP–Ag Guidelines*, designed to be an easy–to–use and accessible document for planners.

They intend to:

- highlight climate vulnerabilities of food security and the agriculture sectors to enable the identification, prioritization and implementation of adaptation options;
- facilitate the integration of concerns and perspectives related to agriculture, and food security and nutrition into national climate change adaptation planning and implementation;
- enable agricultural stakeholders to incorporate climate change adaptation in medium– to long–term policy and planning processes;
- establish a framework for planning, implementing and monitoring adaptation actions in the agriculture sectors;
- empower agricultural stakeholders to participate effectively and efficiently in the

3 The UNFCCC Supplementary Materials to The NAP Technical Guidelines are available at: www4.unfccc.int/nap/Guidelines/Pages/Supplements.aspx

process to formulate and implement NAPs; and

- help non–agricultural specialists to understand the issues related to the agriculture sectors, food security and nutrition in the context of climate change.

The *NAP–Ag Guidelines* are built on several principles that are in line with the principles of the UNFCCC NAP Technical Guidelines, which support "a continuous, progressive and iterative process which follows a country–driven, gender–sensitive, participatory and fully transparent process" (UNFCCC, 2012a). The *NAP–Ag Guidelines* expand on elements and steps within NAP development that are relevant to agriculture. Without duplicating the existing UNFCCC documentation, the *NAP–Ag Guidelines*:

- provide supporting material and examples on the specific aspects of agricultural adaptation planning;
- further emphasize the need for gender–responsive and nutrition–sensitive analyses and solutions;
- stress the many inputs that are essential in an iterative process that spans planning, decision–making, implementation and reviewing progress in improving resilience and adaptation to climate change;
- seek to promote coherence across sectors and subsectors, and across general sectoral planning and climate change adaptation in agriculture;
- help to identify and address gaps in capacity, information and adaptation actions in the agriculture sectors on an ongoing basis; and
- seek to support periodic review of progress and successes of the process through a structured monitoring and evaluation framework.

The *NAP–Ag Guidelines* are targeted to several audiences. They are intended for national planners and decision–makers working on climate change issues in developing countries. This audience includes the men and women who are bringing together information for analysis and decision–making at the high policy level and across many different sectors; the UNFCCC focal points and the national designated authorities of the GCF; and others planners who may have only limited agriculture expertise. The second target group includes authorities and experts within the agriculture sectors who are contributing to climate change adaptation and NAP formulation and implementation. This group also includes other partners and stakeholders, who participate in sectoral, national and subnational planning processes and work to mainstream climate change adaptation into different sectors and programmes. A third group targeted by the *NAP–Ag Guidelines* are climate change experts working at the global level, including United Nations, bilateral donors and financing institutions (e.g. GEF and GCF).

In addition to guidelines directly linked to NAP development, a wealth of technical information and tools exist to guide the development of the contributions that the agriculture sectors can make to NAPs. Links to these resources are included in Chapter 4.

2

Why and how to address agriculture, food security and nutrition in NAPs?

The agriculture sectors are among the most sensitive sectors to changing climate conditions and the most highly exposed to the impacts of climate change.

2.1 Rationale for including agriculture, food security and nutrition in NAPs

There are three main reasons for addressing the agriculture sectors in NAPs. First, the agriculture sectors are among the most sensitive sectors to changing climate conditions and the most highly exposed to the impacts of climate change. Second, crop and livestock production, fisheries and agriculture and forestry are all critical to food security and nutrition, not only because they produce food, but also because they play an essential role in the economy of many countries, especially the most vulnerable, providing livelihoods and incomes to the most vulnerable populations. Third, agricultural production involves the careful management of natural resources, including land, water, biodiversity and genetic resources, and so has a key role to play in the adaptation of ecosystems to climate change. Because of this, agriculture can make a significant contribution to climate change adaptation at a national level.

The agriculture sectors face the challenge of meeting the demand of expanding populations for safe and nutritious food. It is estimated that a 60 percent increase in production will be needed by 2050 to meet growing food demand (Alexandratos and Bruinsma, 2012). This challenge is heightened by the fact that global energy demand is expected to increase about 48 percent by 2040 (United States Energy Information Administration, 2016), and water demand is projected to increase about 55 percent by 2050 (Leflaive *et al.*, 2012). Moreover, malnutrition remains an under–recognized threat to development. Today 1 in 3 people are malnourished, and by 2030, 1 in 2 people are expected to be undernourished or overnourished (Global Panel for Food Systems and Nutrition, 2016).

Agriculture is the main source of livelihood in most developing countries. In 2010, 40 percent of the economically active population (about 1.3 billion people) was directly engaged in crop and livestock production. In many developing countries, this

KENYA
A herd of cattle drinking water.
©FAO/Simon Maina

percentage was much higher (e.g. 93 percent in Bhutan, 89 percent in Burundi, 75 percent in the Lao People's Democratic Republic, 68 percent in the Solomon Islands and 59 percent in Haiti) (FAO, 2012a). Fisheries and aquaculture are also important sources of food, nutrition, income and livelihood for hundreds of millions of people. Fish is one of the most internationally traded food commodities, with more than half of fish exports by value originating from developing countries (FAO, 2016c). Forests support the livelihoods of more than 1 billion people living in extreme poverty and generate formal or informal employment for more than 100 million people in rural areas (FAO, 2012b). How climate change will affect the agricultural sectors and their capacity to respond to these changes will have far–reaching impacts on food security, nutrition and livelihoods for the majority of people in many developing countries (see Box 2), and on national economies.

BOX 2.

Climate change affects all four pillars of food security

Climate change affects all four pillars of food security. The potential impacts on access, utilization and stability have been less studied than the impacts on food production and availability. However, several impact pathways can be identified.

Climate change will affect livelihoods and lead to loss of assets and income of small–scale food producers. Increases and greater volatility in food prices will affect the livelihoods and food security of all poor net food buyers, forcing these populations to reduce the amount of food they eat and to consume foods of lower nutritional value.

There could be a reduction in the production and consumption of some foods, such as fish, fruits and vegetables and wild foods, which are critical to the diets of vulnerable rural and indigenous populations. Many studies also conclude that climate change could increase food safety hazards, and that more research is required to get a better understanding of these problems and to set up adaptation strategies (FAO 2016d). While more carbon dioxide in the atmosphere may fertilize some crops and raise yields, evidence is emerging that it may also reduce their nutritional value, lowering the protein, iron and zinc content of some crops by small, but nutritionally significant amounts (Myers *et al.*, 2014).

Climate change may also affect the stability of the food supply through changes in seasonality, increased variance of ecosystem productivity, greater supply risks and reduced supply predictability (FAO, 2016e). In some regions, these changes may lead to food price volatility and a higher dependency on imports and food aid (FAO, 2011).

Because climate change has a number of different and interconnected impact pathways, increasing the resilience of vulnerable communities to safeguard their food security and nutrition in the face of changing conditions calls for multiple interventions, from adjusted production practices and food systems to social protection and risk management (FAO, 2016c).

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), four out of the eight identified key climate change risks are linked to food security (FAO, 2016e). This is largely a result of the direct and mostly negative impacts of rising temperatures, changes in rainfall patterns and increased frequency of extreme events on the productivity of crops, livestock, forestry, fisheries, aquaculture and ecosystems (Porter *et al.*, 2014). Climate change can also modify the impact of pests and diseases on crops, livestock, forests and fish in a number of ways. Currently, an estimated 10–16 percent of the global crop harvest is lost to plant pests each year (FAO, 2016b).

Climate change is expected to cause substantial reductions in yields. For example, in Southern Africa, there could be a reduction of up to 30 percent for maize production by 2030, and in South Asia a reduction of up to 10 percent for staple crops, such as rice, and more than 10 percent for millet and maize (Lobell *et al.*, 2008). These impacts and their relevance when addressing agricultural issues in NAPs are elaborated in Annex 1.

It is important to note that developing countries that are particularly vulnerable to the adverse effects of climate change are in that situation often not only because of their exposure to climate change and their dependence on agriculture for their national economies and food security and nutrition, but because of their weak adaptive capacity and lack of resilience, but because of their dependence on agriculture for their national economies and food security and nutrition (FAO, 2016d).

Over the last decades, there has been an increase in the occurrence of disasters and their economic damage. Climate–related disasters, such as droughts, floods and storms, have a profound negative impact on agricultural production, livelihoods, food security and nutrition. An analysis of post–disaster needs assessments has revealed that in developing countries, the agriculture sectors absorbed one–quarter of the total impact of climate–related disasters between 2003 and 2013 (FAO, 2015b).

Vulnerable communities and people living in fragile environments, such as dry lands, mountainous areas, coastal zones and Small Island Developing States, are particularly affected by climate extremes and changing climate. These changes will significantly increase the production risks for crop growers, livestock producers, fishers and aquaculturalists and forest–dwellers in these regions. These communities often suffer from chronic soil degradation and water scarcity, face high levels of poverty and hunger and have a high exposure to extreme climate events (FAO, 2008b).

Farmers in some regions in higher latitudes may benefit temporarily from the effects of carbon dioxide fertilization, longer growing seasons and higher yields. For example, some studies suggest potential increase of 34 to 54 percent of wheat, maize and soybean yield in Boreal Europe by 2080 (Porter *et al.*, 2014). These potential benefits and opportunities should be seized, which requires appropriate changes in practices. Nevertheless, the net consequences of climate change are expected to be adverse, particularly for poor and marginalized populations in developing countries. The vulnerability of food insecure people is also determined in part by gender roles, age, health and location (FAO, 2011).

Agricultural adaptation is tightly linked to many other cross–cutting or multisectoral adaptation issues. Cross–sectoral issues, such as early warning systems, DRM, and education and capacity development, are particularly relevant for agricultural stakeholders. In this regard, it is also important to avoid maladaptation, i.e. an action or process that increases vulnerability to climate change–related hazards. Maladaptation is the result of development policies and measures that deliver short–term gains or economic benefits but increase vulnerability in the medium to long term (Olhoff and Schaer, 2010).

The agriculture sectors are also the main users of land and water, and therefore they interact closely with other economic sectors that are competing for these increasingly scarce resources. Climate change adaptation should enhance and build on healthy and functional ecosystems, as they provide a variety of benefits and services on which agricultural production systems and rural livelihoods depend. Sustaining these ecosystems is critical to achieving lasting food security and nutrition.

The formulation and implementation of NAPs is meant to be a cross–sectoral and multistakeholder process. It needs to engage

all relevant stakeholders, including those from all the agriculture sectors, to identify and prioritize adaptation actions, and the allocation of development and climate financing.

2.2 Specific challenges for climate change adaptation in the agriculture sectors

Integrating crop and livestock production, forestry and fisheries and aquaculture in NAPs involves overcoming some specific challenges. First, the different agricultural sectors are extremely diverse and differ in how they will be impacted by climate change and how they will need to adapt. These sectors also engage many different stakeholders, including indigenous people and women and youth, many of whom are not always in a position to effectively engage in planning and decision-making processes.

The preparation of the NAPAs has shown the importance of ensuring a strong engagement of national stakeholders from all sectors in the process of identifying priority actions. Sector–specific actions are needed to ensure that traditionally under–represented systems and communities are considered sufficiently in adaptation planning. Furthermore, the difficulties encountered in engaging stakeholders are likely to increase in the context of NAPs. NAPAs have been addressing immediate adaptation concerns that stakeholders could easily grasp and on which they could have a clear position. As a result, crop and livestock production, forestry and fisheries and aquaculture are very prominent in NAPAs. They were selected and prioritized by the countries themselves, after an evidence-based process involving many stakeholders (Meybeck *et al.*, 2012). Ensuring the same level of stakeholder involvement in NAPs and enabling the development of medium– to long–term plans that are soundly linked to short–term climate change adaptation planning and actions and building on them will require providing stakeholders with a range of plausible visions of the future. Stakeholder engagement is also vital for the prioritization of adaptation actions within and between sectors. Countries characterized by diverse climate, agro–ecological and socio–economic conditions will need to define the focus of the medium– to long–term adaptation and take decisions that address various pressing needs.

A second, major challenge in the development of a medium– to long–term vision for the agriculture sectors at the appropriate scale is the increased difficulty in predicting weather patterns under changing climatic conditions. Agriculture sectors can be disproportionately affected by small and localized changes in temperature and rainfall patterns in micro–environments. As conditions in these agricultural ecosystems are extremely temporally and spatially specific, climate change projections must be done at a very detailed scale and are often not available or would be difficult to produce with sufficient accuracy. There are also huge knowledge gaps on the potential impacts of climate change on many agricultural production systems, food systems and diets. Even more importantly, the impacts of climate change on complex systems, such as ecosystems and agro–ecosystems, are much more difficult to predict than impacts on a single crop, animal or tree species. A key challenge is also related to the lack of systematic collection and use of data on the impact of climate–related extremes and disasters on agriculture. This information is essential to support evidence–based DRR/DRM and adaptation planning for focused actions. In the absence of this evidence, most planners look to build resilience to increasing variability by promoting a no–regret approach – an approach that diversifies land use and livelihoods. No–regrets actions (e.g. rainwater harvesting techniques and water reservoirs, increasing soil organic matter, and improving access to weather information) can have significant development benefits under a range of climate change scenarios.

A third difficulty that is specific to the agriculture sectors, is the need to devise and implement adaptation pathways that are effective in dealing with slow onset climate changes. Infrastructure can be built to resist different stresses in fifty years, but it is much more difficult to manage a forest in such a way that it can thrive under present climate conditions and yet be adapted to conditions that will exist half a century from now. Also the extent and duration to which an agricultural system can be adapted before needing a radical systemic change is not always easy to determine. For instance, it is not clear how long cropping

systems can adapt to drought or to salinity before a switch must be made to other crops or to livestock. Scientific knowledge is often needed to supplement traditional planning systems to modify procedures, as planning practices used today or in the past may not work under the new climate regime. Very often changing to another crop or commodity, calls for a systemic or transformational change of the value chain and changes in human behaviour, culture and customs, food systems and diets.

The situation is compounded by a fourth difficulty: the dependence of stakeholders on crops, livestock, forestry and fisheries and aquaculture for their incomes, livelihoods and food security. Overcoming this difficulty is even harder when countries depend on agriculture for regular production (e.g. cash crops, such as cacao, coffee and banana) to bring in revenue from every production cycle. The farmers and the countries cannot afford to risk their current production to adapt to future negative impacts of climate change. Adaptation by farmers is a gradual and continuous process where choices are made in the short term. Better management of currently known risks is often an initial no–regret step to building resilience for future uncertain risks (Meybeck *et al.*, 2012). Drastic changes in climate will be difficult to adapt to, as farmers may be expected to engage in newer and riskier practices and technologies, or they may be forced to abandon agriculture entirely and move to cities to work in the service sectors or even emigrate.

2.3 Wider planning frameworks and cross-cutting issues and approaches

Climate change interacts with other environmental issues that are covered by specific frameworks and instruments. The UNFCCC, the Convention on Biological Diversity (CBD), and the United Nations Convention to Combat Desertification (UNCCD) – the three Rio Conventions agreed on during the 1992 Earth Summit – all have close linkages to the agriculture sectors, and synergies between these three conventions should be explored at the national level. A fourth global framework that must be considered is the Sendai Framework for Disaster Risk Reduction 2015–2030. The 2030 Agenda and the SDGs also deal with questions relevant to agriculture, food security, nutrition and sustainable management of natural resources (FAO, 2016h). For forestry, the relevant international frameworks for consideration include the United Nations Forum on Forests and The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+).

Adaptation planning needs to take into account other national programmes such as NAPAs and their variants, the Local Adaptation Plans of Action (LAPAs), National Agriculture Investment Programmes (NAIPs), Nationally Appropriate Mitigation Actions (NAMA), green low–carbon growth or development strategies, programmes for low–carbon and climate–resilient pathways, DRR plans, and plans and programmes for fostering food security and sectoral development.

In addition to the many questions related to specific sectoral and subsectoral issues, cross-cutting themes (see Annex 2) need to be properly considered and integrated.

3

Approaches to adaptation planning in the agriculture sectors: description of elements and steps

Agricultural adaptation planning should be harmonized with the overall national planning processes to build synergies with other sectors, such as health, water, and infrastructure; feed timely inputs into planning and utilize the materials and findings from other sectors.

UNITED REPUBLIC OF TANZANIA
Overview of rice paddies in Kiroka.
©FAO/Daniel Hayduk

This third chapter of the *NAP–Ag Guidelines* follows the same structure as the UNFCCC NAP Technical Guidelines (UNFCCC, 2012a). It suggests specific activities, options and interventions that are important for the agriculture sectors in NAPs. The four elements of the planning cycle are part of an iterative process with each element contributing to the following one. Some overlap between elements and steps is expected as some activities initiated under element A can be further strengthened under element B and C, and so forth (see Table 1). Nevertheless, it is not necessary to complete all of the steps in each element. Issues related to crop and livestock production, forestry and fisheries and aquaculture and food security are different for every country and so are NAPs. The appropriate steps and approaches should be identified and prioritized accordingly.

The following guidance is divided in four elements: A, B, C and D. The main issues related to agriculture in each of the elements are as follows:

- **Element A** sets the scene at the country level for adaptation planning in the agriculture sectors, including stocktaking of ongoing sectoral and subsectoral adaptation and development activities and the participatory assessment of individual, organizational and institutional capacity development needs. One of its main objectives is to ensure and facilitate the appropriate involvement of relevant stakeholders from the different agriculture sectors in the process of formulating and implementing NAPs.
- **Element B** proposes issues for consideration when doing in-depth climate change scenario analyses, and vulnerability, risk and impact assessments for the agriculture sectors. It presents various options that agricultural stakeholders and other participants should consider when undertaking adaptation planning, including enhancing capacities for climate change mainstreaming.
- **Element C** guides the design of nuanced implementation strategies for the adaptation plans. For agriculture, the main output is a strategy for implementing the NAP that takes into consideration crop and livestock production, forestry and fisheries and aquaculture. Implementation issues

are also discussed, such as strengthening long–term institutional and regulatory frameworks that are particularly important for agriculture. Implementation considers the results of the stocktaking of existing work in the agriculture sectors and related areas in Element A and builds as much as possible on ongoing activities.

- **Element D** focuses on how to monitor the development of the agriculture sectors' contribution to the NAP, the inclusion of agriculture sectors in the NAP, the progress in strengthening human and institutional capacities, and the progress of adaptation measures, from the design stage to implementation on the ground.

TABLE 1.

Checklist for elements and steps in the NAP–Ag process

A: Laying the Groundwork and Addressing Gaps	❑ A1. Initiate participation of representatives from the agriculture sectors in national adaptation planning, including clarifying mandates and engaging focal points for the different sectors ❑ A2. Take stock of existing vulnerability and risk assessments, knowledge, methodologies, and possible capacity and institutional gaps, policies, plans and investment frameworks in the agriculture sectors ❑ A3. Address capacity gaps and weaknesses in adaptation planning in the agriculture sectors ❑ A4. Assess and identify links between adaptation needs and development goals in the agriculture sectors
B: Preparatory Elements	❑ B1. Analyse current and future climate scenarios for production and sustainability ❑ B2. Assess climate impacts, risks and vulnerabilities and identify adaptation options for the agriculture sectors ❑ B3. Select and appraise adaptation options in the agriculture sectors ❑ B4. Compile and communicate agricultural perspectives for NAPs ❑ B5. Review the integration and alignment of climate change adaptation in the agriculture sectors in development planning and NAPs, including national, subnational and sectoral and subsectoral plans
C: Developing Implementation Strategies	❑ C1. Ensure appropriate priority for the agriculture sectors in national adaptation planning and NAPs ❑ C2. Develop a long–term adaptation implementation strategy that includes potential options for scaling up adaptation actions and leveraging climate finance ❑ C3. Improve capacity for planning and implementing adaptation in the agriculture sectors ❑ C4. Promote coordination and synergies at the national and subnational level
D: Monitoring, Reporting and Review of the process	❑ D1. Prepare for monitoring adaptation planning and implementation in the agriculture sectors ❑ D2. Review the national planning process assessing how the agriculture sectors are being addressed ❑ D3. Monitor and iteratively update the process of adaptation planning and implementation in the agriculture sectors ❑ D4. Outreach on the process, and report on the alignment of NAP/NAP–Ag progress and effectiveness

3.1 Preparations and institutional arrangements for NAPs in the agriculture sectors

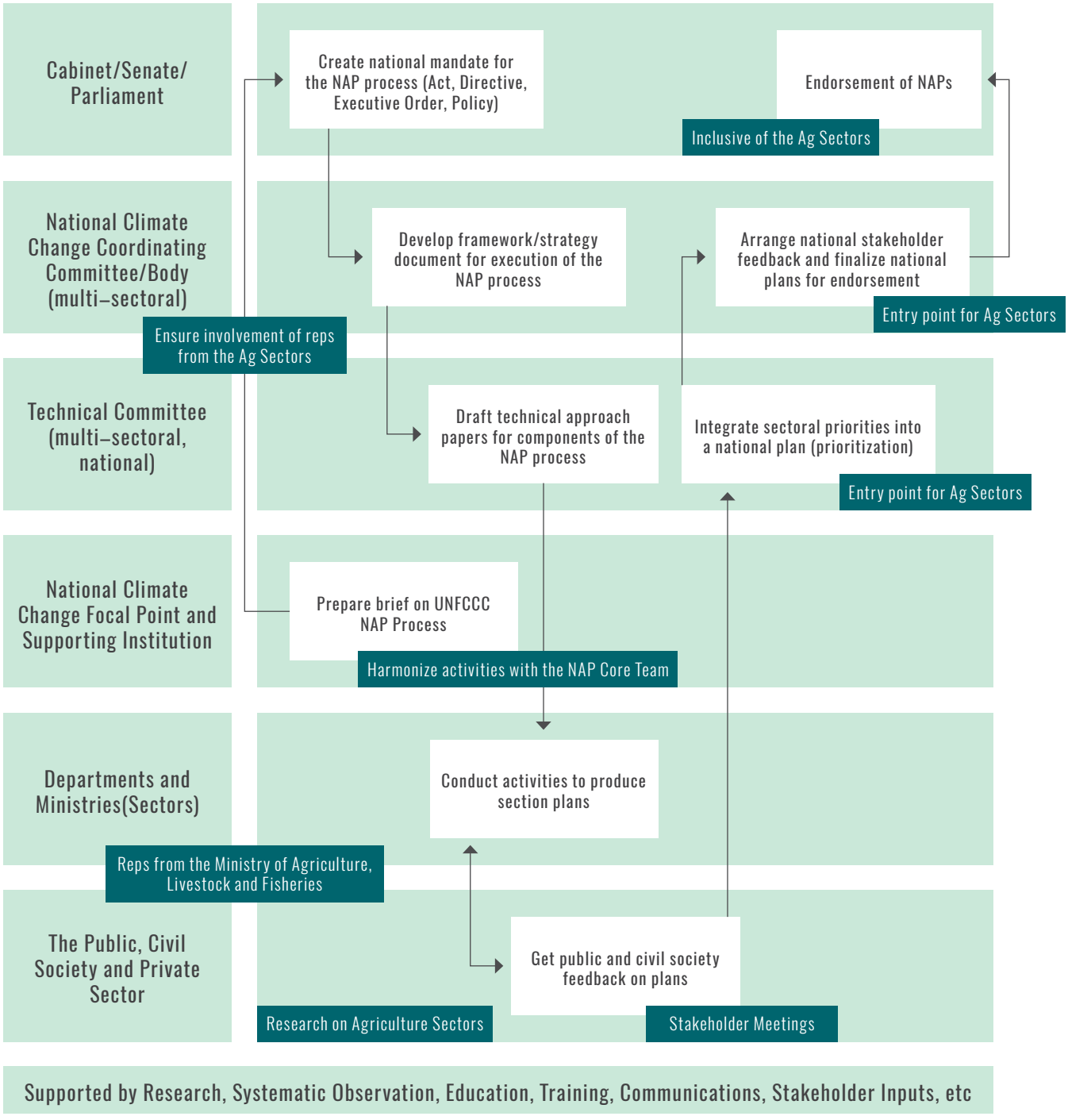
This section outlines the contribution the agriculture sectors can make in the formulation and implementation of NAPs (see also Figure 1 and Table 2). This subject is further elaborated in Chapter 4, which includes case studies and examples of planning processes, and links to relevant tools, methods and other materials related to the agriculture sectors. It is important to realize that no single approach will work for all the adaptation planning needs in the agriculture sectors in all countries. The country–specific circumstances and the stage the country has reached in its NAP must be considered. This calls for flexibility in terms of the process and its elements, and in the steps and activities relevant for accomplishing the planning.

Within a country, the institutional arrangements for the development and implementation of adaptation plans will vary according to national circumstances. Most countries have appointed a government agency to lead efforts on climate change adaptation, particularly for NAPs. This agency is typically given a mandate to coordinate the cross–sectoral efforts of other agencies, ministries and non–state actors, such as civil society organizations (CSOs) and facilitate the adaptation planning, including setting up a national core NAP team and/or steering group. Agricultural adaptation planning should be harmonized with the overall national planning processes to build on synergies with other sectors, such as health, water, infrastructure; feed timely inputs into national planning; and utilize the materials and findings from other sectors. In some countries, the cross–sectoral NAP team takes a very clear lead. In other countries, a single sector, such as agriculture, can spearhead the NAP process, but then needs to align itself closely with the UNFCCC focal point and other sectors.

Before the actual planning can start, responsible entities need to be selected and mandated. This can include, for example NAP–Ag focal points and a task force and/or thematic working groups and cross–sectoral working groups to engage representatives from all agricultural sectors. For example, in Uruguay, the existing Sustainability and Climate Change unit of the Ministry of Livestock, Agriculture and Fisheries is the mandated entity, while in Uganda, the Climate Change Task Force of the Ministry of Agriculture, Animal Industry and Fisheries was given the lead. The role of these entities is to lead the preparation of the agriculture sectors' contributions to NAP and represent the different sectors in the national core NAP team. In many cases, crop and livestock production, forestry, and fisheries and aquaculture are dealt with in separate ministries or departments, which calls for effective cross–sectoral and cross–ministerial collaboration. In countries that have a NAPA, the experience of its preparation in terms of intersectoral and intrasectoral coordination can guide the setting up of the necessary structures for adaptation planning. In many countries, the agriculture ministry and other government ministries have already established climate change coordination units or nominated climate change focal points, and have been actively participating in national–level climate change coordination (see Boxes 3, 4 and 5 for the differences in the sequencing of sectoral and national level planning). This can serve as an entry point for adaptation planning in agriculture. It is recommended that for each step, the agriculture sectors' focal points, task forces and/or technical and cross–sectoral working groups seek expertise from research institutions, specialized government agencies and other institutions and stakeholder groups.

FIGURE 1.

Possible process flow for addressing the agriculture sectors in the formulation and implementation of NAPs



Source: Adopted from the UNFCCC NAP Technical Guidelines (UNFCCC, 2012)

BOX 3.

Uganda – Institutional arrangements for the agriculture sector to spearhead adaptation planning

In Uganda, the UNFCCC focal point is the Climate Change Department (CCD) in the Ministry of Water and Environment (MWE). The agriculture sectors (crops, livestock and fisheries) are overseen by the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), while forestry is housed in the Ministry of Water and Environment. Planning and implementation of climate change interventions in MAAIF is coordinated by a Climate Change Task Force, which is composed of representatives from the crop, livestock, fisheries and planning sectors.

The development of the agriculture component for the NAPs in Uganda was facilitated by FAO and coordinated by the MAAIF Climate Change Task Force, which conducted consultations with representatives from different sectors, including agriculture, water, environment, land, finance and planning, at the central and local government levels. The consultations were guided by a designed NAP road map aligned to the framework of the National Climate Change Policy (2013), and involved non–state actors, such as non–governmental organizations (NGOs) and the private sector. The consultations identified priorities in the agriculture sectors and potential adaptation options. Development of the agriculture sectors' contribution to the NAP also used lessons learned from the implementation of the NAPAs and priorities identified in Uganda's NDC. The agriculture sectors' contributions to Uganda's NAP have been drafted and validated at national and subnational levels and are being finalized for implementation. The agricultural adaptation planning process in Uganda has been guided by the UNFCCC NAP Technical Guidelines and has been and is currently facilitated by the collaborative FAO and the United Nations Development Programme (UNDP) Integrating Agriculture in National Adaptation Plans Programme (UNDP–FAO NAP–Ag Programme) and the Government of Belgium through FAO. The overall NAP process in Uganda is still in the preparatory stages and will draw lessons from all the agriculture sectors.

Source: FAO Uganda, 2016

BOX 4.

Kenya – Aligning agriculture priorities in NAPs, NDCs and national development plans through broad stakeholder engagement

Kenya has been on the forefront of addressing climate change, launching a National Climate Change Response Strategy (NCCRS) in 2010 and a National Climate Change Action Plan (NCCAP) in 2013. The Action Plan outlines adaptation as a priority for the country because of the serious adverse socio–economic impacts climate change is expected to cause and the increasing vulnerabilities of different sectors.

The National Adaptation Plan (NAP 2015–2030), whose development started in 2014, is Kenya's first plan on adaptation, and builds on the

BOX 4. (CONTINUED)

comprehensive technical analysis in the Adaptation Technical Analysis Reports (ATAR) developed as part of the NCCAP (2013–2017). The aim of Kenya's NAP is to consolidate the country's vision on adaptation, which is supported by macro–level adaptation actions targeting economic sectors and country–level vulnerabilities to enhance long–term resilience and adaptive capacity.

The national adaptation planning was informed by a highly participatory process coordinated through the Adaptation Thematic Working Group (TWG) and the NCCAP task force. The process included consultations at national and county levels that involved many different stakeholders, including national government ministries, departments and agencies, county governments, CSOs and the private sector. The finalization of the NAP was the first priority action in the ATAR and the Adaptation TWG was tasked with completing it, and fulfilling the consultation and analytical guidelines as stipulated in the UNFCCC NAP Technical Guidelines. Issues related to gender, vulnerable groups and youth have been outlined and budget estimates allocated. Financial support came from multiple sources, including the United Kingdom's Department for International Development (DFID) through the Strengthening Adaptation and Resilience to Climate Change in Kenya (StARCK+) Project and the Climate and Development Knowledge Network (CDKN). Part of the team that developed the NAP underwent UNFCCC–led NAP capacity building in Zambia and Ethiopia and received support through the UNDP–FAO NAP–Ag Programme. During the process of developing the NAP, the agriculture sectors were represented in the TWG. This ensured that agricultural concerns were incorporated into the NAP. The NAP recognises the climate–smart approach as the approach through which the agriculture sectors can achieve their adaptation goals.

All these developments are addressed in Kenya's INDC, which was submitted in 2015.[4]

Source: The Ministry of Agriculture, Livestock and Fisheries, Kenya, 2016

BOX 5.

Nepal – Building on experiences of LAPA and other adaptation and resilience initiatives

The Government of Nepal launched the NAP formulation process in September 2015 to reduce climate vulnerabilities and risks by prioritizing and implementing medium– and long–term adaptation actions. It has planned to formulate the NAP based on the knowledge, experiences and lessons learned during the preparation and the implementation of the National Adaptation Programme of Action (NAPA, 2010), the Climate Change Policy (2011), the National Framework on Local Adaptation Plans for Action (LAPA, 2011), and from other initiatives that have promoted

4 The INDC of Kenya and other UNFCCC Parties can be accessed at the UNFCCC Web site: www4.unfccc.int/submissions/indc

climate resilience and low–carbon economic development. Funding is being channelled through a dedicated climate change budget code.

The Ministry of Population and Environment (MoPE), Nepal's UNFCCC Focal Point, has mobilized resources to formulate the NAP through a working group approach. As of January 2017, nine multistakeholder working groups have been formed. Each working group is coordinated by a relevant ministry based on the Business Allocation Rules of Nepal (2015). This means that nine ministries will be involved in the coordination, with MoPE having the overall responsibility for coordination, support and enhanced consultations. Furthermore, 191 members (institutions and experts) of the nine working groups will offer institutional and professional services to prepare the NAP document. The working groups have representatives from government institutions, NGOs and community–based organizations, federations and networks, indigenous communities, the private sector, associations of local governments, women, youth, media, academia and research organizations. These representatives are grouped into policy stakeholders, service providers, beneficiaries, enablers and advocates.

Nepal will align its NAP with the SDGs, the Sendai Framework on Disaster Risk Reduction and the outcome of the 2016 HABITAT–III, as well as with national priorities. The NAP formulation is part of the implementation of the Paris Agreement and Nepal's NDC. Nepal is now engaged in analysing climate change trends and scenarios, finalizing a framework for vulnerability and risk assessment that is in line with IPCC's Fifth Assessment Report and will soon begin assessing climate vulnerability and risk for identified themes and areas.

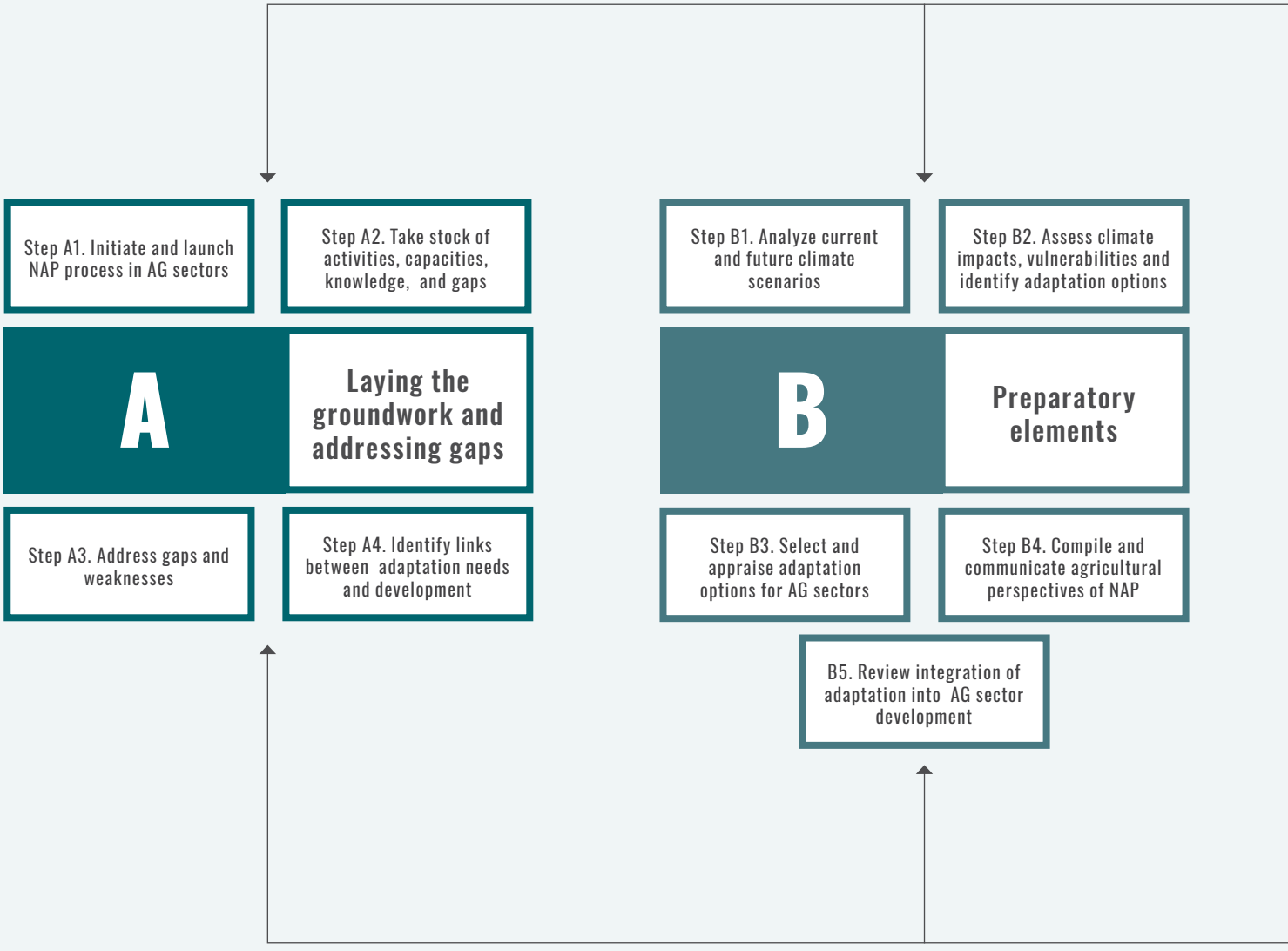
Nepal builds its NAP on experiences and lessons learned from LAPAs, NAPA–prioritized adaptation options and climate resilience programmes. The LAPAs are targeted to the poorest and most climate–vulnerable communities. Priority has been given to women in the implementation of over 2 030 adaptation actions, which have benefited more than 600 000 vulnerable people. Lessons learned during the LAPA have been used in the NAP process for people–centred adaptation planning and its integration into ongoing planning processes and participatory implementation. The government's public finance management system has been adopted to enhance institutional capacity and ownership.

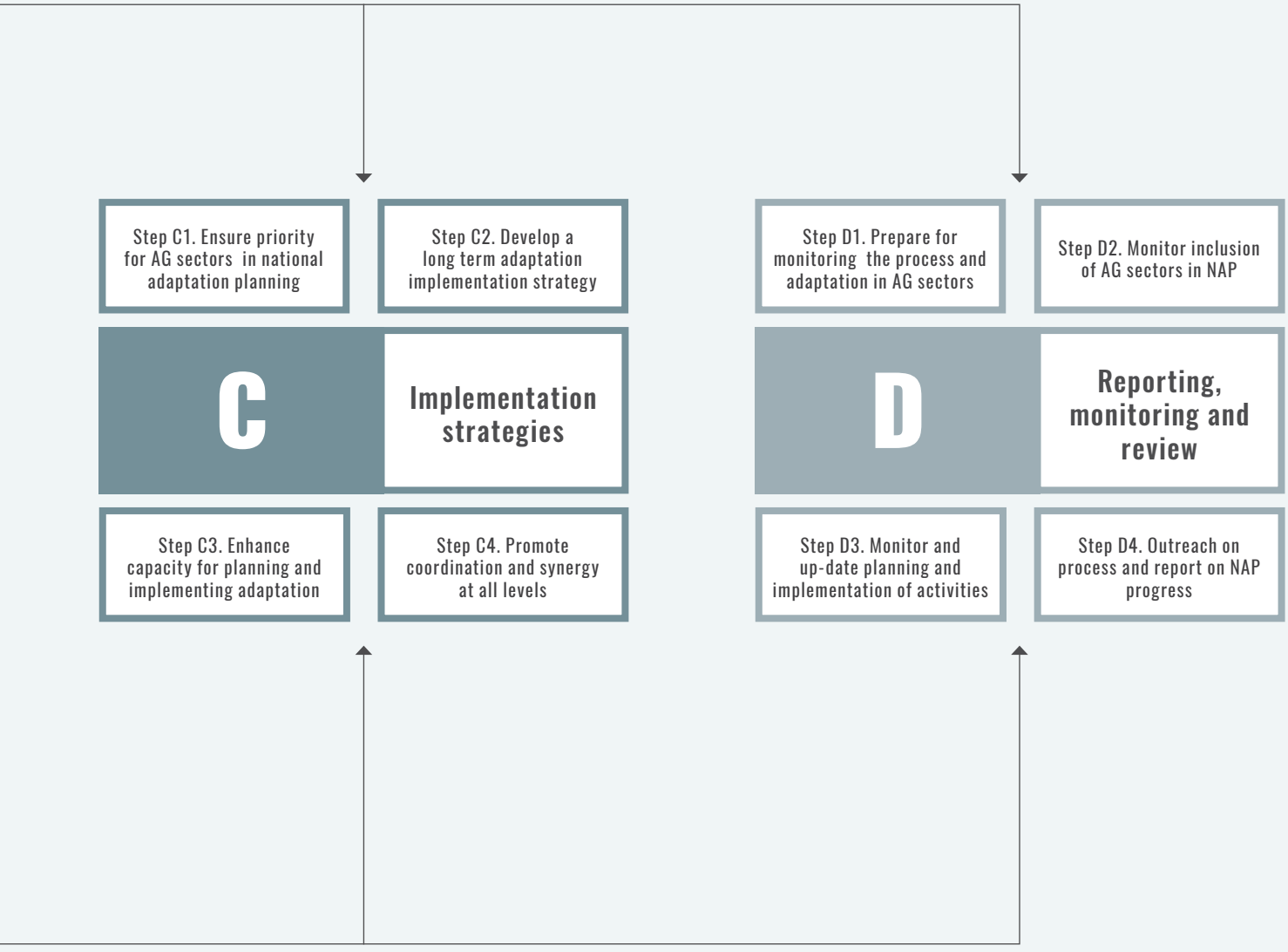
The NAP process considers the 2018–2030 period as the medium term and up to 2050 as long term. This process is supported by UK Aid, Action on Climate Today and Oxford Policy Management and Practical Action. The Department of Hydrology and Meteorology is engaged in climate change trend and scenario analysis with support from the International Centre for Integrated Mountain Development (ICIMOD). Some of the consultations are supported by World Wildlife Fund (WWF) Nepal, CARE Nepal and the Nepal Climate Change Support Program. The UNDP–FAO NAP–Ag Programme supports this NAP process for the agricultural sectors. In November 2016, Nepal was the first country to secure funding from the GCF NAP Readiness Fund through the United Nations Environment Programme (UNEP) to formulate and implement the NAP.

Source: Government of Nepal, Ministry of Population and Environment, January 2017

FIGURE 2.

Outline of the formulation and implementation of NAPs: elements and steps for the agriculture sectors




Step C1. Ensure priority for AG sectors in national adaptation planning
Step C2. Develop a long term adaptation implementation strategy
C
Implementation strategies
Step C3. Enhance capacity for planning and implementing adaptation
Step C4. Promote coordination and synergy at all levels
Step D1. Prepare for monitoring the process and adaptation in AG sectors
Step D2. Monitor inclusion of AG sectors in NAP
D
Reporting, monitoring and review
Step D3. Monitor and up-date planning and implementation of activities
Step D4. Outreach on process and report on NAP progress

Elements, steps and indicative activities in addressing the agriculture sectors in NAPs

As a NAP is a national plan and its preparation a national process, all relevant sectors need to be involved.

This section presents the four elements and related steps for preparing the agriculture sectors' contributions to NAPs. As mentioned earlier, the relevance of each step and indicative activity depends on the national context. For example, some pieces of information may have been collected for other purposes, such as for NAPA planning, the National Communication to the UNFCCC or the preparation of the adaptation component of the INDC, and require only updating. As a NAP is a national plan and its preparation a national process, all relevant sectors need to be involved. Different sectoral pathways may be followed during the preparation, but they should come together in the end. The final prioritization and decisions are made at the national level.

The description of an element starts with a definition of its focus and possible outputs. Each element consists of four to five steps, which in turn are split into indicative activities. A list of guiding example questions are provided in the introduction of each element as a checklist of questions to be asked throughout each of the steps. At the end of each element, guiding example questions are listed to help navigate through the element. There is a list of tools and resources that provide more detailed guidance for undertaking the activities outlined as part of elements A to D.

The NAP–Ag Guidelines are complimented by briefing notes produced by the UNDP–FAO *Integrating Agriculture in National Adaptation Plans* (NAP–Ag) Programme.[5] The briefing notes provide in–depth technical guidance on cost–benefit analysis, impact evaluation, gender, DRR, vulnerability assessments, climate finance, co–benefits, social protection, institutional arrangements, and monitoring and evaluation. The NAP–Ag Programme has generated an online *Knowledge Tank for agriculture sectors' adaptation to climate change*,[6] providing relevant and updated tools and knowledge resources to support decision makers and other stakeholders dealing with adaptation, resilience and DRR in agriculture.

CENTRAL AFRICAN REPUBLIC
A Farmer Field School facilitator teaching participants about potable water.
©FAO/Riccardo Gangale

5 UNDP–FAO NAP–Ag Programme Web site: www.fao.org/in–action/naps

6 Knowledge Tank for agriculture sectors' adaptation to climate change: www.fao.org/in-action/naps/knowledge-tank

Several other multilateral and bilateral research and development institutions support developing countries in their climate change adaptation planning and implementation actions in agriculture. These include but are not limited to UNDP, UNEP, the German International Cooperation Agency (GIZ), the International Union for Conservation of Nature (IUCN), the Global Water Partnership, the World Health Organization (WHO), the World Meteorological Organization (WMO), the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS) and on Forests, Trees and Agroforestry (FTA), GEF, the Adaptation Fund and GCF. Dedicated and tailored country support is also provided by many partnerships, for example the NAP–Ag Programme, the UNDP/UNEP–led NAP Global Support Programme, the NAP Global Network and the Climate Technology Centre and Network.

4.1 Element A: Laying the groundwork and addressing gaps

The focus of this element is on setting the scene for integrating the agriculture sectors in NAPs and engaging agricultural stakeholders in the process of formulating and implementing NAPs.

First, it is crucial to understand the status and milestones of the NAP development and the interface between the national adaptation planning processes and agricultural planning processes. The gap analysis of capacities, knowledge and institutions will reveal areas where additional work, including capacity development is required. Stocktaking of ongoing climate change and development activities and available data and information on climate change and its impacts, as well as a stakeholder analysis and identification of capacity gaps in the agriculture sectors will lay the groundwork for any new or scaled up adaptation actions. Monitoring and evaluation needs should also be considered throughout the element. Guiding questions for steps from A1 to A4 can be found in Table 2.

The main outputs of this element could include:

- ❑ The initiation of climate change adaptation planning in the agriculture sectors as part of the national process to formulate and implement the NAP.
- ❑ Nomination of focal points and the establishment of the necessary task forces or multistakeholder thematic/cross–cutting working groups for all the agriculture sectors with clear mandates.
- ❑ Preparation of stocktaking report(s) including, for example report(s) regarding ongoing climate change and DRR activities; the main agricultural development policies and investment projects and programmes; the results of gender analysis of climate activities in the agriculture sectors; the available knowledge (including conducted assessments), and methodologies for assessing climate risks, impacts, vulnerabilities and adaptation options; and an analysis of stakeholder and institutional capacities in the agriculture sectors.
- ❑ Preparation of a comprehensive human and institutional capacity development plan with cost implications based on assessed needs and actionable recommendations by the stakeholders.
- ❑ Exploration and documentation of opportunities and practical steps for integrating climate change adaptation into agricultural development.

A1	*Initiating and launching*	• Has the process to formulate and implement NAP started at the national level? • If not, when will it start? • Are key actors in all the agricultural sectors aware of the process? • Are the national NAP planners aware of the challenges facing agriculture? • Does the NAP formulation process engage both men and women stakeholders involved in crop and livestock production, fisheries and aquaculture and forestry? • If not, why? How can this be addressed? • Are all the agricultural sectors integrated into NAP planning milestones?
A2	*Taking stock*	• What are the key strategies, policies and programmes related to climate change and the agriculture sectors? • What is the level of knowledge on climate change in the agricultural sectors? • Who are the stakeholders in climate change and agricultural issues? • What institutions are engaged or should be engaged? • What are their present capacities for adaptation planning? • Is there adequate coordination among the institutions and all the agriculture sectors?
A3	*Addressing gaps and weaknesses*	• What plans and resources are there to address the capacity gaps in NAP–Ag planning? • What coordination mechanisms are needed? Who will lead? • What are the best mechanisms for awareness raising and knowledge sharing?
A4	*Linking adaptation and development*	• What are the development goals and tools in the agriculture sectors? • How can adaptation be best integrated into agricultural development? • Is there enough information on climate risks and vulnerabilities to enable sustainable interventions?

Table 2. Guiding questions for Element A – Laying the groundwork and addressing gaps

Step A1. Initiate and launch the agriculture sectors' participation in national adaptation planning, including clarifying mandates and engaging subsectors

A.1a Briefings for the process – Meet with the UNFCCC and NAP focal points in the country to understand the current state of the NAP and request, if not already the case, that representatives from all the agriculture sub–sectors become part of the NAP core team, steering committee or similar body. Provide briefings to policy–makers and implementers about the adaptation challenges and opportunities in agriculture. Emphasize the importance of climate change risks and vulnerabilities in the different agriculture sectors and their consequences for food security, water security, ecosystems, poverty, gender equality, rural livelihoods, trade and growth. If necessary, consult Annex 1 of this publication for some arguments and facts.

A.1b Institutional arrangements and coordinating mechanism – Advocate for ensuring that the national NAP coordination mechanism includes state and non–state actors and other stakeholders (both men and women) from the agriculture sectors and that the protocols for making decisions and sharing information and data take into consideration the needs of all the agriculture sectors. Establish and mandate the responsible entities for the agriculture sectors (e.g. a NAP–Ag task force or working groups and focal points) so that they include fisheries and aquaculture, crop and livestock production and forestry, and cover cross–cutting themes, such as gender and nutrition. These entities will represent the agricultural sectors in the core NAP team and lead the preparations for the sectors. Propose that the national coordination mechanism would assign responsibilities to key actors, including in the agriculture sectors (see Boxes 3, 4 and 5 on the institutional arrangements in Uganda, Kenya and Nepal). Explore available technical and financial support for adaptation planning in agriculture (see Box 6 on the Green Climate Fund's NAP readiness financing).

BOX 6.

Green Climate Fund's Readiness and Preparatory Support Programme

In response to the Paris Agreement, the GCF Board decided to expedite support for the formulation of NAPs and other adaptation planning processes. Support for adaptation is central to the GCF and in line with its governing instrument. GCF supports full and incremental cost for activities to enable and support action on adaptation. Half of GCF funds will be directed towards adaptation. The GCF policies follow a country–driven approach, respect environmental and social safeguards and take into account gender. Stakeholder engagement and consultative approach are also central elements of the GCF operational modality.

Through its Readiness and Preparatory Support Programme, the GCF can approve funding of up to US$3 million per country to support the formulation or strengthening of their NAPs and/or other adaptation planning processes. These processes should be carried out in coordination and complement other related initiatives and support. This Programme also supports countries to develop strategic frameworks for engagement with the GCF, building on existing strategies and plans, and country–driven national adaptation processes including NAPs. The support for adaptation planning activities is also aimed at enabling countries to identify country-driven pipelines of effective adaptation and cross–cutting projects.

For more information, please refer to the GFC's Readiness Support Web page: www.greenclimate.fund/funding/readiness-support.

Source: The Green Climate Fund, March 2017.

A.1c National vision and mandate for NAPs in the agriculture sectors – Collect and review lessons from past or existing adaptation measures in the agriculture sectors, including NAPAs. Based on these lessons and in consultation with stakeholders from the agriculture sectors and other sectors, define a vision for the role of agriculture in national adaptation planning and determine what is needed to realize this vision. To support the formulation of this vision, conduct a foresight analysis that includes national, regional and global perspectives and considers, for example, how the agriculture sectors are expected to develop and how they can contribute to the SDGs.

A.1d NAP framework/strategy and roadmap for the agriculture sectors – In collaboration with the agricultural stakeholders and taking into account the country–specific conditions, consider what are the necessary steps in agricultural adaptation planning and how they should be sequenced. Keep in mind their alignment with ongoing development processes, including the process of formulating and implementing NAPs and adaptation actions. Throughout the process, consideration should also be given to monitoring, related indicators and the needs of a monitoring and evaluation system (see also Element D on Monitoring, Reporting and Review).

Step A2. Take stock of existing vulnerability and risk assessments, knowledge, methodologies, and possible capacity and institutional gaps, policies, plans and investment frameworks in the agriculture sectors

A.2a Stocktaking of adaptation activities – Continue from A.1c and compile information on past and ongoing adaptation and DRR/DRM projects, programmes, policies and related capacity development efforts in the agriculture sectors, including their financing and implementation arrangements. Also check how these adaptation efforts have been incorporated into the National Agriculture Investment Plans (NAIP) or other similar frameworks. Also integrate gender analysis in the stocktaking (or do it later in Element B) to identify relevant gender issues in agriculture and existing climate change adaptation activities.[7] This information needs to be well documented, as it will lay the groundwork for identifying and prioritizing adaptation options in Step B.2c. It also provides valuable lessons and helps avoid overlapping actions in the future.

A.2b Synthesis of available knowledge and methodologies on impacts, vulnerability and adaptation – Assess and take stock of available information on climate risks and impacts, vulnerabilities, and adaptation and development needs in the agriculture sectors. Synthesize the state of knowledge on the gender dimensions of agricultural climate change adaptation, focusing on the different knowledge, skills, and needs that men and women have with respect to their different roles. Include a synopsis of how and what gender issues are addressed in National Communications to the UNFCCC and NDC.

A.2c Capacity and institutional gap analysis – To foster dialogue, ownership and commitment, it is recommended to conduct a participatory capacity assessment across the three capacity development dimensions (individual, organizational and enabling environment) facilitated by the task force (FAO, 2017). The capacity assessment focuses on enhancing existing capacities looking at the present state; the future or desired scenario; and how to get there (i.e. actionable recommendations).

To enhance inclusiveness, take stock of the institutions and stakeholders (public, private, academia, NGOs and CSOs) in all the agriculture sectors, and their existing or potential roles in climate change adaptation at all levels. Using participatory approaches, review the capacity of the agencies working in the country's agriculture sectors to develop a capacity framework on mainstreaming climate change into agriculture and addressing the needs of all the agriculture

7 A policy or programme is gender–responsive when it fulfils two basic criteria: 1) gender norms, roles and relations are considered; and 2) measures are taken to reduce the harmful effects of gender norms, roles and relations, including gender inequality. For guidance in gender analysis, see FAO, 2001; 2014a and FAO–CCAFS, 2013.

sectors in the formulation and implementation of the NAP. When conducting the assessment, consider the existing institutional knowledge base, skills and instruments (e.g. sectoral strategic plans) and institutional arrangements (e.g. reporting chains, institutional coordination mechanisms) and the enabling policy environment (e.g. alignment between agriculture and environment policies, strategies, plans) to enable the individuals and institutions to plan, implement and monitor adaptation measures.

The capacity assessment aims to identify capacity gaps and opportunities including on knowledge, institutional mechanism and policies. It is recommended to be conducted across individual (staff of Ministries or members of non-governmental organizations), institutional (e.g. research and extension systems, seed systems and risk management institutions) and the regulatory and strategic environment to address adaptation strategies (e.g. legal frameworks, political will and specific sectoral issues, such as land tenure and water policies).

Complementing proposed "functional" capacities (FAO, 2015c), the assessment across individual, organizational and enabling environment could cover the following NAP-specific areas:

1. capacity of climate governance, mainstreaming and coordination;
2. capacity to design and implement policy and regulatory frameworks;
3. technical capacity to plan adaptation responses for specific projects and programmes; and
4. coordination capacity to integrate the agriculture sectors in NAP formulation and implementation.

The analysis will inform the preparation and implementation of a capacity development plan in steps A.3a and C3. The analysis can be conducted through a step–by–step approach that includes (FAO, 2017):

1. the sharpening of the terms of reference of the task force or working groups to include budget and deliverables for two stakeholder workshops (assessment, validation and action planning), a capacity assessment report and a capacity development strategy;
2. Training and preparation of the task force to facilitate the stakeholder capacity assessment and validation workshops, design capacity development actions and track results;
3. 2–3 day assessment workshop engaging representatives from all the agriculture sectors and country stakeholders with the output being a capacity assessment report; and
4. 1–2 day validation and action planning workshops, whose output is a capacity development strategy with prioritized capacity development areas and results framework.

Assess capacities for monitoring and evaluation through 'forward looking planning', including the current and future desired state with consensus on priorities. Incorporate tracking of individual, organizational and institutional capacity development results, including political commitment, into the monitoring framework..

A.2d Barriers, constraints and opportunities analysis – Identify and document barriers to adaptation planning and implementation in the agriculture sectors. The barriers may relate to technical and financial resources, capacity gaps, coordination, management, political constraints, institutions or social issues. At the same time, it is important to take stock of opportunities and strengths that could support and enhance the agricultural planning in the NAP.

Step A3. Address capacity gaps and weaknesses in adaptation planning in the agriculture sectors

A.3a Developing institutional and technical capacity for the agriculture sectors – Effective capacity development involves taking a systemic, interconnected approach to strengthening the capacities of individuals, organizations and institutions and the enabling environment. It also involves enhancing technical and functional capacities and strengthening development effectiveness principles, such as country ownership, leadership and joint commitment.

Based on the capacity needs assessment and strategy, prepare a plan for participatory capacity development (individual, organizational and institutional) and for communication and information dissemination activities that use a variety of media (e.g. print publications, radio, television and cell phones) to ensure all stakeholders in the agriculture sectors are involved. Also consider e–learning and capacity development that is based on social media. Explore financing opportunities to support the capacity development plan (see Box 6 on the financing from the GCF Readiness and Preparatory Support Programme and Box 14 for other adaptation financing opportunities). Concrete capacity development actions are further elaborated in Step B5 and Step C3.

A.3b Creating awareness of opportunities for integrating adaptation into development of the agriculture sectors – One objective of the national adaptation planning is to integrate climate change adaptation into crop and livestock production, forestry, fisheries and aquaculture, food security and nutrition and DRR and DRM policies, strategies and programmes at the national, subnational and local levels. At this point, identify the stakeholders who are in charge of policy planning and programming in the agriculture sectors and raise their awareness of the connections between development and adaptation objectives, including their synergies and trade–offs. This may take place through joint workshops or communication tools.

A.3c Communication, public awareness raising and education programmes on climate change adaptation in the agriculture sectors – Reach out and share information and knowledge with the general public and stakeholders in the agriculture sectors on climate change and its impacts, vulnerabilities and potential adaptation options in agriculture. Use a variety of media, such as print communication, television and radio, school and university curricula, web sites and social media. It is important to include young men and women in rural communities in knowledge sharing and capacity development activities.

Step A4. Assess and identify links between adaptation needs and development goals in the agriculture sectors

A.4a Compiling comprehensive development objectives, policies, plans and programmes in agriculture – Building on the work done in Step A.2, take stock of and document the main development and investment policies, strategies, plans and programmes in the agriculture sectors (e.g. national agriculture, forestry and fisheries policies and action plans, NAIPs) and national, regional and international frameworks (e.g. the Comprehensive Africa Agriculture Development Programme), including their status, timelines, focus, coverage and financing.

A.4b Synergy between development and adaptation objectives, policies, plans and programmes – Jointly with stakeholders, assess the synergies and trade–offs between the objectives of climate change adaptation and development policies, plans and programmes related to crop and livestock production, forestry, fisheries and aquaculture, food security and nutrition and DRR/DRM with the aim of integrating adaptation in the agricultural development. An example of guidance in this area can be found in *Integrating climate change adaptation into development planning* (GIZ, 2011a). Screen existing development and sectoral policies, strategies and plans through a climate lens to determine whether they might lead to maladaptation or missed opportunities. The assessment should also include the analysis of salient aspects of current policies and development efforts that are at risk from climate change. Where necessary, conduct a more detailed climate–risk assessment of existing policies and programmes, and consider necessary actions to make development interventions more sustainable.

Efforts should also be made to climate proof all future development plans and interventions in the agriculture sectors, which would start with determining whether the plans are climate-sensitive. Climate–proofing involves ensuring that climate risks are reduced to acceptable levels through long–lasting and environmentally sound, economically viable and socially acceptable changes implemented at one or more of the stages of the project cycle (FAO, 2014b). A climate–proofing for development–method has been designed by GIZ with the purpose of integrating climate considerations

into planning at all levels. It facilitates climate change oriented analyses of policies, projects and programmes with the aim of highlighting the risks and opportunities that climate change poses. For guidance on climate–proofing, see GIZ, 2011b.

Identify and enhance links between the national and subnational policies and programmes and international processes, such as the 2030 Agenda, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction (2015-2030).

Tools and resources to support the Steps in Element A

The National Adaptation Plan Process: A brief overview (UNFCCC, 2012b)
http://unfccc.int/resource/docs/publications/publication_ldc_napp_2013.pdf

Climate change and food security: risks and responses (FAO, 2016d)
www.fao.org/3/a-i5188e.pdf
The report brings together evidence from the IPCC, updated by the latest evidence and scientific findings and results from experience on the ground, on the impacts of climate change on food security and nutrition. It analyses the direct and indirect impacts of climate change and food security and nutrition and presents adaptation pathways for all agriculture sectors to reduce vulnerabilities and build resilience to climate change. In this way it contributes to stocktaking activities in the agriculture sectors.

The impact of disasters on agriculture and food security (FAO, 2015b)
www.fao.org/3/a-i5128e.pdf
The publication fills existing knowledge gaps about the nature and magnitude of disaster impacts triggered by natural hazards on the agriculture sectors in developing countries. The study provides systematized data, analysis and information, and gives recommendations for securing agricultural investments through improved resilience, data collection and monitoring systems on sector–specific damage and losses.

Climate Change Implications for Fisheries and Aquaculture: Overview of Current Scientific Knowledge (Cochrane *et al.*, eds., 2009)
www.fao.org/docrep/012/i0994e/i0994e00.htm
This FAO technical paper provides an overview of scientific knowledge available on the effects of climate change on fisheries and aquaculture.

Climate Change Adaptation and Mitigation. Sustainable Forest Management (SFM) Toolbox, (FAO)
Website: www.fao.org/sustainable-forest-management/toolbox/modules/climate-change-adaptation-and-mitigation/basic-knowledge

The State of Food and Agriculture 2013, Food systems for better nutrition (FAO, 2013)
www.fao.org/publications/sofa/2013
The report highlights the importance of addressing the entire food system – from inputs and production, through processing, storage, transport and retailing, to consumption – as it can contribute much more to the eradication of malnutrition.

Assessing Climate Change Vulnerability in Fisheries and Aquaculture: Available Methodologies and Their Relevance for the Sector (Brugère and De Young, 2015)
www.fao.org/3/a-i5109e.pdf
This FAO technical paper provides an overview of vulnerability assessment concepts and methodologies and sheds light with illustrative examples on the different methodologies that have been developed and how they have been applied in fisheries and aquaculture.

Integrating climate change adaptation into development planning (GIZ, 2011a)
www.oecd.org/dac/environment-development/45856020.pdf
A practice–oriented training based on an Organisation for Economic Co–operation and Development (OECD) policy guidance training manual that provides examples and case studies related to agriculture and climate change adaptation. It contains training material for making vulnerability assessments.

Review of Key National and Regional Policies and Incentives to Support Adaptation and Adaptive Capacity in the Agricultural Sector (Bizikova and Crawford–Boettcher, 2011)
www.iisd.org/pdf/2011/2010-0057-eng.pdf
The publication presents two predominant approaches or frameworks that are used to guide adaptation policy development: vulnerability-based and risk–based approaches.

Based on their analysis on the ways how four countries belonging to the Organisation for Economic Co–operation and Development (OECD) and the European Union plan to tackle challenges that agriculture sectors face, the writers give recommendations on policy development, institutional involvement, adaptation strategies and their implementation for reducing risks and vulnerability and increasing overall resilience of agricultural systems.

Planning climate adaptation in agriculture. Meta-synthesis of national adaptation plans in West and East Africa and South Asia (Kissinger *et al.*, 2013)
http://hdl.handle.net/10568/33959
The CCAFS report maps agriculture sectors and NAPA case studies in three regions in Africa and South Asia and gives recommendations for the agriculture sectors, on a range of issues, such as water, forests and other land uses.

Stocktaking: Climate Vulnerability on Agricultural Sector for National Adaptation Plan Process
(Jalsrot Vikas Sanstha/Global Water Partnership Nepal, 2015)
www.jvs-nwp.org.np/sites/default/files/Stocktaking%20Climate%20Vulnerability%20on%20Agricultural%20sector_0.pdf
The report from Nepal is an example of a national review on priority risks and vulnerabilities and includes a comparative analysis and synthesis of National Adaptation and Action Programs and National Communication on Climate Change. The report lists best adaptation practices in agriculture, ecosystem, water and livestock management, and gives clear recommendations based on the case study.

FAO submissions to the UNFCCC on issues related to agriculture, food security and climate change
Website: www.fao.org/climate-change/resources/submissions/
FAO's submissions to the UNFCCC summarize the current understanding of the challenges and solutions that the agriculture sectors face due to climatic variability and change. They offer an analytical framework, list technical options, and offer support for communicating key issues related to the topic.

FAO Corporate Strategy and Tools on Capacity Development
Website: www.fao.org/capacity-development

- **Module 1 on Capacity Development – Basic Principles**
  www.fao.org/3/a-i1998e.pdf
- **Module 2 on Capacity Development – Programming (Revised edition)**
  www.fao.org/3/a-i5243e.pdf
- **Module 3 on Capacity Development – Good Learning Practices**
  www.fao.org/3/a-i2532e.pdf
- **Module 4 on Capacity Development – Organization Analysis and Development**
  www.fao.org/3/a-i3538e.pdf

Effective capacity development approaches to integrate agriculture into NAPs. A policy brief
(FAO, 2017)
This brief provides hands on guidance for human and institutional capacity development needs assessment and designing capacity development strategies in the context of addressing agriculture in the process of formulating and implementing NAPs.

4.2 Element B: Preparatory elements

The focus of this element is on analysing climate change scenarios, risks and vulnerabilities in the agriculture sectors and identifying, selecting and prioritizing medium– to long–term adaptation options. The information generated through the process will be consolidated into a component that contributes to the cross–sectoral NAP and to development planning processes. Monitoring and evaluation needs should also be considered throughout this element. Guiding questions for steps from B1 to B5 can be found in Table 3.

The main outputs of this element could include:

- ❑ An assessment of climate change impacts on agricultural systems based on climate change scenarios.
- ❑ Risk and vulnerability assessments, including a ranking of risks and vulnerabilities.
- ❑ Identification, appraisal and prioritization of adaptation options for the agriculture sectors.
- ❑ Agricultural adaptation perspectives compiled into a specific agriculture component (or programme) that feeds into the NAP.
- ❑ Initiation of processes for integrating adaptation into agricultural development plans and programmes and national and subnational planning, including the strengthening of institutional capacities

B1	*Assessing climate scenarios*	• Is adequate climate information available and accessible? Where? • What are the climate scenarios (sudden extreme events and slow onset processes) for the country and its regions? • What are the likely short–, medium– and long–term climate change impacts and risks for the agriculture sectors?
B2	*Assessing impacts and vulnerability*	• Which agricultural sectors, systems or regions are most exposed to climate change and are at risk? • What are the particularly sensitive and vulnerable ecosystems and livelihoods? • What are the adaptation options to address vulnerabilities? • What is already in place? (e.g. early warning, storage, insurance) • What adaptation options have the potential for scaling up?
B3	*Selecting adaptation options*	• What are the important criteria for adaptation options – Cost? Time frame? Political buy–in? Sustainability? Co–benefits? • How are adaptation options ranked and prioritized? By whom? • Do they consider gender, food security and nutrition, and poverty reduction?
B4	*Compiling and communicating priorities*	• What are the top adaptation priorities for the agriculture sectors? • Are these communicated to stakeholders and other ministries and government actors engaged in NAP planning? • How can marginal groups, including women, indigenous people and extremely poor be included?
B5	*Reviewing integration*	• Is climate change integrated in the agricultural planning and budgeting activities? • What are the opportunities/barriers to integrating agricultural adaptation needs in national planning and budgeting? How can they be addressed?

Table 3. Guiding questions for Element B – Preparatory phases

Before entering into the steps and indicative activities, some issues on the spatial scale of analysis need to be clarified.

Because the analysis serves as an input from the agriculture sectors at the national level to the cross–sectoral NAP, the primary spatial scale of this analysis for steps B1 to B3 is national with subnational disaggregation. Typical outputs from these steps are prioritized lists of adaptation options by sector, by region and/or agro–ecological zone. On the other hand, concrete adaptation practices that will be implemented on the ground need to be location– and context–specific.[8]

Identifying and appraising adaptation options for the NAP can be done either using a top–down or bottom–up approach. In a top–down approach, national, provincial or regional information (e.g. climatic, sectoral and socio–economic information) is used to identify and appraise broad categories of potential adaptation options (e.g water resource management). When adaptation actions are designed and implemented on the ground, a separate exercise will be necessary to determine, for the particular location, the exact menu of adaptation practices (e.g. irrigation, water harvesting or drainage in a specific location) that fall within the identified category of adaptation options. In a bottom–up approach, local information (e.g on farming systems, livelihoods, gender roles, agro–ecological conditions, risks and vulnerabilities) at various levels (e.g. municipal, county, district and zone) is used to identify and appraise location– and context–specific adaptation options. Consolidation of the adaptation options from different locations forms the basis for adaptation prioritization (see Step B3 on prioritization) in the NAP formulation and implementation process. The bottom–up approach takes more time but, when done properly, is more comprehensive.

There is a variety of tools and methodologies to support the assessment of risks, impacts, vulnerabilities and adaptation options. Links to several tools and methods can be found in the end of this element. It is recommended to carefully choose an appropriate tool, as each method is designed for assessments at different spatial and temporal scales and for different purposes.

Step B1. Analyse current and future climate scenarios for production and sustainability

B.1a Consultations with the NAP Core team and climate and agro–meteorological entities for climate information and scenarios – With help of meteorological experts, collect and analyse the current level of information on climate variables, indices and patterns that are needed to assess climate change impacts (e.g short–term and long-term projections for extreme weather events and changes in temperature and rainfall patterns) and vulnerability and risks for the agriculture sectors (e.g. temperature thresholds, saline water intrusion). See also Step B.1b. In case of major information gaps, advocate for the generation of additional and more localized climate information.

B.1b Analysis of current climate relevant to agriculture systems and groups – Based on the available climate information and scenarios and with help of meteorological experts, analyse short– and long–term climatic hazards and impacts, including slow onset events (e.g sea level rise, increasing temperatures of the atmosphere and sea water, ocean acidification, glacial retreat, salinization, land and forest degradation, desertification, and loss of biodiversity and genetic resources), and sudden onset extreme events and climate hazards that affect agriculture (e.g temperature extremes, droughts and floods). There are several multimodel intercomparison projects, such as the Coordinated Regional Climate Downscaling Experiment (CORDEX) [9], which covers almost all regions of the world in 14 different spatial domains. Through such initiatives, a large amount of high–resolution climate information is becoming available in all regions, including Africa (FAO, 2016d).

8 For further guidance on spatial scales consult Dazé, Price–Kelly and Rass (2016).

9 CORDEX Web site: www.cordex.org

In the analysis, it is useful to consider agro–meteorological indices that are of particular interest to agriculture (e.g. the length of rainy season and number of growing days). Other useful variables include rainfall patterns, amount and area; seasonality of climate (e.g. the timing of monsoons, and rainy and dry seasons); water availability for rain–fed and irrigated agriculture; temperature (e.g. daytime maximum and night time minimum); evapotranspiration; and the frequency and intensity and duration of droughts and floods.

This step should result in the preliminary identification of the sectors, regions, ecosystems, communities and groups that are vulnerable to climate change and provide preliminary rationale for targeted adaptation actions. The analysis will be continued in Steps B.1c and B.2.

B.1c Analysis of climate projections relevant to agriculture systems – Given an improved understanding of current climate conditions in relation to the agriculture sector (Step B.1b), information on future climate projections should be interpreted for the agricultural context. For climate projections to be useful, they may need to be downscaled to national, subnational and local levels. Also take into account any socio–economic scenario relevant to agriculture (e.g. population projections), the uncertainty of climate projections, and the shifting of zones that are suitable for plants, trees, animals, fish and other genetic resources. Additional considerations include the anticipated changes in the prevalence of pests and diseases affecting crops, livestock, trees, fish as well as of pollinators and other important species. Challenges, including the communication of uncertainties, and difficulties obtaining locally relevant data at the right spatial scale should also be considered and addressed.

To support countries in linking information and decision making to improve food security, FAO has developed MOSAICC, a Modelling System for Agricultural Impacts of Climate Change (see the tools and resources section in the end of the element). Other FAO tools that can be of use include, CLIMPAG, AQUASTAT and FAOSTAT.[10] The CCAFS spatial downscaling data can also be helpful.[11] It is important to note that some of these scenarios may already have been prepared for development and climate change projects and programmes or national climate change strategies and National Communications to UNFCCC. Modelling often requires specific skills and investments in data and advanced technologies (e.g. satellite imagery and geographical information systems). This activity is often outsourced to a recognized research institution and can then be customized to the relevant circumstances for agricultural planning in the NAP.

Step B2. Assess climate vulnerabilities, risks and impacts and identify adaptation options for the agriculture sectors

B2a. Assess vulnerabilities, risks and impacts of climate change on the agriculture sectors at subnational and national levels – As adaptation needs differ by sector and location, assessments of climate vulnerabilities and risks for the agriculture sectors and agricultural regions are fundamental first steps for planning appropriate adaptation strategies. These assessments help to determine how production systems, ecosystems and ecosystem–dependent communities will be affected by climate change. They can then inform local and national policies and actions that will reduce vulnerabilities and facilitate adaptation. Before reviewing practical actions to facilitate these assessments, it is useful to reflect upon a few core concepts related to climate change vulnerability, risks and impacts.

According to the IPCC Fourth Assessment Report, vulnerability is 'the degree to which a system is

10 CLIMPAG Web site: www.fao.org/nr/climpag/
AQUASTAT Web site: www.fao.org/nr/water/aquastat/climateinfotool/index.stm
FAOSTAT Web site: http://faostat.fao.org/

11 CCAFS data are accessible at www.ccafs-climate.org/statistical_downscaling_delta/

susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes' (IPCC, 2007). The degree of vulnerability is derived from a given system's exposure[12] and sensitivity[13] to changes in climate and climate variability, the potential impact that relates to that change, and the adaptive capacity[14] of the system to cope with this impact (Lavell *et al.*, 2012).

The approach and definitions of the IPCC Fourth Assessment Report are applied in this document because many countries are already familiar with and using these definitions. It is worth mentioning, however, that according the IPCC Fifth Assessment report, the concept of climate risk is conceived as the probability of occurrence of hazardous events or trends multiplied by the impacts, if these events or trends occur. Risk results from the interaction of climate-related hazards with vulnerability and exposure of human and natural systems. Changes in both the climate system and the socioeconomic process, including adaptation and mitigation, are drivers of hazards, exposure and vulnerability. Under this framework, hazards refer to climate changes and their effects on geophysical systems (e.g. floods, droughts, sea level rise, and increasing temperatures), while vulnerability refers to the characteristics of human or socio–ecological systems exposed to hazardous events and trends (Oppenheimer *et al.*, 2014).

Examples can clarify these concepts as they relate to agriculture (see also an example from Thailand in Box 7). Some potential climate hazards for agriculture are rising temperatures, changes in precipitation patterns, and frequency and intensity of extreme heat. Related vulnerabilities include the susceptibility of human systems, agro–ecosystems, and natural ecosystems to: the loss of their capacity to regulate pests and diseases, fires, landslides, erosion, flooding, avalanches, water quality and local climate; the loss of their capacity to provide food, livestock, fibre and bioenergy; the loss of their capacity to support recreation, tourism, aesthetic and cultural values, and biodiversity. Key risks following from the interaction of the hazard and vulnerabilities are the reduction of biodiversity and potential losses of important ecosystem services; the risk of loss of endemic species and increased dominance of invasive organisms (Oppenheimer *et al.*, 2014). Risks for agriculture could be the gradual depletion of natural resources (e.g. groundwater) that cannot maintain productivity in the face of persistent increases in climate–related stressors (e.g. increased temperature or reduced rainfall).

In terms of assessment, information on evolving climate–related hazards can be combined with assessments of different vulnerabilities to allow policy makers to better estimate and respond to climate risks. Vulnerability and risk assessments can be conducted at different levels (e.g. household, local, subnational, agricultural system and ecosystem) or expanded to cover an entire sector or even transboundary vulnerabilities and risks. The assessments serve also as a situation analysis, which can be used to set baselines and projections, and as a basis for monitoring and evaluation systems.

12 Exposure refers to the presence (location) of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by physical events and which, thereby, are subject to potential future harm, loss, or damage (Lavell *et al.*, 2012).

13 Sensitivity considers both biophysical attributes of the system and human activities, which affect and are affected by the system. Together exposure and sensitivity represent the potential impact of climate change on the system (Lavell *et al.*, 2012).

14 Adaptive capacity includes socio–economic, institutional and technical factors which determine the capacity of the system or an individual to plan and implement adaptation measures (Lavell *et al.*, 2012)

BOX 7.

The concept of climate risk in the agriculture sectors at national and subnational levels in Thailand

In Thailand, agriculture is at the heart of national development and constitutes a major element of national identity. More than 40 percent of the population works in the agriculture sectors. The farming population is aging, with a majority of agricultural workers over 40 years old. Climate change is recognized as one of the key challenges facing agriculture, posing a significant risk to the sectors' capacity to ensure the quality of life in farming communities, food security and national income. Working within the IPCC's Fifth Assessment Report risk framework, government representatives, in close collaboration with academia, have developed an impact chain model to enable a more action–oriented approach for policy–making related to climate change adaptation. Impact chains employ participatory processes to foster a deeper understanding of key climate drivers that trigger generic and sector–specific vulnerabilities and heightened sectoral exposure to negative impacts.

The elaboration of sector–based impact chains is part of Thailand's NAP process. It is specifically aimed at increasing the understanding of climate change risks and impacts and highlighting the interlinkages across sectors. A diagrammatic overview of the agriculture impact chain for Thailand is provided in Annex 5. In Thailand, the exposure of the agricultural sectors has been categorized in terms of agricultural output clusters (fisheries, livestock and crops) and agricultural factors (soil and water) that may be affected in various ways by hazards related to climate change. Exposure of these clusters and factors to climate risks could compromise the productive capacity of producers and lead to higher production costs and a shift in agricultural labour.

The impact chain will be used as a basis for weighting climate risks and identifying national adaptation priorities and options. The impact chain concept can be applied to any sector and spatial/geographical unit, allowing for a greater level of detail and information on sector–specific or localized climate risks. As Thailand's NAP process continues, the Royal Thai Government will apply the impact chain approach in different NAP pilot areas, both at the provincial and farm level, to provide better information to decision–makers on possible adaptation strategies in future development plans. The expected output of the subnational climate change impact chain and risk assessment process is improved integration of local inputs and experiences into national and sectoral adaptation planning.

Source: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

In assessing risks of climate impacts, it is necessary to understand the potential climate hazards and vulnerabilities of human and natural systems. The following categorization of key risk areas for the agriculture sectors and food security and nutrition may be helpful when identifying and assessing potential risks (Oppenheimer *et al.*, 2014):

- Risk of food insecurity and the breakdown of food systems linked to warming, drought,

flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings.

- Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi–arid regions.
- Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic.
- Risk of loss of terrestrial and inland water ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for livelihoods.

As climate change risks are cross–sectoral and affect systems at multiple scales (local, subnational, national and international), vulnerability and risk assessment require collaboration among a range of actors, including government agencies, NGOs, and stakeholders in multiple sectors. Vulnerability assessments at the national level are useful for providing insight on where to plan vulnerability assessment and adaptation options at the community level. Vulnerability analysis at the community level also help to identify concrete adaptation measures for reducing vulnerabilities at the national level. An example of a community level cross–sectoral vulnerability analysis in Cameroon is presented in Box 8.

BOX 8.

How Cameroon forest communities were engaged in cross–sectoral vulnerability assessment

A team of researchers conducted vulnerability assessment in two forest communities in Cameroon: the Lekié community in the central region and the Yokadouma community in the eastern region. The aim of the analysis was to understand how climate change affected the communities and identify their specific adaptation needs.

The researchers first consulted all relevant documents and data, and identified key stakeholders and local authorities. Next, local community representatives participated in focus group discussions to examine potential future climate conditions, the possible impacts on their livelihoods and their adaptive strategies. These discussions involved a variety of activities, such as brainstorming sessions and an analysis and diagnosis of historical trends. The researchers also carried out surveys to collect information on the communities' knowledge and experiences.

People in the project sites perceived droughts, changing seasons, heavy rainfall and strong winds as the main climate–related hazards. Forest–related activities appeared to be less sensitive to weather extremes than crop and livestock production. Forest foods are used extensively to help meet dietary shortfalls during periods of crop failures. Because forests are less affected by changing seasons, perhaps owing to their diversity and resilience to climate variability, forest resources constitute a safety net for local communities during periods of hunger. People highlighted community–created firebreaks to protect their forests and farms as one option for climate change adaptation.

They also pointed out that support from national authorities is needed to overcome financial, technological and educational constraints. It was clear that national policies and actions have a strong influence on local adaptive capacity.

BOX 8. (CONTINUED)

This local study provided suggestions for long–term adaptation actions that could be integrated with national adaptation and development processes. The results also increased the awareness of policy–makers about the contribution forests can make to the development of adaptation actions.

Adapted from Bele et al., 2013.

Climate change vulnerability assessments of production systems, ecosystems and ecosystem–dependent communities can involve different approaches, methods and tools, depending on the particular system, the available resources, information and data, the expertise, and the temporal and spatial scale. Qualitative and participatory methods (e.g. focus groups discussions, resource mapping) are mainly used to assess vulnerability at a small scale and at the community level. In most cases, vulnerability is assessed at a short–term time scale. Quantitative and scientific methods (e.g. indicators, data mining and empirical modelling) are generally applied for analysing vulnerabilities at large–spatial scale and at the national and subnational levels. This analysis is often conducted at a long–term time scale. Usually, the most comprehensive and effective approach integrates both local knowledge and science–based methods.

A key challenge is accessing data and information on climate trends and projections at an appropriate scale. UNFCCC (2010) provides a review of available agricultural models. These include: agro-climatic indices with geographic information systems; statistical models and yield functions and process-based crop models; and economic models, such as farm–level micro-economic models, household and village models, and macro-economic models. These models can support climate impact and vulnerability assessments and adaptation planning.

There are a range of approaches and tools that policy makers can draw upon to develop vulnerability and risk assessments at different scales in different agricultural sectors.

The approaches listed below can be helpful:

1. Quantifying potential climate impacts on the agriculture sectors (e.g. crop yields and water availability) and then combining this with socio–economic data to derive vulnerabilities of agricultural livelihoods to climate change. The numerical models used in the approach help stakeholders better understand the mechanism of impacts and how to address them (GIZ, 2012);
2. Overlaying maps of different indices (e.g. climatic, geographic, socio–economic, biophysical) to highlight vulnerability hotspots within a country (UNDP, 2010; Bourne *et al.*, 2012);
3. Collecting and analysing all relevant information and data at local level and characterizing the vulnerabilities of the agricultural households to climate change and other socio–economic, environmental and political risks (CARE, 2009; Tiani *et al.*, 2015).

Some tools and guidance available for vulnerability and risk assessments at different scales include:

- CARE's Climate Vulnerability and Capacity Analysis Handbook (CARE, 2009) for local vulnerability assessments;
- FAO's interdisciplinary impact and vulnerability assessment system (see more in Box 9);
- FAO's vulnerability assessment methodologies for the fisheries and aquaculture sector (Barsley, De Young and Brugère, 2013; Brugère and De Young, 2015);
- The Center for International Forestry Research (CIFOR) methods and tools for assessing vulnerability of forests and forest–dependent people to climate change (Locatelli *et al.*, 2008),
- The Canadian frameworks for assessing vulnerability of sustainable forest management (Williamson, Campagna and Odgen, 2012) and forest–based communities to climate change (Williamson *et al.*, 2007).

More tools and resources are listed at the end of Element B.

The information from vulnerability and risk assessments can also be used to quantify the economic impacts of climate change on agriculture. Information on the economics of climate change impacts, particularly in terms of loss and damage, can provide another useful way to prioritize adaptation actions. For example, the Ricardian technique (Mendehlson, 2008) can provide estimates for the damages that the agriculture sectors will incur from climate change, while offering insights into the kinds of adaptation actions that producers can adopt. As it relies on statistically correlating producers' annual net revenues with the climate changes they experience, this technique requires some experience in statistics and a statistical software package.

BOX 9.

Interdisciplinary assessment system for risks and vulnerabilities in the agriculture sectors for medium– to long–term adaptation planning

While addressing short–term vulnerabilities to climate variability and extreme weather events in the agriculture sectors is imperative, a strengthened evidence–base on medium– to long–term climate change impacts on agriculture and vulnerabilities of farming systems and communities can help guide governments in strategic investment planning, policies and programmes for adaptation.

As part of the Analysis and Mapping of Impacts under Climate Change for Adaptation and Food Security (AMICAF)[15] project funded by the European Union, FAO supported Morocco, Peru and the Philippines in assessing the potential impacts of climate change on national crop productivity and water resources under various climate change scenarios. MOSAICC helped create a collaborative working environment among experts from different disciplines in which they could work together to produce information on policy–relevant climate impacts with subnational disaggregation. In Peru and the Philippines, biophysical information on crops and water were then submitted to an econometric analysis to characterize vulnerable groups and explore policy options to address their challenges.

Source: FAO, 2016b.

As mentioned earlier, vulnerability assessments can consider vulnerabilities of sectors, different agricultural and agro–ecological zones and resources, including land, soil, water, energy, fisheries and forests, and cross–cutting issues, such as the sensitivity and adaptive capacity of women and men, youth and the disabled and marginalized community groups. An example of a gender–sensitive vulnerability analysis is presented in Box 10. Regardless of the chosen vulnerability and risk assessment method, it is important to ensure that there is a broad stakeholder involvement; the chosen method is carried out in a transparent way; the steps are recorded for later reference; and the results are communicated to all stakeholders (Matteoli, 2016).

15 AMICAF Web site: www.fao.org/climatechange/amicaf/

BOX 10.

A gender–sensitive, multilevel vulnerability assessment informing adaptation planning in Mali

Lake Faguibine, part of the lake system fed by the Niger River in northern Mali, used to be a productive area for agriculture and fishing, but has become mostly dry since the mid–1970s. Using the case of Lake Faguibine as a model for ecological, political and social changes that are driven by climate change, researchers from the Tropical Agricultural Research and Higher Education Center (CATIE) and CIFOR set out to explore the vulnerability of livestock– and forest–based livelihoods to climate variability and change using a multilevel gender–sensitive participatory approach. The researchers collected qualitative data on past, present and future coping strategies through interviews and workshops in local communities and with women–only groups. Similar data collection was done at the national, regional and district levels, where additional discussions took place on vulnerability and adaptive capacity in terms of resource availability, entitlements and the ability of people to use the resources during droughts.

The analysis revealed that after drastic ecological, social and economic changes, forests have gained importance in adaptive strategies around Lake Faguibine. Those changes have resulted in shifts in endowment, entitlements and power in the different livelihood systems and for different social groups inside those systems. Differences among the various actors emerged in terms of their perceptions of vulnerability and related preferences for adaptation strategies. Regional and district–level stakeholders preferred infrastructure–based adaptation (refilling the lake), whereas community members expressed a preference for ecosystem–based approaches (implementing sustainable forest management). Gender–based differences also emerged. While persistent inequity in access to land was seen as a factor in women's vulnerability, a possibility for change and new opportunities for women, such as increased participation in decision-making, was also linked to the ecosystem and social changes.

These findings demonstrate that vulnerability and related adaptation strategies are not viewed in the same way by actors within the same level, or at different levels. To inform adaptation planning with a deeper understanding of vulnerability, the researchers recommended using approaches with four important features: multilevel (from local to national and vice versa); participatory (with different tools for eliciting people's views, depending on the level); integrative (with consideration of ecological, social, economic and political factors); and gender–sensitive.

Source: Adapted from Djoudi, Brockhaus and Locatelli, 2013.

B.2b Rank climate change risks and vulnerabilities in the agriculture sectors – As risks and vulnerabilities are identified at different levels and scales, they need to be ranked and categorized (e.g. key and emergent risks and vulnerabilities) using different criteria. Consider and select appropriate criteria for ranking, such as the one adapted from the LEG Technical Guidelines (UNFCCC, 2012a) and the IPCC Fifth Assessment Report (Oppenheimer *et al.*, 2014).

For risks, consider:

- magnitude (number of people or size of area affected);
- probability (likelihood of a certain climate hazard occurring);
- capacity to reduce the magnitude or frequency of the hazardous climatic event and trends;
- persistence and reversibility (are the climate risks and their impacts on agricultural production or food security reversible?); and
- urgency of actions (is urgent action required to prevent the deterioration of food security and nutrition?).

For vulnerabilities, consider:

- capacity of the societies, communities and systems to cope with and adapt to the consequences of the climate–related hazards;
- biophysical sensitivity (how sensitive is the biophysical environment, such as cropping systems, the ecosystem, coastal areas, dry lands, degraded lands, mountains, woodlands or savannah, to the impacts of climate change?);
- social sensitivity (will particularly vulnerable groups be affected? Who belongs to these groups?);
- food system resilience in terms of quality of diets and nutrition;
- types of impacts (e.g. loss of lives or livelihoods, malnourishment, famine, degradation of ecosystems, economic losses); and
- other relevant criteria (e.g. the importance of the system at risk for national development).

When selecting the criteria, pay particular attention to risks and vulnerabilities that are specifically related to crop and livestock production, forestry, fisheries and aquaculture and food and nutrition security. Rank the risks and vulnerabilities by scoring the different criteria selected (see the list above). Conduct ranking through a consultative process to ensure that the most urgent and important risks and vulnerabilities are considered.

B.2c Identify adaptation options to address key vulnerabilities and risks in the agriculture sectors – Once an agreement on the main vulnerabilities and risks has been reached, identify appropriate adaptation options. In the Fifth Assessment Report of IPCC's Working Group II (Porter *et al.*, 2014) options for adaptation interventions are organized into three general categories: structural and physical, social, and institutional. FAO's Framework Programme on Climate Change Adaptation (FAO–Adapt) considers five groups of intervention options (FAO, 2011):

- data and knowledge for impact and vulnerability assessment and adaptation;
- institutions, policies and financing for strengthened capacities;
- sustainable and climate–smart management of land, water and biodiversity;
- technologies, practices and processes for adaptation; and
- DRM.

A slightly different way of grouping the adaptation options is presented by CCAFS (Dinesh, ed., 2016):

- governance, policy frameworks and readiness;
- national planning;
- local planning;
- finance, economic incentives and value chains;
- research, extension, capacity development and knowledge systems; and
- foresight, modelling and scenarios.

These groupings can be helpful when considering options that can reduce vulnerability to risks, increase resilience, and enable adaptation to changes and variability in climatic events. Broad categories of adaptation options need to be considered first at a wider national or subnational scale to feed into national planning. It is important to remember, however, that concrete adaptation actions that have been selected for implementation should be location– and context–specific and their socio–economic dimensions (e.g. gender-differentiated access to and control over resources, such as land and credit) and agro–ecological dimensions should be considered (see Box 11 for examples from Malawi and Zambia). Actions are needed at different levels, from adjustments at the farm and local levels to national–level policy changes. Different timeframes for adaptation planning implies that

priorities and options may also differ in time. Additionally, definitions of the timeframes differ.

- short–term adaptation (1–5 years), mainly DRM;
- medium–term adaptation (5–10 years), DRM and adaptation; and
- long–term adaptation (10 years and beyond), systemic and transformational changes.

When considering the timeframes it is important to bear in mind that DRM is often intended to reduce disasters in the short to medium term and reduce vulnerabilities in the long term. The effect of DRM actions are thus meant to exceed the short– to medium–term lifespan. In some countries, long–term adaptation may extend to 20–50 years.

Many communities are already adapting to climate change. It is crucial to start by assessing the effectiveness of existing adaptation activities, and evaluate their potential for scaling up good practices and technologies and the potential need to supplement traditional knowledge and local practices with scientific research. It is also important to engage indigenous communities.

Concrete examples of adaptation options for crop, livestock, forestry, fisheries and aquaculture management practices and technologies are presented in Annex 3. It is also worth considering adaptation actions not only in primary production, but also along agricultural value chains. Strengthening value chains by emphasising market development and sensitizing consumers to the relationship between agricultural products and climate change may support resilience at the primary production level.

BOX 11.

From vulnerability analysis to potential solutions using a CSA approach in Malawi and Zambia

FAO is working in Malawi and Zambia to build the evidence base for CSA and channel it into major policy processes at the national and regional levels. Activities combine multiple disciplines to support CSA policies that explore options for adopting diversified cropping practices and integrated crop–livestock systems, overcoming barriers to adoption and building capacities to conduct down–scaled climate projections. Based on existing national information, the first component of the project consists in carrying out an analysis and validation of climate variability, and modelling the impacts of climate change on crops using MOSAICC. Training is also provided to build the capacity of country experts to conduct analysis of climate change and its impacts on crop productivity at the subnational level.

The second component involves screening the availability and suitability of leguminous cover crops and forages to country–specific farming systems. The goal is to improve the resilience of these systems by both improving soil cover and fixing nitrogen in the soils. Possible best bets for both cover crops and forage crops are to be identified to harness crop–livestock synergies.

In the third component, assessments are conducted of livestock production under climate constraints along with an analysis of the inter–annual variability in biomass availability for livestock feed and its impact on animal production. An assessment is also done of the potential for improving productivity and reducing emissions. Options to be assessed

using the Global Livestock Environmental Assessment Model (GLEAM) were reviewed during a workshop in Zambia, where country–specific parameters were identified. Results revealed that feasible interventions in feed management, animal health and husbandry in Zambia could contribute to a more than 50 percent increase in the production of meat and milk even under drought conditions. The same interventions also help to reduce inter–annual variability in the production of animal products and lower emissions per unit of product by up to 25 percent.

All of the above analyses are supported by a fourth component that involves a socio–economic analyses of the impact of identified CSA solutions, including agricultural practices and livelihood diversification strategies, on productivity and welfare, and on the barriers to their adoption under climate change. This component uses nationally representative household data combined with high–resolution climate and institutional data to understand how historical and current climate variability affect livelihoods and the adoption of CSA options. The objective of this component is to highlight policy entry points for establishing an effective enabling environment for CSA.

Source: Adapted from FAO, 2016d.

Step B3. Select and appraise adaptation options in the agriculture sectors

B.3a Select the appraisal methodology and criteria for adaptation options – Several criteria can be used to appraise the adaptation options that were identified in Step B.2d. The following list provides examples of methodologies and criteria for the appraisal. They have been adapted from the UNFCCC NAP Technical Guidelines and FAO's *Sustainable Forest Management Toolbox* (see the list of tools and resources for element A) and can be customized during appraisal:

- timing and urgency for action (would a further delay increase vulnerability or lead to increased costs at a later stage?);
- short–term benefits versus long–term benefits (could the short–term benefits lead to possible maladaptation over the long term?);
- cost–benefit analysis, i.e. an analysis of the overall cost of a proposed option, including human and other resources, and, where relevant, economic costs and benefits and local affordability. An ecosystem–based approach that identifies the ecosystem services of adaptation options can be combined with a plain cost–benefit analysis. The needs and costs of technical assistance and the cost and availability of new technologies needed for the adaptation options can also be considered.[16]
- co–benefits and externalities, i.e. would the adaptation option have positive or negative impacts on other aspects of agricultural development, such as productivity and GHG reductions, or vulnerable populations?;
- efficiency and effectiveness, i.e. the extent to which the option is able to effectively reduce the risk;
- uncertainty and 'no regrets', i.e. would the option be beneficial even if future climate impacts are not certain and climate change threats do not occur exactly as anticipated?;
- flexibility or robustness, i.e. would the option allow for adjustment or change in the future if climate change impacts differ from those expected?
- feasibility, i.e. the economic, social, technological and environmental feasibility of implementing an option, including the enabling conditions, such as laws and policies for its successful implementation;

16 CCAFS has provided examples of site–specific methodologies for cost–benefit analysis of adaptation options in agriculture. For an example from Guatemala, see Sain *et al.* (2016). For an example from India, see Khatri–Chhetri *et al.* (2017).

- the impact on food security and nutrition of vulnerable populations;
- gender–responsiveness of the option, i.e. are both men's and women's needs, priorities and constraints addressed?;
- participation, i.e. would this option enable the participation of stakeholders who should be involved to ensure successful implementation?;
- replicability of the option, i.e. the ease of up-scaling;
- the ease of monitoring, i.e would it be possible to set relevant indicators of success for the option, and how these will be monitored?; and
- socio–economic and cultural considerations.

B.3b Appraise adaptation options using selected methodologies and criteria – Apply the set of criteria selected in B.3a to produce an assessment of the adaptation options. This would address questions such as: How expensive would this option be? Would financial incentives to farmers be needed? Would female farmers have special barriers to adopting this option? One way to apply the criteria is to create a decision matrix in collaboration with stakeholders and using scores (e.g. 1=low, 2=medium, 3=high) for each of the adaptation options against criterion selected (see an example in Table 4). Summing the scores for each criterion would indicate which adaptation options could be prioritized and implemented.

TABLE 4.

Example of appraisal criteria and scoring for adaptation options in cattle keeping

ADAPTATION OPTION	SHORT–TERM BENEFITS	LONG–TERM BENEFITS	AFFORDABILITY TO FARMERS	EFFECTIVENESS IN REDUCING RISKS	TOTAL
Disease surveillance	2	3	1–2	3	9–10
Animal breeding	1	2	2	2	7
Grazing management	2	3	2	2	9
Supplementary feeding	2	2	1	1	6
1=low; 2=medium; 3=high					

The process of ranking and prioritization may vary among countries, depending on the availability of resources, key vulnerabilities and risks, and social and political dynamics and politics. Using several methods often leads to a better solution than using a single method. Engaging the stakeholders from all agricultural sectors in ranking is important to ensure that their opinions are considered in decision–making. Obtaining information and views from them can be done through public consultations, participatory methods, questionnaires and expert groups. Economic calculations (e.g. cost–benefit analysis or cost–effectiveness analysis) require the engagement of specialists in these fields. A multicriteria analysis allows adaptation options to be analysed against a number of criteria. For additional information, see the UNFCCC Technical guidelines (UNFCCC, 2012a, pages 76–77). CCAFS and the International Center for Tropical Agriculture (CIAT) have developed a prioritization framework for CSA that can be applied in ranking the adaptation options. The four steps of the framework move from initial assessment of the options to participatory prioritization, a cost–benefit analysis and the evaluation of barriers to adoption (CCAFS, 2017).

Before coming to final decisions and integrating the adaptation priorities into the NAP, it is important to verify the final results of the ranking exercise with stakeholder groups, including men and women, local communities and vulnerable people.

In the agriculture sectors, the adaptation options are often a mix of existing and improved practices and approaches. Responding to climate change does not mean rejecting everything that has been learned about agricultural development. Rather, it is often a case of choosing small incremental improvements to existing technologies and practices (see Box 12 on the traditional Minga systems).

BOX 12.

The traditional Minga system for drought management in the Plurinational State of Bolivia

Twenty–eight years ago, farmers from the Chiquitania region of Santa Cruz in the Plurinational State of Bolivia established a community adaptation plan to deal with climate variability. As part of the plan, they developed a practice for harvesting rainwater to cope with the greater fluctuations in rainfall, as well as the increased concentration and high variability of rains. Using a diversified production system, they grow maize, cassava, peanuts and organic coffee.

The practice consists of digging a row close to the plants, filling it with manure and then covering it with mulch or vegetation residues. According to the farmers, this technique has increased their yields and kept production stable even during droughts. The manure improves the soil structure, which increases water storage and the soil's nutrient content. This technique is being spread by the *Instituto Nacional de Innovación Agropecuaria y Forestal* and FAO to other communities to help them cope with water scarcity resulting from climate change.

Source: FAO, 2016b.

Step B4. Compile and communicate agricultural perspectives for NAPs

B.4a Integrate the adaptation perspectives from the agriculture sectors in the draft NAP – This procedure is likely to be different in each country, as the NAPs will have country–specific characteristics. The aim is to compile all the agricultural perspectives into a specific agriculture component or programme, or integrate them fully into the draft NAP for endorsement at the national level. Depending on the country's approach, the NAP may focus on issues of national strategic importance and cross–cutting issues and/or include a collection of priorities for each sector. Country activities are likely to be in the form of national policies and programmes, designed to guide actions by all stakeholders and sectors. Separate sectoral climate change adaptation programmes or action plans may be necessary as a next step to transform operations that will be heavily affected by climate change (for example, see Box 13 on adaptation planning in Finland).

The sectoral adaptation programmes and action plans can also be annexed to the NAP or become a component of the NAP.

To integrate the agricultural perspectives into the NAP, it is preferable to use an approach that considers how interventions can be aligned across sectors and with national planning priorities and development programmes (e.g. food security programmes). Take into account the need to coordinate among all the agriculture sectors and to interact with other sectors for shared resources (land, water and energy). In integrating the agriculture sectors, seek to establish links between climate change impacts, DRR, adaptation and long–term development. Consider also the needs of each of the agricultural sectors for institutional mechanisms and capacity development for responsive planning and location–specific adaptation issues.

BOX 13.

Finland's National Climate Change Adaptation Planning

Finland launched its medium–term National Climate Change Adaptation Plan 2022 in 2012 as an update of the 2005 National Climate Change Adaptation Strategy. It was prepared through an inter–ministerial process led by the Ministry of Agriculture and Forestry, guided by the scientific community, and approved as a Government Resolution. The aim of the NAP is to ensure that the Finnish society has the capacity to manage the risks associated with climate change and adapt to changes in the climate. The three objectives of the plan are:

1) integrating adaptation into the planning and activities of both the various sectors and their actors;
2) giving the actors access to the necessary climate change assessment and management methods; and
3) using research and development work, communication and education and training to enhance the adaptive capacity of society, develop innovative solutions and improve citizens' awareness on climate change adaptation.

As the Finnish NAP is not sector–specific, the various sectors affected by climate change were invited to prepare sectoral climate change programmes. Consequently, the Ministry of Agriculture and Forestry took the initiative and led the preparation of the 'Climate Programme for Finnish Agriculture – steps towards climate–friendly food', which was launched in 2014. It addresses both adaptation and mitigation issues in the agriculture sectors. Similar sectoral programmes have been prepared for other sectors.

Source: The Finnish Ministry of Agriculture and Forestry Web site: www.mmm.fi

B.4b. Communicate and disseminate the NAP widely among agricultural stakeholders – Transparent communication and stakeholder participation are important at all stages of the process. When agricultural adaptation priorities and the NAP priorities are clear, and when the NAP has been endorsed at the national level, ensure that information on its objectives and consequent activities reach the agricultural stakeholders at all levels.

Step B5. Review integration of climate change adaptation in the agriculture sectors in development planning, including national, subnational and sectoral plans

B.5a Identify opportunities and constraints for integrating climate change into planning – Crop and livestock production, fisheries and aquaculture and forestry are all important for adaptation priorities because of the impact climate change will have on food security, livelihoods, ecosystems and economies. The linkages between these agriculture sectors and climate change must be addressed in two planning processes, with the first involving all agricultural sectors and the second relating to cross–sectoral development and investment planning and financing. To do

this, it is necessary to consider various existing planning cycles, prepare documents on issues related to agricultural adaptation and submit them in a timely manner. Finding suitable entry points for integrating adaptation into subnational planning (e.g. regions, provinces, districts) is also very important. Integrating climate change in planning is a multiyear, multistakeholder effort that entails working with government and non–government actors, the private sector and the development community.

B.5b Develop and enhance capacity for integrating climate change into planning – Understanding climate change and the risks and vulnerabilities linked to it is an entry point for enhancing adaptation and promoting sustainable development frameworks. Integrating climate change into overall development planning processes requires sound institutional and individual capacities of all agricultural stakeholders. This may require organizational and institutional capacity development that would include strengthening horizontal and vertical intersectoral coordination mechanisms (e.g. within line ministries to reach district and local levels; between relevant ministries; and among stakeholders involved in the planning and implementation). The institutional and capacity assessment and the capacity development plan prepared in Step A.3c help to address the main capacity gaps and planning capacity development actions for the various sectors and subsectors. The implementation of capacity development is further elaborated in Step C3.

B.5c Facilitate the integration of climate change adaptation into existing national and sub–national planning processes – Consider existing planning processes at different administrative levels and where and how the agriculture sectors' related adaptation issues can be considered in planning frameworks such as the pre–budget strategic papers, the budget lines, investment plans, overarching sector strategies, and sub–sector strategies and programmes. It is necessary to find relevant entry points into the planning cycles. For this, it is important to understand the planning and policy processes. Furthermore, representatives from the agriculture sectors' need to become part of those processes and influence and contribute to them.

Guidance for the integration of adaptation in development planning is provided in *Mainstreaming climate change adaptation into development planning. A guide for practitioners* (UNDP–UNEP, 2011), which is included in the list of tools and resources below.

Tools and resources to support the steps in Element B

Climate Data and Tools (FAO)
Website: www.fao.org/climate-change/resources/data-tools/

Agro–Ecological Zones Database (FAO)
Website: www.fao.org/nr/gaez/about-data-portal/

The Climate Adaptation Knowledge Exchange (CAKE): Library
Website: www.cakex.org/search/

Tools, maps, models and data (CCAFS)
Website: https://ccafs.cgiar.org/resources/tools-maps-models-and-data#.V7xiR_l95pg

Incorporating Climate Change Considerations into Agricultural Investment Programmes (FAO)
Website: www.fao.org/elearning/#/elc/en/course/FCC2
The E–learning, launched in 2014, course provides training on how to make rapid assessments on climate change impacts, and plan agricultural investments accordingly.

How do we actually change the business as usual management of agricultural systems? A methodology for building climate–smart agriculture (FAO, 2014c)
www.fao.org/3/a-i4314e.pdf
This brief reflects the experiences that have been gained in CSA from the development of an evidence base, dialogue and policy harmonization, investment analyses and links to climate finance. It lays out the methodology and the variation in its implementation across varying circumstances in Malawi, Viet Nam and Zambia.

MOSAICC – Modelling System for Agricultural Impacts of Climate Change (FAO, 2016f)
www.fao.org/3/a-i5294e.pdf
Web site: www.fao.org/climatechange/mosaicc
The modelling system allows for the

quantification of impacts of climate change on agricultural production and food security. MOSAICC helps in guiding strategic development and adaptation planning and in carrying out studies using each country's own data. The system integrates climate data processing tools, crop models, a hydrological model, a forest landscape model and an economic model.

GLEAM – The Global Livestock Environmental Assessment Model (FAO)
Web site: www.fao.org/gleam/resources
GLEAM is a modelling framework that simulates the bio–physical processes and activities along livestock supply chains under a life cycle assessment approach. It provides a detailed description of herd dynamics, feed rations and manure management systems, and can support the assessment of feed balances and impact of climate change on livestock production.

Vulnerability Sourcebook (GIZ, 2016)
www.adaptationcommunity.net/knowledge/vulnerability-assessment/vulnerability-sourcebook/
The GIZ Sourcebook, available in English, French and Spanish, provides step–by–step guidelines to conduct vulnerability assessments and monitor changes in vulnerability over time. Repeated assessments are a tool for monitoring and evaluating the effectiveness of adaptation. Examples and lessons learned from pilot applications in Burundi, Mozambique, Pakistan and the Plurinational State of Bolivia are provided.

Economic approaches for assessing climate change adaptation options under uncertainty, Excel tools for Cost–Benefit and Multi–Criteria Analysis (GIZ, 2013)
www.adaptationcommunity.net/?wpfb_dl=31
This study looks at approaches for the economic assessment of climate change adaptation options. It provides an overview of experiences and a review of the most common and promising methodological approaches for economic assessments and their uncertainty.

Cost–Benefit Analysis Template
www.adaptationcommunity.net/?wpfb_dl=144
The Excel template is designed to compare up to three adaptation options according to their net present value and their internal rate of return.

Climate risk assessment in value chain projects, an IFAD "how to do" note (Vermeulen, 2015)
www.ifad.org/documents/10180/30b467a1-d00d-49af-b36b-be2b075c85d2
This document provides step–by–step guidance for building climate risk analysis into the value chain project cycle.

The Economic Advantage: Assessing the value of climate change actions in agriculture (Vermeulen *et al.*, 2016)
http://hdl.handle.net/10568/77628
This report is intended to provide support in building economic evidence for the inclusion of actions on agriculture in climate change plans and programmes, particularly at the national level under the umbrella of NDCs to the Paris Agreement.

The Traditional Knowledge Advantage. Indigenous peoples' knowledge in climate change adaptation and mitigation strategies (IFAD, 2016)
www.ifad.org/documents/10180/2a1e3eb4-51a3-4746-8558-2fc1e6d3e645
The long record of adaptations to climate change practised by indigenous peoples, such as the use of traditional management techniques to cope with scarce and climate–sensitive resources, and enhance their resilience, can also provide example for other communities, especially when triangulating scientific and indigenous knowledge. The publication lists experiences and gives recommendations working with indigenous communities to support adaptation strategies, build resilience and sustain livelihoods and traditional ways of life.

Climate Change 2014: Impacts, Adaptation, and Vulnerability (IPCC, 2014)
www.ipcc.ch/report/ar5/wg2/
The IPCC Fifth Assessment Report presents different emission pathways scenarios and observed and potential regional climate change impacts. It maps sectoral risks and potential for adaptation in different systems, including food production systems. The regional reports can be of particular interest.

Climate Change 2007: Impacts, adaptation and vulnerability (IPCC, 2007)
www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf
This report provides a comprehensive and scientific assessment of the impacts of climate change, the vulnerability of natural and human environments, and the potential for response through adaptation.

Multi–factor, multi–state, multi–model scenarios: Exploring food and climate futures for Southeast Asia (Mason–D'Croz *et al.*, 2016)
http://hdl.handle.net/10568/75860
The article gives an example of a regional process that supported decision–making through scenarios that give insights into potential climatic, socio–economic and environmental changes in Southeast Asia.

Mainstreaming climate change adaptation into development planning. A guide for practitioners (UNDP–UNEP, 2011)
www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Change/Adaptation/Guide%20Mainstreaming%20Climate%20Change%20Adaptation%202011.pdf?download
This guide is designed to assist advocates and practitioners engaged in mainstreaming climate change adaptation. It should be seen as an invitation for mainstreaming specialists and adaptation experts to partner and bring added value to the overall endeavour.

Climate Services for Supporting Climate Change Adaptation. Supplement to the Technical Guidelines for the National Adaptation Plan Process (WMO, 2016)
www.wmo.int/gfcs/node/925
The publication introduces climate– and weather–related tools and services available for supporting national–level adaptation planning, including in the agriculture sectors.

4.3 Element C: Implementation strategies

The focus of this element is on developing a strategy and enhancing capacities to implement adaptation actions in the agriculture sectors. One of the main goals is to ensure that agricultural adaptation priorities are similarly prioritized in the NAP. New work on adaptation should be built as much as possible on existing adaptation and agricultural development activities. Ongoing projects should be expanded and, as appropriate, new adaptation projects and programmes could be formulated, and financing sought from national and international climate and development funds. Coordination across sectors and subsectors and capacity development are essential elements of planning and implementing adaptation. The monitoring and evaluation needs should also be considered throughout the element. Guiding questions for steps from C1 to C4 can be found in Table 5.

The main outputs of this element could include:

- ❑ The agriculture sectors' priorities and their implementation are included and prioritized accordingly in the NAP.
- ❑ A completed strategy for implementing adaptation actions in the agriculture sectors.
- ❑ Plans for mainstreaming adaptation in all the agriculture sectors' policies and programmes and accessing financial resources.
- ❑ Cost estimates for the main adaptation projects and programmes (expanded or new).
- ❑ Capacity development actions for planning and implementing adaptation.
- ❑ Institutional coordination mechanisms, both horizontal and vertical, across the agriculture sectors.

C1	*Addressing agriculture in NAP*	• Are agricultural adaptation priorities adequately included in the NAP? If not, what actions could be taken? • What are the lessons from ongoing programmes? How could they inform the planning and implementation of new programmes? Can new actions be built on the existing ones?
C2	*Planning implementation*	• What are potential approaches for implementing adaptation? • How can adaptation be integrated in agricultural planning processes (e.g. annual plan, budget, donor projects)? • What are the opportunities for (new) financing for adaptation?
C3	*Developing implementation capacities*	• Is there a capacity development programme to support implementation? • Are the districts and local level actors being contacted? • Is the work connecting with all sectors?
C4	*Promoting coordination and collaboration*	• Are all relevant ministries and other stakeholders engaged? • How can regional organizations be reached? • Is there alignment with global conventions and agreements (e.g. Paris Agreement and SDGs)?

Table 5. Guiding questions for Element C – Implementation strategies

Step C1. Ensure appropriate priorities for the agriculture sectors in national adaptation planning and the NAP

C.1a Contribute to selecting national criteria for defining implementation priorities for climate change adaptation – Negotiate with the NAP Core Team and decision–makers to ensure that agricultural priorities are considered in selecting and prioritizing actions for NAP implementation at the national level. The prioritization should consider aspects such as the development needs and vulnerabilities of men and women crop farmers and livestock producers, fishers and aquaculturalists and forest–dwellers and their communities, and the ongoing adaptation activities in all agriculture sectors (refer back to Elements A and B). The criteria used for determining the agricultural priorities in Element B could also help the national prioritization. The review of poverty reduction strategy papers, national development plans, sectoral strategies, NAPAs, NAIPs and other agriculture, forestry and fisheries development plans and investment programmes could be helpful for defining the national adaptation priorities and entry points for implementation. At this stage, the way in which adaptation needs and priorities are described in the country's INDC and NDC can also guide decisions.

C.1b Continue to identify opportunities for building on existing adaptation activities in the agriculture sectors – Stocktaking of the ongoing adaptation activities, projects and programmes was conducted at the start of the NAP–Ag process (see Element A). To achieve sustainable results and avoid duplicating efforts, it is important to build on and complement existing work on adaptation. Identify good practices among the existing adaptation activities and efficient ways of using resources to ensure that adaptation activities align with sectoral priorities.

Step C2. Develop a long–term adaptation implementation strategy

C.2a Strategy for implementing adaptation in the agriculture sectors – When aligning agricultural adaptation actions with the development of the national overall NAP implementation strategy, consider and document prioritized adaptation objectives, actions and approaches (e.g. ecosystem–based approach, programmatic approach, sector–wide approach, or climate-proofing) for their implementation in the agriculture sectors. As part of the formulation of the implementation strategy, consider which adaptation objectives can be achieved through ongoing climate change and development projects, and which ones require new interventions.

For the new adaptation and development projects and programmes, define adaptation–relevant objectives, impacts, outcomes and outputs, target areas and beneficiaries, responsible authorities, and timing and sequencing of actions. The following wider objectives can be considered: the attainment and safeguarding of food security and nutrition and water security; the protection of life, livelihoods and property against climate extremes; the protection and enhancement of ecosystems; and the climate–proofing of major components of national economies. Consider also the potential budget needs, resource mobilization from the government, private sector and international funds (see Box 14 on adaptation finance) and the inclusion of adaptation actions in the overall NAP, as well as co–benefits, and impacts on food security, nutrition and gender equality. NAPAs have shown the challenges of mobilizing resources for implementation and the need for efficient integration or linkage with NAIPs to ensure adequate resources. This requires looking synergistically at agriculture and climate financing. For example in Benin, a study was carried out on how to integrate CSA in the NAIP based on information gathered during the NAPA process and the preparation of National Communication to the UNFCCC.

Consider the required technical and human resources and how to best strengthen them. Include criteria on gender, age, ethnicity, and cultural balance in working groups and implementation teams (e.g. a certain percentage of team members are female).

BOX 14.

Adaptation finance

Along with investments in adaptation from their national budgets, developing countries need support to respond to the impacts of climate change. The current adaptation finance architecture includes finance flows and mechanisms from private and public finance, as well as resources from development finance institutions and increasingly from insurance and risk pooling mechanisms. The table below contains information from the dedicated multilateral climate funds (US$ million) targeting adaptation actions 2003–2015.

NAME OF THE FUND OR PROGRAMME	PLEDGED	DEPOSITED	APPROVED	PROJECTS APPROVED
Pilot Project for Climate Change Resilience (World Bank's Climate Investment Funds)	1 125.00	1 125.00	857.31	70
Least Developed Countries Fund (UNFCCC)	963.66	961.87	794.62	203
Adaptation Fund (UNFCCC)	487.10	482.54	330.30	51
Adaptation for Smallholder Agriculture Programme (IFAD)	366.46	326.44	239.00	28
Special Climate Change Fund (UNFCCC)	350.08	344.07	277.89	64

The GCF, which is to become a major channel of climate change financing, is set to devote half of its funding to adaptation, with half of that proportion going to Small Island Developing States, LDCs and African states.

Source: ODI, 2015.

C.2b Implementation of adaptation activities – Depending on the country, the NAP document may or may not include concrete adaptation programmes and projects. In any case, the sectoral adaptation actions should be nested in the NAP framework. In the agriculture sectors, implement and integrate adaptation as much as possible into related national agriculture, forestry, fisheries and food security policies, programmes and projects. These could include programmes for sustainable agriculture intensification, food security, the sustainable management of forest, rangelands and pastoral areas, water and watershed management, sustainable fisheries and aquaculture and social protection. Implementation will also require the mobilization of funding and resources and building capacities. The application of appropriate technologies and practices is location– and context–specific, i.e. they depend on the climate change impacts in a specific setting, and the related vulnerabilities, risks and adaptive capacity.

Step C3. Improve capacity for planning and implementing adaptation in the agriculture sectors

C.3a Strengthen long–term institutional and regulatory frameworks on climate change for addressing long–term adaptation in the agriculture sectors – Refer also to Step A.3a and Step B.5b. The adequate capacity of national and local government institutions, NGOs, community–based organizations, organization of farmers, fishers and forest users, women's and youth organizations, research institutions and academia is essential for increasing long–term adaptation capacity. Based on the assessed needs, relevant regulatory frameworks (e.g. acts, legislative and policy frameworks, and accountability frameworks) may also need

updating and strengthening. This also includes assessing and strengthening multistakeholder processes and platforms for policy formulation and implementation.

C.3b Capacity development at sectoral and subnational levels on adaptation and climate–smart practices and policies – Due to the evolving nature of climate change adaptation, a continuous and evolving training and learning programme for national, subnational and local capacity development for experts, systems and institutions is needed. For example, FAO Kenya undertook capacity development of decentralized governments and stakeholders to promote the large–scale adoption of CSA and developed an extension manual to guide this forward. A training and outreach programme at the sectoral and national level could support a process of promoting adaptation and building resilience in the agriculture sectors. Areas covered could include CSA, agro–ecology, sustainable forest management, the conservation and sustainable use of genetic resources, the integration of land and water management, sustainable fisheries and aquaculture and the inclusion of women and youth (see also A.3a as well as Box 15 for a concrete example of farmer–level training and Box 16 for institutional and individual capacity strengthening). The engagement of national, subnational and local training institutions could be an efficient way of organizing capacity development. Ensure also adequate budget for the capacity development activities. Establish a link to Element D (monitoring) by defining appropriate capacity development results.

BOX 15.

Farmer field schools to integrate climate resilience in Mali

The Farmer Field Schools (FFS) are an approach to community education based on the principles of experimentation, learning by doing and cooperation. Through weekly field learning sessions, groups of 20–25 farmers from the same village are provided with a risk–free environment to test innovations and build their capacity to adapt to climate change throughout the season. The FFS cross-sectoral approach enables farmers to integrate crops, agroforestry and pastures and improve water management practices. Learning is supported by a facilitator who has gone through the same learning cycle to understand the principles of non–formal education and become familiar with existing climate change adaptation practices. FFS provide ideal learning platforms for farmers to adapt existing climate change adaptation practices that have been developed through research, extension services and traditional methods to their own needs and contexts.

The project in Mali aimed to strengthen farmers' capacities to adapt to climate change by building on an expanding network of FFS initiatives already supported by FAO and the Malian Government. With support from FAO and funding from GEF, a national climate group was established that brought together the Ministry of Agriculture, the Agency for the Environment and Sustainable Development, the Ministry of Finance, research organizations, farmers' organizations, and other partners, to facilitate the coordination and contribute to defining Mali's INDC. Thanks to the full involvement of the national and local authorities, the project was able to scale up the FFS climate change adaptation approach from nine communes in 2012 to more than 134 communes in 2014. It resulted in the capacity building of 16 237 producers of which 5 321 were women; the adoption of improved seeds in 242 villages through the dissemination of 13 improved and adapted varieties of sorghum, cowpea, rice, millet and maize in three agro–ecological zones; and the implementation of four new agroforestry perimeters managed and maintained by four farmers' organizations, of which 75 percent of the members are women.

Source: Adapted from FAO, 2016d.

BOX 16.

Strengthening individual and institutional capacities for adaptation in the Lao People's Democratic Republic

Wetland areas are vulnerable to changes in the quantity and quality of their water supply, and it is expected that climate change will have a pronounced effect on these areas. At the same time, wetlands can help reduce the impacts of climate change on local livelihoods. Two wetland sites in the Lao People's Democratic Republic are experiencing pressures from their use by local communities and from the effects of climate change. The intensification of agriculture is putting these wetlands under great pressure, and climate change is further increasing their vulnerability. At the request of the Government of the Lao People's Democratic Republic, GEF has agreed to support a project through FAO, to enable wetland users to adapt to climate change, by changing their practices to manage the wetlands more sustainably. The IUCN is an implementing partner.

Through a series of multistakeholder processes and climate vulnerability studies, FAO, with the leadership of the IUCN, has supported national stakeholders to self–assess their capacity needs, identify opportunities to respond to these needs, and plan effective capacity–development actions. Areas of the assessment covered organizational and institutional issues from both a horizontal and vertical perspective, appropriate mandates and multistakeholder coordination mechanisms. The findings of the capacity assessments revealed several important areas for attention: local awareness and knowledge; networks and collective management; linking climate change, conservation and livelihoods; and strengthening institutional coordination mechanisms across sectors and stakeholders.

To respond to these needs, detailed action plans with concrete activities are jointly developed at the local level. These plans include raising awareness among local communities, capturing and sharing indigenous knowledge, strengthening co–management systems among wetland users, sharpening climate change policies and strategies, strengthening cross–sectoral coordination mechanisms and identifying alternative livelihood options for local community members.

Source: FAO, 2016e.

C.3c Implement outreach on planning outputs nationally and promote international cooperation – In the agriculture sectors, national and international focus could be on sharing examples of sustainable crop, livestock, forestry and fisheries and aquacultural practices and stakeholder participation. This sharing of experience could include regional and South–South collaboration. It is also important to ensure that agricultural stakeholders have access to data and information on adaptation planning and the process to formulate and implement NAPs.

Step C4. Promote coordination and synergy at the national and subnational levels

C.4a Coordinate collaboration across all the agriculture sectors for efficient actions – Consider coordination needs at the national and subnational levels across government ministries, including agriculture, livestock, fisheries, environment, forests, natural resources, gender, local government, lands, water and energy. The finance and planning ministries also need to be included from the outset to ensure sufficient funding for agriculture adaptation. Cross–sectoral coordination creates synergies at all levels and can be enhanced using participatory approaches. Regional collaboration can also support agricultural adaptation by reducing the likelihood of cross–border negative externalities (Matteoli, 2016). See also Step C3 on how to assess coordination mechanisms and strengthen organizational capacities.

C.4b Synergy with international processes, including multilateral environmental agreements – Consider other development processes that support agricultural adaptation actions (e.g. SDGs, CBD, and UNCCD).

Tools and resources to support the steps in Element C

Disaster risk management system analysis: A guidebook (FAO, 2008)
www.fao.org/docrep/011/i0304e/i0304e00.htm
This guide provides a set of tools and methods to assess existing structures and capacities of national, district and local institutions with responsibilities for DRM to improve their effectiveness and integrate DRM concerns into development and sectoral planning. Particular reference is made to disaster–prone areas, vulnerable sectors and populations. The guide helps to identify gaps within the existing DRM institutions and/or systems including sectoral line agencies that are often responsible for implementing the technical aspects of DRM (e.g. agriculture, water and health sectors). It also provides guidance in setting up a system for monitoring and evaluation.

The Policy Advantage. Enabling smallholders' adaptation priorities to be realized (IFAD, 2015)
www.ifad.org/documents/10180/16492d6f-f842-4695-9493-4e5fbdd1c6af
The publication presents case studies from five developing countries (Cambodia, El Salvador, The Gambia, Mozambique and Sudan) and defines policy engagement (e.g. creation of enabling environments) in a project context. It gives examples of stakeholder engagement, coordination between key institutions at different levels, and the integration of climate change into sectoral policies.

Climate–Smart Agriculture Sourcebook (FAO, 2014b)
www.fao.org/documents/card/en/c/6f103daf-4cd2-5a95-a03c-3d5d6b489fff/
The Sourcebook helps decision–makers to identify different options for planning, policies, investments and practices that can make the agriculture sectors, landscapes and food systems more climate–smart. The Sourcebook is a point of reference that covers technical and policy aspects of crop and livestock production, forestry, and fisheries and aquaculture in relation to climate change. For adaptation planning and implementation, it covers social safety nets and provides guidance in gender mainstreaming, institutional and capacity development, and assessing, monitoring and evaluating progress.

The Role of the 2015 Agreement in Enhancing Adaptation to Climate Change (Helgeson and Ellis, 2015)
www.oecd.org/env/cc/Role-of-2015-Agreement-in-Enhancing-Adaptation-to-cc-2015(1).pdf
The OECD Climate Change Expert Group Paper clarifies the roles and potential for synergies with multilateral environmental agreements, compares the NAPAs and NAPs, and lists lessons learned from national adaptation strategies. It also provides a list of existing institutions and arrangements for climate change adaptation that can help clarify how the UNFCCC addresses the subject.

4.4 Element D: Reporting, monitoring and review

The focus of Element D is on building effective monitoring and review systems to assess: the progress, the effectiveness and the gaps in identifying and prioritizing adaptation options for the agriculture sectors; the integration of agricultural issues in the process of formulating and implementing NAPs; and the success in implementing agricultural adaptation actions, with a possibility for evidence–based learning and revisions. The groundwork for the monitoring and review system was laid already in Elements A, B and C. Sharing information on the NAP with the sector stakeholders will enhance transparency and commitment. Guiding questions for steps from D1 to D4 can be found in Table 6.

The main outputs of this element could include:

- ❑ Focal areas for monitoring and evaluation, and related indicators and data collection methods for the agriculture sectors.
- ❑ Active monitoring of the process to formulate and implement NAPs with special focus on the level of integration and prioritization of agricultural perspectives.
- ❑ Mechanisms for monitoring the implementation of adaptation actions in the agriculture sectors, including the tracking of the development of human and institutional capacities.
- ❑ Milestones for evidence–based learning and revising the NAP–Ag documentation.
- ❑ Active information sharing among stakeholders.

D1	*Preparing for monitoring*	• What are the key areas for monitoring? • What are key indicators for monitoring these areas? • Are there existing monitoring and evaluation procedures and management information systems in the agriculture sectors?
D2	*Monitoring the planning*	• Are the agriculture sectors' concerns and needs included and prioritized in the NAP? • If not, what can be done?
D3	*Monitoring the implementation*	• Is there a review and revisions process for NAP/NAP–Ag? • What can be learned from successes and challenges? • What adjustments are needed in NAP/NAP–Ag? Who is in charge?
D4	*Disseminating information*	• How can it be ensured that experiences and information are shared with stakeholders? • What are the mechanisms for learning across borders?

Table 6. Guiding questions for Element D – Reporting, monitoring and review

Step D1. Prepare for monitoring adaptation planning and implementation in the agriculture sectors

D.1a Identify areas of the adaptation planning in the agriculture sector to monitor progress, effectiveness and gaps – The aim of the Element D is to establish a monitoring framework for the adaptation planning and implementation in the agriculture sectors. The monitoring can be undertaken at different levels, and the NAP–Ag Task Force should choose whether the focus is on:

- monitoring the adaptation planning in the agriculture sectors as part of the NAP (including its gaps);
- how the agriculture sectors are addressed in NAP;
- mainstreaming of adaptation into sectoral policies, programmes and plans; and/or
- implementation and results of the agricultural adaptation actions.

This choice has implications on the monitoring process, including on data collection and indicators. It is also important to enhance monitoring capacities and ensure that capacity development results are part of the general monitoring framework.

D.1b Define indicators for documenting progress, effectiveness and gaps of the adaptation plan as well as outputs and broader outcomes – Consider the costs and the timeframe to ensure monitoring is possible. Different sets of indicators are needed for monitoring at different levels (e.g process indicators, output and outcome indicators, and impact indicators) (FAO, 2016g). An example of a process indicator could be the extent of the integration of adaptation into development planning of all agricultural sectors, which can be measured through a qualitative assessment using a set of questions or a scorecard. It is important to use gender–sensitive indicators, where relevant, to measure who is vulnerable or who is taking up the adaptation options. Defining the areas for monitoring and indicators through a participatory process helps to better engage stakeholders in the monitoring and review actions. Some examples of impact, outcome and output indicators for concrete adaptation actions for crop and livestock production, forestry and fisheries and aquaculture are listed in Annex 4.

D.1c Identify a method for collecting and storing the data throughout the planning process, and decide who will be in charge and when this will happen – Design a monitoring and evaluation framework, with methods to collect and store data across sectors, agencies and stakeholders, and a management information system for the data. It is important to note that the country may already have a monitoring and evaluation system for reporting on the implementation and impacts of adaptation actions for their National Communications to UNFCCC or as part of the implementing and reporting procedures for NAPAs. Also explore opportunities for building on existing monitoring and evaluation systems and management information systems in the agriculture sectors. The use of experimental and quasi–experimental techniques should be considered for the evidence–based evaluation of policy interventions aimed at climate change adaptation. Finalize a monitoring and evaluation plan with institutional roles and responsibilities, including actors involved in data collection, agree on the lead institution responsible for coordination, and ensure adequate capacity to collect data, which should be gender–disaggregated.

Step D2. Review the national planning process assessing how all the agriculture sectors are addressed

D.2a Review the draft NAP to assess whether the main concerns of all the agriculture sectors are addressed. This could include assessing whether:

- the main climate impacts, risks and vulnerabilities of all the agriculture sectors are elaborated;
- the adaptation concerns and actions of all the agriculture sectors are included and prioritized;
- necessary policy actions are proposed to ensure an enabling environment for agricultural adaptation;
- adequate resources are allocated for implementing agriculture adaptation;
- new adaptation projects or programmes are proposed for the agriculture sectors;
- the agriculture sectors' needs and gaps are considered in capacity development programmes; and
- sector–specific gender issues are adequately reflected.

From a procedural perspective, the frequency and level of participation of the representatives from each agriculture sector in the national adaptation planning and decision–making could also be monitored.

D.2b Take corrective actions as deemed necessary – In cases where it is strongly felt that agricultural concerns have been inadequately reflected in the draft NAP, and that representatives from the agricultural sectors could have been better engaged in the process, negotiate for a better integration of agricultural priorities before the NAP is finalized and approved or when it is updated. It is good to note, however, that every country has its own planning, decision–making and prioritizing processes, which are influenced by a range of technical, political and financial issues.

Step D3. Monitor and iteratively update the process of adaptation planning and implementation in the agriculture sectors

D.3a Monitor the process and/or implementation results and identify room for improvement – Depending on the areas of monitoring decided in Step D.1a, set up baselines for planned indicators that focus on the process and/or existing adaptation activities and new interventions resulting from the adaptation planning, and measure outputs, outcomes and results and impacts. Using experimental and quasi-experimental techniques will enable policy–makers to generate evidence of impacts and update their policies accordingly. Consider how adaptation actions have changed vulnerabilities and risks in the agriculture sectors in the medium and long term. Identify room for improvement. Consider if activities are actually contributing to the adaptation and resilience of different socio–economic groups and to both men and women working in the agriculture sectors. Engage stakeholders in monitoring activities and keep the focus on sector-specific achievements.

D.3b Repeat steps above and update NAP–Ag and related documentation – Consider coordination and implementation mechanisms and the need to adjust the plans to improve effectiveness, and create knowledge management and learning cycles, especially at the subnational level. Ensure coordination with sectoral policies and strategies, and explore new financing needs and budgetary allocations.

D.3c Synthesize results of new assessments and emerging science and outcomes from implemented adaptation activities – Regularly review the agricultural adaptation plan and/or the agriculture component of the NAP and their performance and make necessary up–dates based on results of new assessments, scientific findings and feedback from implemented activities.

Engaging research institutions to inform this process is advisable. Compiling lessons learned and good practices from ongoing and past adaptation initiatives requires sustained communication with international and national organizations, including community–based organizations and NGOs.

D.3d Align updates to the agricultural adaptation plans with relevant national plans – Once the NAP is finalized and approved, consider the necessity to adjust the agricultural adaptation plans and programmes based on the national–level prioritization, resource allocations and the level of integration of agricultural priorities in the NAP.

Step D4. Outreach on the process and report on progress and effectiveness

D.4a As it becomes available, **disseminate the documentation related to agricultural adaptation planning and related outputs to relevant stakeholders**, including sectoral ministries, research and extension agencies, organizations representing both men and women working in crop and livestock production, forestry, fisheries and aquaculture and the private sector. There are also numerous opportunities for countries to present their agricultural adaptation planning as part of the NAP in the international climate negotiation context, for example along the UNFCCC's COPs, Subsidiary Body for Scientific and Technological Advice (SBSTA) and LEG meetings. Sharing lessons learned and good practices through South–South communication is highly recommended.

D. 4b Incorporate information on the progress and effectiveness of agricultural adaptation planning – Promote the buy–in by affected communities, raise awareness of adaptation planning, disseminate success stories and opportunities to expand and scale up successful activities. Consider possibilities to use modern media in disseminating information. The national monitoring exercises that generate information for adaptation communications under the Paris Agreement could also help to inform reporting for other development agendas, such as the SDGs and the Sendai Framework for Disaster Risk Reduction. There can also be linkages between adaptation monitoring and other work streams under the UNFCCC (e.g. the Nairobi Work Programme on Impacts, Vulnerability and Adaptation) and general information and knowledge dissemination.

Tools and resources to support the steps in Element D

Monitoring & evaluation for climate change adaptation: A synthesis of tools, frameworks and approaches (Bours, McGinn and Pringle, 2013)
www.ukcip.org.uk/wp-content/PDFs/SEA-change-UKCIP-MandE-review.pdf
This report presents a comprehensive summary of existing frameworks and practical guidance for monitoring and evaluation of climate change adaptation relevant to international development.

Measuring effective and adequate adaptation (Craft and Fisher, 2016)
http://pubs.iied.org/10171IIED/)
This IIED issue paper defines the components of effective and adequate adaptation and recommends a way of reviewing progress. The methods and tools to assess the effectiveness and adequacy of adaptation also need to support learning and improvement in the adaptation activities, and to be flexible enough to capture local contexts and allow aggregate assessments at different scales over time.

Monitoring & Evaluation (GIZ)
www.adaptationcommunity.net/knowledge/monitoring-evaluation-2/
The toolbox explains and gives an overview of monitoring and evaluation tools for climate change adaptation at different levels.

Monitoring and Evaluation of Adaptation to Climate Change: An Introduction and Toolbox (GIZ, 2016)
www.adaptationcommunity.net/?wpfb_dl=287 (Powerpoint presentation)
Monitoring and evaluation needs to ensure that investment in adaptation to climate change actually contributes to climate–resilient sustainable development. This toolbox provides an overview of the GIZ support tools available for the monitoring and evaluation of adaptation to climate change. It answers general questions about monitoring and evaluation of adaptation and then gives a brief description of the available monitoring and evaluation support tools, such as lists of indicators.

Developing national adaptation monitoring and evaluation systems: A guidebook (GIZ, 2015).
www.adaptationcommunity.net/knowledge/monitoring-evaluation-2/national-level-adaptation-me/developing-national-adaptation-me-systems/
This guidebook builds on publications, tools and examples, especially from countries that have recently or are currently developing national adaptation monitoring and evaluation systems. It directs readers to relevant sections of the NAP Technical Guidelines, as well as to monitoring and evaluation tools that have been specifically designed for monitoring the process to formulate and implement NAPs. The agriculture sectors and other sectors that are dependant on natural resources are covered through country case studies from Kenya and Morocco.

Glossary

Adaptation
Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation (IPCC, 2007).

Adaptation benefits
The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures (IPCC, 2007).

Adaptive Capacity
The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007).

Adaptation costs
Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs (IPCC, 2007).

Agriculture sectors
For FAO, agriculture covers crop–based farming systems and livestock systems, including rangelands and pasturelands, forestry, fisheries and aquaculture and the related resources they use (water, land, soils, genetic resources and biodiversity). When the discussion concerns a specific agriculture sector it is specified in the text.

Climate change
Any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

Climate variability
Variations in the climate (as measured by comparison with the mean state and other statistics such as standard deviations and statistics of extremes) at all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007).

Climate–smart agriculture
An approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas (GHG) emissions, where possible (FAO, 2014b).

Disaster Risk Management
The systematic process of using administrative directives, organizations and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster (UNISDR, 2009).

Disaster Risk Reduction
The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, improved preparedness for adverse events. (UNISDR, 2009).

Ecosystem–based adaptation
An approach to adaptation that integrates the use of biodiversity and ecosystem services into an overall strategy to help people adapt to the adverse impacts of climate change. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to both current climate variability, and climate change. Ecosystem–based adaptation contributes to reducing vulnerability and increasing resilience to both climate and non-climate risks and provides multiple benefits to society and the environment (Colls, Ash and Ikkala, 2009).

Exposure to climate change related events
External forcing refers to a forcing agent outside the climate system causing a change in the climate system. Volcanic eruptions, solar variations, and anthropogenic changes in the composition of the atmosphere and land use change are external forcings (IPCC, 2012).

Hazards
The characteristics of climate change and its effects on geophysical systems, such as floods, droughts, deglaciation, sea level rise, increasing temperature and frequency of heat waves (Oppenheimer *et al.*, 2014).

Impact assessment of climate change
The practice of identifying and evaluating, in monetary and/or nonmonetary terms, the effects of climate change on natural and human systems. Potential impacts are all the impacts that may occur given a projected change in climate, without considering adaptation. Residual impacts are the impacts of climate change that would occur after adaptation (FAO, 2014b).

Institutions
Formal organizations and contracts, as well as informal social and cultural norms and conventions, that operate within and between organizations and individuals (FAO, 2014b).

Impact of climate change
The effects of climate change on an exposed human or natural system and its components. This includes lives, livelihoods, health, economic, social and cultural dimensions, available services, infrastructure, ecosystems and the environment (FAO, 2014b).

Integration of adaptation
The integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes and budgets at all levels and stages (Lim and Spanger–Siegfred, eds., 2005).

Maladaptation
Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead (IPCC, 2001).

Landscape approach
An approach to sustainable development that deals with large–scale processes in an integrated and multidisciplinary manner, combining natural resources management with environmental and livelihood considerations. It differs from ecosystem approaches in that it may include multiple ecosystems. The landscape approach also factors in human activities and their institutions, viewing them as an integral part of the system rather than as external agents (FAO, 2012c).

Natural hazard
Natural process or phenomenon 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 (FAO, 2014b).

Resilience
The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self–organization and the capacity to adapt to stress and change (IPCC, 2007).

Sensitivity to climate variability or change
Degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea–level rise) (FAO, 2014b).

Vulnerability
The propensity or predisposition to be adversely affected; a function of potential impacts (exposure and sensitivity to exposure) and adaptive capacity. (FAO, 2014b).

Water scarcity
The point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be fully satisfied (UN–Water, 2014).

Annexes

1. Key issues in climate change and agriculture, forestry and fisheries.
2. Cross–cutting issues and approaches to consider in adaptation in the agriculture sectors
3. Examples of adaptation actions
4. Examples of indicators for monitoring adaptation actions
5. Sector–based climate change impact chain for agriculture in Thailand

Annex 1. Key issues in climate change and the agriculture sectors

1. Key issues in climate change and crop and livestock production

This section highlights the key vulnerabilities of crop and livestock production systems to climate change and describes the vital role of crop and livestock production in providing livelihoods and contributing to food security. It also emphasizes the need for integration across subsectors and for agricultural and livelihood diversification.

1.1 Climate change impacts on crop and livestock production

Climate change can have both direct and indirect impacts on crop and livestock production systems. Direct impacts are those that are directly caused by a modification of physical characteristics (e.g. temperature levels and water availability for a specific agricultural production system). Indirect effects are those that affect production through changes in other species (e.g. pollinators, pests, disease vectors and invasive species). Direct effects are easier to project and model. To date most efforts on future projections of the impacts of climate change have focused on main staple food crops, and there is a reasonable level of agreement on the main impacts. However, research into impacts on other minor crops, fodders and livestock, is less well developed. Indirect effects are much more difficult to model given the complexity of the interactions to take into account. In some cases, it can be useful to refer to observations of the impacts of climate change on a comparable system (FAO, 2016j).

Crop and livestock production are already being affected by increasing temperatures, changing precipitation patterns, and more frequent and intense extreme weather events (FAO, 2011). These have direct effects on crop growth, water and energy needs, soil fertility, water supply for irrigation and the prevalence of pests and diseases. For livestock production, climate change affects the quality and quantity of feed and water supply, and the carrying capacity of pasturelands. These changes will also have indirect effects on market prices (FAO, 2011).

The impacts of climate change on agriculture vary by region and production system. For example, rain–fed agricultural practices are usually more vulnerable in the short–term to climate change than irrigated systems (FAO, 2011). But in the long–term, irrigated systems may also be seriously affected owing to the drying of boreholes and open water bodies as a result of reduced rainfall, diminished upstream melt from dwindling glaciers and slower recharge of groundwater in aquifers.

Climate change is expected to cause substantial yield reductions in southern Africa (up to 30 percent by 2030 for maize production) and South Asia (up to 10 percent for staples, such as rice, and more than 10 percent for millet and maize) (Lobell *et al.*, 2008). In middle and high latitudes, depending on the crop, productivity may rise slightly with increases in local mean temperatures of up to 1 to 3 degrees Celsius. At lower latitudes, crop productivity will decrease even with a relatively minor change in temperature (IPCC, 2007). Localized extreme weather events and sudden pest and disease outbreaks are already causing greater unpredictability in production from season to season and year to year (FAO–PAR, 2011).

Climate change can also alter the impact of plant pests and diseases with more frequent outbreaks, expansion into new environments, the evolution of new strains and types, and increased vulnerability of plant defence mechanisms. For example, while drier conditions might suppress some pests and diseases, they can at the same time increase the susceptibility of crops to other pests and diseases. In general, warming is expected to lead to intensification of certain important plant pests and diseases and their expansion into larger areas. One example of this phenomenon is the evolution of strains of wheat yellow rust adapted to higher temperatures that have been affecting wheat crops in Near East, Central Asia, Australia and the Americas in the 2000s (Milus *et al.*, 2009). Similair climate change–related disease outbreaks and expansions have been observed recently with recurring wheat rust epidemics (Hodson, 2011)

and with the coffee leaf rust epidemics in Central America (Avelino *et al*, 2014). Warmer temperatures can lead to intensification and expansion of cassava virus diseases (Legg *et al*., 2013) and banana bunchy top disease (Anhalt *et al*., 2008) in some environments of the tropics owing to the increased mobility of insect vectors of the viruses. The analysis of Bebber *et al*. (2013) on the effect of global warming on plant pests suggests an average 2.7 km poleward movement of crop pests per year.

Adaptation actions can help the uptake of new crops and increase their production, consumption and marketing to support the livelihoods of the poor. However, attention may need to be paid to both the crop and its potential pests. For example, cassava is considered as a promising crop that could play an important role in making crop production systems more resilient to climate change in tropical environments. However, while considering advantage of cassava`s potential, national programmes must also take into account that the viral diseases that affect cassava could also expand due to the greater mobility of disease vectors resulting from higher temperatures.

Traditionally, livestock keepers have been capable of adapting to livelihood threats. In some situations, livestock keeping is itself an adaptation strategy, particularly in pastoral communities where livestock have always been the main asset in harsh climatic conditions (Scoones, 1996; Ashley and Carney, 1999). Livestock can be used as a diversification and risk management strategy in case of crop failure. In some regions, switching from crop to mixed crop–livestock or to livestock systems will be a key adaptation strategy (Jones and Thornton, 2009).

Despite the key role of livestock in building resilience, there are few assessments on this subject that are capable of informing decision–makers and providing evidence for policies to support adaptation. Particularly lacking are frameworks and methodologies for assessing livestock productivity under climate constraints that integrate biophysical data, including vegetation, feed resources, and animal requirements with management options. This is due to the diversity and complexity of livestock production systems with complex interactions that will be affected in many ways by climate change. Consequently, information and data to support and guide interventions in the sector, and move from an emergency type of response to policies supporting resilience building, are also unavailable (FAO, 2016a).

The gap in livestock vulnerability assessments compared to crops, and the need to specifically address this sector for adaptation have been recognized in the IPCC Fifth Assessment Report. The report states that "The relative lack of evidence reflects the lack of study in this topic, but not necessarily a lack of real–world impacts of observed climate trends" (Porter *et al*., 2014). This calls for increased investment in international and national research on the impacts of climate change on livestock.

1.2 The importance of addressing climate change in crop and livestock production

Crop and livestock production are essential to food supply – the most basic human need. Food production depends directly on natural resources, including biodiversity, land, water and sunlight, which are, in turn, closely linked to climate and weather conditions.

As indicated in Chapter 2, crop and livestock production are the main sources of livelihood for the majority of the population in many developing countries, especially LDCs. In 2010, 40 percent of the global economically active population (about 1.3 billion people) was engaged in these sectors. In many developing countries, this proportion was much higher (e.g. 93 percent in Bhutan, 89 percent in Burundi, 75 percent in the Lao People's Democratic Republic, 68 percent in the Solomon Islands and 59 percent in Haiti) (FAO, 2012a).

As agriculture provides livelihood for over 60 percent of the extremely poor (around 750 million people), the impacts of climate change on agriculture is already affecting vulnerable rural populations and have far–reaching implications for their food security and nutrition (FAO, 2016d).

It has been estimated that to meet the demand for food in 2050, annual production of crops and livestock will need to be 60 percent higher than it was in 2006 and that about 80 percent of this increase should come from higher yields, i.e. productivity increases, and 10 percent from increases in the number of yields per year (Alexandratos and Bruinsma, 2012). Climate change

poses an extra challenge to increasing crop and livestock productivity, especially under conditions where productivity is already constrained by the degradation of natural resources.

Significant improvements in food security and nutrition, and greater resilience to climate change can be achieved with the introduction of sustainable agricultural practices. The wide adoption of practices (e.g. the use of nitrogen–efficient and heat–tolerant crop varieties, reduced tillage and integrated soil fertility management) would boost productivity and farm incomes, and help stabilize food prices (FAO, 2016d).

Adaptation actions in crop management, especially planting dates, changes in cultivar choices and increased irrigation, have been studied to varying extents (FAO, 2016j). In many regions, farmers are already adapting to changing conditions, by taking up existing climate risk management practices. Adaptive changes in crop management have the potential to increase yields by an average of 7–15 percent (Müller and Elliot, 2015). These results however, depend strongly on the region and crop being considered. For example, responses are dissimilar between wheat, maize and rice, with temperate wheat and tropical rice showing greater potential adaptation benefits (Porter *et al.*, 2014).

For livestock production, the adaptive capacity depends on the production system, including the choice of species and breeds and the genetic diversity within herds; the availability and adaptability of alternative feed resources; the accessibility of livestock health and extension services; the type and efficiency of response to outbreaks of diseases; and household wealth (ICEM, 2013). A range of adaptation options are available on different scales that are related to the choice of animals, the feeding and housing systems, production systems and institutions. Adaptation options also differ between small-scale livestock production with low market integration and large–scale production that is closely connected to markets. Breeding schemes, feeding strategies, disease control and grassland and grazing management are considered as key adaptive responses (FAO, 2015e; FAO, 2016j).

Farmers can also enhance their resilience through the diversification of their on–farm or off–farm economic activities. This can reduce the impact of climate shocks on income and consumption patterns and provide households with options for risk management. One form of diversification is to integrate crops, livestock and trees. Some agroforestry systems for example, use the leaves of nitrogen–fixing trees to feed cattle, use manure to fertilize the soil, and cultivate pulses to provide extra protein. Livelihood diversification through non–farm rural employment, entrepreneurship or migration to cities may also be potential options. Adaptation through the sustainable intensification of crop and livestock production and on–farm diversification may need to be combined with the creation of off–farm opportunities (FAO, 2016d).

In crop and livestock production, as in all the agriculture sectors, adaptation initiatives should consider collaboration across sectors and investments at different levels (e.g. field, farm, ecosystem, landscape, and national). Adaptation activities need to be supported by the sustainable management of land, water and genetic resources; strengthening institutions and building capacity development; providing needs–based climate information services and early warning systems, support services (inputs and technology) (HLPE, 2012); and mainstreaming climate into agricultural policies and making appropriate policy adjustments (FAO, 2016j). Resilient crop and livestock production can continue to feed a growing global population and provide the basis for economic growth and poverty reduction.

Crop and livestock production are a significant and increasing source of GHG emissions, with agricultural emissions in 2005 estimated at 10–12 percent of total global emissions, and if emissions from land use, land–use change and forestry are added, the proportion reaches approximately 24 percent (Smith *et al.*, 2014). Reducing and removing emissions from crop and livestock production will not only contribute to climate change mitigation, but can also increase productivity and deliver adaptation co–benefits. Climate change mitigation can also be a significant co–benefit of activities aimed at improving food security and adaptation. Seeking synergies and addressing trade–offs between adaptation and mitigation, which is a key component of the CSA approach, is often the most sensible approach and has been highlighted in several developing countries INDCs. CSA aims to address food security and climate change challenges at the same time. It calls for a set of actions by decision–makers from the farm to the national and global levels to enhance the resilience,

the adaptive capacity and the productivity of crop and livestock systems; reduce the risk of food insecurity; and where possible, reduce or remove GHG emissions, (FAO, 2014b).

2. Key issues in climate change and forestry

This section gives an overview of the threats posed by climate change on forests and related ecosystems and illustrates the role forests play in providing incomes and livelihoods, maintaining ecosystems and supporting food security. It also briefly recalls the key role of forests in climate change mitigation.

2.1 Climate change impacts on forests

Forests are already under threat. Human activities, including logging and land conversion, are driving large–scale deforestation. Between 1990 and 2015, the global forest area declined by three percent, from 4 128 million ha to 3 999 million ha. The rate of decline in forest area decelerated between 2010 and 2015. The 2015 Global Forest Resources Assessment showed that forest area expanded in Europe, North America, the Caribbean, East Asia, and Western–Central Asia, but declined in Central America, South America, South and Southeast Asia and all African regions (Keenan *et al.*, 2015).

Climate change poses a major threat to forest systems and the communities they support. There is evidence that climate change, characterized by extended dry periods and higher temperatures, is one of the drivers for decreased forest productivity, tree diebacks, increased risk of forest fires, pest outbreaks, changes in the range of forest plants and animals and disruptions in the functions that forests provide in regulating the hydrological cycle and climate, and storing carbon (Braatz, 2012; FAO, 2016j). Climate change and climate variability threaten the delivery of a range of goods and environmental services from forests. The changing quality of forest cover is also important, with most forest losses taking place in natural forests (Petersen *et al.*, 2016). The replacement of natural forests by plantation forests as a means of adapting to climate change needs to be tailored to new requirements.

It is likely that tree species distribution will move poleward and towards higher altitudes. Tropical forests are at risk of degradation. There is evidence that forest fire frequency and severity are increasing, due to a combination of land-use change and drought (Miles *et al.*, 2006). In temperate forests, the longer growing season, higher atmospheric carbon dioxide and nitrogen deposition may increase tree growth rates, but this may be undermined by climate stress and increases in tree mortality, forest fires and pests and diseases (FAO, 2016j). Damage to forests will have negative impacts on surrounding areas, increasing the risks and severity of floods, landslides, reduced groundwater recharge, avalanches, erosion, saltwater intrusion and storm damage. Loss of forest area and tree degradation also reduce carbon storage capacity, creating a negative cycle of forest losses and increased GHG emissions.

The degradation of forest environments will also have negative social and economic consequences. Communities that rely on forests will have their food security and livelihoods jeopardized, and the social and ecological integrity that forests provide will be compromised. This can lead to a loss of community cohesion, reduced incomes, unemployment, poor nutrition and stress–induced migration. For example, in recent years, West Africa has experienced concurrent extremes of droughts and floods, which have affected the natural regeneration and survival of the forest resources. Research in northern Burkina Faso indicated significant reductions in the distribution and availability of some non–wood forest product species and high variability in their productivity. This has increased the vulnerability of forest–dependent communities. These changes are attributed to rising temperatures and changing rainfall patterns in combination with human activities, such as deforestation, agricultural expansion, over¬harvesting, annual bush fires and overgrazing (Idinoba *et al.*, 2009).

2.2 The importance of addressing climate change in forestry

Forests are a vital part of rural economies and livelihoods and are generally considered as an integral part of the broader agricultural sector. Up to one–fifth of the global population – over 1.6 billion people – derive direct and indirect benefits from forests in the form of employment, forest products, livelihoods, food security, nutrition and income (United Nations, 2011). Globally, the formal

timber sector contributes about 1 percent of gross domestic product, with that proportion doubling when the informal sector is included (World Bank, 2016).

Billions of people use forest outputs to meet their needs for food, energy and shelter. Many more people benefit indirectly from the ecosystem and environmental services forests provide. The number of people that benefit directly from forests through income and employment is smaller, but if informal activities are included, the number reaches the tens – if not hundreds – of millions (FAO, 2014d). Forest foods also provide safety nets in periods of food insecurity by offering a source of foods that are rich in vitamins and micronutrients, such as fruits, honey, roots and tubers, mushrooms, insects, leaves and nuts (Vinceti *et al.*, 2013; Franzo *et al.*, 2012).

Forests provide useful products and services to surrounding communities, including energy for domestic use. Woodfuel is most often the only available means that forest–dependent communities have to cook food and sterilize water. About 2.4 billion people cook with fuelwood (FAO, 2014d). If managed sustainably, woodfuel could be a renewable and affordable energy source that is almost carbon–neutral – the carbon dioxide released in combustion is recaptured as new trees grow. Forests also provide timber for building, plants and animals for human consumption, habitat for wildlife, recreational spaces, and other ecosystem services, including climate regulation, the maintenance of watershed catchment processes and carbon sequestration. Forests contribute to landscape integrity, which is important for soil fertility, flood control, groundwater recharge and water purification. This role is even more important in the face of climate change. Forests' environmental regulatory functions are vital for society.

All forest types contribute, in various ways, to microclimate regulation and stabilization, sediment retention and nutrient detention, all of which are important services for building the resilience of adjacent ecosystems and agricultural systems. Forests also help to buffer society from the brunt of many natural disasters by preventing landslides, moderating the force of waves or wind during storms and reducing temperatures during heat waves (Russell *et al.*, 2012). Forests are also home to more than 80 percent of land–based biodiversity, which is an important source of genetic resources for agriculture, food security and nutrition (FAO 2012b).

Forests are also important for climate change mitigation. Forests absorb and store carbon, above ground and in the soil. When forests accumulate biomass or expand in area, they absorb more carbon from the atmosphere and help control climate change. When forests are burnt, lost or degraded, they release carbon and contribute to global warming. The Fifth IPCC Assessment Report (Smith *et al.*, 2014) shows that land use, land–use change and forestry accounted for approximately 12 percent of anthropogenic carbon dioxide emissions between 2000 and 2009. According to Tubiello *et al.* (2015), in 2010, land use, land–use change and forestry contributed 10 percent of the total GHG emissions. Deforestation played a major role, being responsible for 8 percent of total anthropogenic emissions in 2010.

Many people who rely on forests are poor and live in fragile environments, and are highly vulnerable to the impacts of climate change. Forests can act as a safety net for people at the margin of development. Indigenous communities are often characterized by high poverty rates, isolation and limited socio–economic opportunities, and rely on forests and traditional knowledge for a variety of uses, including livelihoods, shelter, medicine and cultural practices. Gender differentiation has been noted in the collection of forest products, with men more engaged in the collection of animal products and construction materials, and women gathering products that require less physical labour. Both men and women collect predominantly for subsistence use, but men's share in the sales of forest products is generally higher than women's (Sunderland *et al.*, 2014).

For people who cultivate crops or raise livestock, forests provide opportunities for diversifying their livelihoods in ways that can improve income stability and dietary health. Forests are often also a last resort for food during crisis periods, when harvests fail or are destroyed by droughts or floods, or during civil unrest when normal livelihoods are disrupted.

Forests support the resilience of landscapes for agricultural production and rural livelihoods. A good example of this is the protection mangroves provide to inland agriculture

activities against rising sea levels rise and saltwater intrusion. Through their positive effects on soil, water, ecosystems, climate processes and biodiversity, forest management practices and landscape restoration can support forest productivity and the productivity of nearby agricultural areas, helping surrounding communities, including the most vulnerable, to build resilient and adaptive livelihoods.

The different regimes for forest management have implications for adaptation in national and subnational planning. Local co–management, community forest management, *de–f acto* use, state ownership, smallholder and large–scale private ownership and policy incentives and disincentives, all have implications for the effective planning and implementation of adaptation actions.

3. Key issues in climate change and fisheries and aquaculture

This section gives an introduction to the vulnerabilities of aquaculture and small scale and industrial fisheries to climate change risks. It also describes the important role that fisheries and aquaculture play in providing employment, income and nutritious food, particularly in developing countries.

3.1 Climate change impacts on fisheries and aquaculture

Climate change has multiple negative environmental, social and economic impacts on fisheries. Warming conditions of aquatic environments will result in physical and chemical changes (e.g. sea surface temperatures, ocean circulation, oxygen content and acidification). These external changes, particularly in temperature and oxygen availability, have major impacts on aquatic habitats and on cold–blooded aquatic organisms, changing their breeding patterns, biomass and migratory routes (FAO 2016d).

Extreme weather events can also cause major damage to fisheries and aquaculture. Heavy winds, storms and hurricanes can disrupt the integrity of ecosystems (e.g coral reefs and mangrove swamps) and reduce the shelter they provide for the biodiversity that lives there (FAO, 2016j). Storm surges, waves and strong winds can destroy aquaculture systems (e.g. cages and longlines) and wash out fish stocks held in ponds (Cochrane *et al.*, eds., 2009; Karim *et al.*, 2014).

Both marine and freshwater fisheries and aquaculture will be affected by climate change. Models used to anticipate changes in environmental conditions, habitat and primary production of phytoplankton, forecast that global marine fish catch potential will change significantly across regions; with an increase in high–latitude regions of 30–70 percent, and a decrease of up to 40 percent in tropical regions (Cheung *et al.*, 2010). River environments are very sensitive to changes in runoff and flows that may result from changes in climate, with most negative effects felt in Africa and South Asia. These regions are also disproportionately dependent on fisheries for economic development and food security (Allison *et al.*, 2009). For aquaculture, broader changes in hydrological conditions and seasonal changes in temperature, pH, salinity and ecosystem health are all expected to decrease productivity and increase risks, such as diseases (De Silva and Soto, 2009; Cochrane *et al.*, eds., 2009; Brugere and De Young, 2015; FAO, 2016c). Climate change may, however, also create opportunities for aquaculture expansion, for example, by creating growing conditions that extend the range of species (De Silva and Soto, 2009; Karim *et al.*, 2014).

Both small–scale and industrial fishers are exposed to the direct and indirect impacts of climate change. Small–scale fishers are particularly exposed to direct climate change impacts (e.g. increased intensity and frequency of extreme weather events and coastal erosion) as they tend to live near coasts and are at risk from damages to property and fishing infrastructure (e.g landing sites, slipways and markets). More intense extreme weather events can also increase the risks associated with working at sea and larger inland water bodies, and changes in weather patterns may disrupt fishing practices based on traditional knowledge of local weather and currents (Daw *et al.*, 2009).

Both small–scale and industrial fishers can be expected to be highly affected by large–scale climatic changes that alter the spatial distributions of species and reduce the productivity of marine organisms and ecosystems (Pörtner *et al.*, 2014). There will be changes in fish production and the

potential catches of exploited marine species (Barange *et al.*, 2014). Some fish species might move beyond the limited reach of small–scale and medium–sized fleets. This means that in the short–term, full–time fishers will likely have to fish longer or travel further to maintain catch rates, which will have implications for incomes and safety. The location of existing infrastructure (e.g. landing facilities and processing plants) may become less desirable as they may no longer be located close enough to new fishing grounds. Additionally, changes in the distribution of stocks and catches may occur across national boundaries and disrupt existing allocation arrangements. Industrial fisheries are also prone to the direct impacts of climate change (e.g. increasing frequency and intensity of extreme weather events), as fishing operations may be disrupted by poor weather, while extreme events can damage vessels and infrastructure. City ports and facilities required by larger vessels may be affected by rising sea levels and extreme weather (Daw *et al.*, 2009).

3.2 The importance of addressing climate change in fisheries and aquaculture

Fisheries are a vital source of employment, livelihoods and food security and nutrition in the developing world. In 2014, approximately 57 million people were directly employed in fisheries, with at least 21 million working as capture fishers in inland waters (rivers, lakes, reservoirs, wetlands and inland saline water systems) and 19 million working in aquaculture (FAO, 2016c). Up to a further 200 million households are involved in other activities connected to the fish value chain, including processing, marketing and supply (Cochrane *et al.*, eds., 2009). In addition to incomes and employment directly associated with fishing, there are forward linkages to other economic activities (e.g. trade, processing, transport, and retail) and backward linkages to supporting activities (e.g. boat building, net making, engine manufacture and repair, the supply of services to fishermen and fuel to fishing boats) (Daw *et al.*, 2009). Most of the global population involved in the fisheries and aquaculture are in Asia (84 percent), with a smaller proportion in Africa, Latin America and the Caribbean (FAO, 2016c).

In 2014, women accounted for 19 percent of the workforce directly engaged in the primary production, but women make up about half of the workforce in the fish value chain (FAO, 2016c). Fisheries represent a holistic livelihood activity that supports the entire household. Although men are engaged in catching and large–scale marketing of fish, women play a crucial intermediary role. Indigenous people also often rely on fisheries. However, large–scale fishing and aquaculture operations can sometimes conflict with small-scale indigenous practices, and this relationship must be managed.

From 1990 to 2012, the importance of fisheries increased, with the number of people working in fisheries as a proportion of those economically active in the broader agricultural sector rising from 2.7 to 4.4 percent. More than 90 percent are small-scale operators living in developing countries, with 70–80 percent of aquaculture ventures considered small–scale (HLPE, 2014).

Fisheries are very important to the economy in many regions and provide high net incomes to the households that depend on them. For example, in the Niger Delta where fishing activities generated over US$3 000 of net annual income per fishing household, fish are the most abundant and readily available source of animal protein for consumption and incomes (Adekola *et al.*, 2015). Fish and fish-related products are the most widely traded food items and can support economic growth of poorer countries through export earnings, with more than half of fish exports originating from developing countries (FAO, 2016c).

Fish provide essential protein, fatty acids and micro–nutrients, which are often missing in diets, especially of the poor. In 2013, fish accounted for around 17 percent of the world's animal protein intake (FAO, 2016c). This figure can rise to up to 50 percent of animal protein consumption for populations in coastal countries and Small Island Developing States (FAO, 2016c). In Asia, fish farming has developed rapidly over the last 30 years. Total dietary protein from fish is between 50 and 60 percent in Bangladesh, Cambodia, Indonesia and Sri Lanka (HLPE, 2014). A recent study on fisheries in the dry lands of sub–Saharan Africa concluded that in these ecosystems, fast growing small–sized fish could be crucial to ending hunger (FAO, 2016h).

Those fishing for survival are often the poorest who are most at risk if the access to fisheries should change. Small–scale and artisanal fisheries

employ 99 percent of fishers, but produce 50 percent of global seafood catches (Daw *et al.*, 2009). The proper management of fisheries and adaptation measures to prevent the damage caused by the severe impacts of climate change will be essential to enable communities to continue to build resilient livelihoods in the fisheries sector. Better managed fisheries achieved through incentive–based and participatory ecosystem management with more efficient enforcement measures, will help ensure that fish stocks can better withstand biophysical impacts and that fisheries ecosystems will be more resilient to changes (Daw *et al.*, 2009).

Fisheries can provide a source of income and nutrition when other agriculture sectors (e.g. crops and livestock production) fail. Fishing is less directly affected by some climate hazards, such as droughts.

Aquaculture offers fishers, farmers and others options for diversifying livelihoods, food systems and diets. However, as climate change will have potentially severe impacts on aquaculture, shifting to aquaculture production can in certain circumstances increase rather than decrease vulnerability (Cochrane *et al.*, eds., 2009; Karim *et al.*, 2014; Brugère and De Young, 2015).

Annex 2. Cross–cutting issues and approaches to consider in adaptation in the agriculture sectors

ISSUE	CONSIDERATIONS
Co–benefits and externalities	It is important not to propose adaptation actions in isolation from existing and new climate change, environment and development goals. One prioritization criteria for adaptation actions is whether in addition to increasing resilience, they will have positive or negative impacts on other aspects of agricultural development (e.g. productivity or GHG reductions) or on vulnerable populations or women. It is also important to identify and weigh possible synergies and trade–offs between the objectives and where possible, compensate for the trade–offs. It is also crucial to ensure that actions aimed at increasing productivity or reducing GHG emissions will not lead to maladaptation in the agriculture sectors.
Gender–responsive adaptation	Women farmers are more exposed to climate risks compared to men because women usually have fewer endowments and entitlements, have limited resources to invest in required inputs, have less access to information and services, and are less mobile. The same inequalities also often affect female fishers, fish–farmers and forest–dwellers. Women are often excluded from decision–making and may not benefit from technologies and practices that help farmers adapt to new climatic conditions. Gender inequality not only has negative impacts on women, but also on their households, communities, and on the society as a whole, and hinders agricultural production and sustainable development. A gender–responsive approach to adaptation identifies and addresses the different constraints faced by men, women, youth and the elderly and recognizes their specific capabilities. It reduces gender inequalities and ensures that men, women, boys and girls can equally benefit from adaptation interventions and practices, and helps to bring about more sustainable and equitable results (World Bank, FAO and IFAD, 2015). Integrating a gender perspective into the NAP can help to ensure that there is equal participation of men and women in the decision–making and in the implementation of adaptation activities. It can also help to ensure that the NAP and the activities it entails will not exacerbate gender inequalities. It can lead to better adaptation, and more resilient communities. Gender integration requires conducting a gender analysis to identify gender–based differences. Gender analysis can be expanded into a wider social analysis to ensure that marginalized and disadvantaged groups, who often depend on smallholder agriculture, forestry and fisheries, will be included in formulating and implementing adaptation actions. A gender and social analysis can reveal the barriers to adaptation faced by different groups and suggest ways of overcoming them. In this context, youth often require special attention.
Indigenous peoples	Indigenous peoples are among the first populations to face the direct consequences of climate change because of their dependence upon, and close relationship with the environment and its resources. Climate change exacerbates the difficulties indigenous communities already face: marginalization, loss of land and resources, human rights violations and discrimination. However, by drawing on ancestral knowledge, indigenous peoples can also provide solutions to the problems created by climate change and contribute to building the resilience of the ecosystems they live in. Indigenous women often suffer a triple discrimination due to gender inequality, racial bigotry and poverty. This discrimination affects all spheres of their lives and exacerbates inequalities. Despite their key role as custodians of seeds, traditional knowledge, and ecosystem management, indigenous women suffer from a wide range of rights violations both inside and outside their communities. It is paramount to empower indigenous women to achieve gender equality and to work in partnership with them in adaptation initiatives.

ISSUE	CONSIDERATIONS
Nutrition	Climate change affects nutrition status and dietary choices because of its impacts on food security, diseases, water safety, sanitation, livelihoods and caregiving. In turn, these impacts limit people's capacity to adapt to, or mitigate, climate change (IFPRI, 2015). Climate change amplifies the impact of droughts, floods and storms and exposes large numbers of people to the risk of undernutrition following extreme climate events (Confalonieri *et al.*, 2007). Seasonal patterns of inadequate food availability and access, a major cause of undernutrition among poor rural communities, are accentuated by climate change, which also has impacts on livelihood security and on intrafamily food distribution, which particularly affects the nutritional status of children and women (Wijesinha–Bettoni *et al.*, 2013). Some studies indicate that in some climate change scenarios the nutritional quality and safety of key food crops could be diminished due to lower mineral and protein content and increases in food–borne pathogens and toxic compounds. When assessing climate change impacts and vulnerabilities, using nutritional aspects as one of the criteria can result in a deeper analysis and reveal specific challenges of the most vulnerable groups. Using nutritional impacts as criteria in the prioritization of adaptation actions can help to target the most affected populations.
Social protection	Social protection can contribute to household adaptive capacity. It includes three broad components: social assistance, social insurance and labour market protection (FAO 2015d). Of these three, social assistance programmes are the most relevant to climate change adaptation. They include publicly provided conditional or unconditional cash or in–kind transfers or public work programmes. Other types of interventions have also an explicit social protection function as they are aimed at reducing risks (e.g. crop insurance). The increased climate–induced agricultural production variability in some regions is likely to increase the importance and need for safety nets in reducing hunger (FAO, 2015d). Social assistance programmes play an important role in risk management and building the overall resilience of households and individuals. The risk management function is a prime area of focus in the context of the increasing exposure to risk from climate change (HLPE, 2012). This is why social protection has a potentially key role to play in adaptation strategies. In addition to reducing vulnerability to climate change related hazards, social protection programmes can enhance the households' ability to invest time and money in adaptation and more effective natural resource management (HLPE, 2012; Béné, Devereux and Roelen, 2015).
Disaster risk management and reduction	Increasing frequency and intensity of extreme weather events calls for strengthened DRM, improved local practices for risk reduction and enhanced emergency response and rehabilitation. Measures for DRR may include risk assessment, early warning systems and preparedness for climate–related hazards in crop and livestock production, forestry, and fisheries and aquaculture. It is also important to expand and improve the transition and linkages between emergency prevention and response, rehabilitation, climate change adaptation and development (FAO, 2011; Cattermoul *et al.*, 2014; LEGS, 2014). Integrating DRR and climate change adaptation allows for a more effective use of resources, knowledge, capacities, technologies, and innovations that can address both the short– to medium–term challenges of coping with shocks and the long–term challenges of slow onset impacts of climate change. DRR and climate change adaptation are seen more and more as complementary and inseparable elements to be merged under national comprehensive policy frameworks. A global framework that guides countries DRR work is the Sendai Framework for Disaster Risk Reduction 2015–2030.

ISSUE	CONSIDERATIONS
Migration	Climate change can be a root cause of rural migration and is exacerbating other socio–economic drivers of migration, such as rural poverty and food insecurity. Observations and scenarios suggest that the increasing frequency and intensity of climate extremes is likely to lead to increased migration. The vulnerability of agricultural communities to climate change is one of the drivers of distress migration, i.e. the movement of people for whom migrating is perceived as the only viable option out of poverty. Climate change has considerable impacts on rural areas, which can be both the places of origin for migrants and their destination. The consequences of these impacts in urban areas further amplify the challenges facing migrant populations. Migration is a coping strategy and can be an opportunity for reducing rural poverty. Disruptive climate–related events can be conflict stressors. They have the potential to make existing conflicts worse, or to increase the likelihood of conflicts where there are pre–existing tensions. This can in turn lead to greater migration. Improving food security in climate sensitive and vulnerable areas is central to the global response to the migration crisis. Sustainable agricultural development is essential to enhance resilience against climate risks, increase livelihood opportunities and reduce distress migration from rural areas. Investing in resilient rural livelihoods, providing rural communities in developing countries with access to social protection and decent jobs, especially for young men and women, creates a more stable living environment in areas prone to climate risks. These investments can limit the damage and losses caused by hazards and address some of the root causes of distress migration.
Tenure rights	Insecure land tenure has proved to be a major barrier to the adoption of practices and technologies (e.g. agroforestry, irrigation infrastructure and soil conservation) that can reduce vulnerability to climate change. It also discourages long–term planning in favour of maximizing short–term profits and complicates the implementation of effective climate change adaptation and mitigation plans. Tenure is a decisive factor in the identification of stakeholders whose food security and livelihoods are affected by the impacts of climate change. People with insecure tenure face the risk that their rights to resources will be threatened by competing claims, or may even lose their rights through evictions. Climate change is likely to increase competition for land, especially when linked to water. Strengthening smallholder farmers' tenure rights can contribute to empowering them to become drivers for climate change adaptation and custodians of natural resources. Bolstering tenure institutions can enhance systems for disaster risk preparedness and management, for the reallocation and redistribution of land as well as for redefining use and property rights both in rural and urban settings. Tenure security is seen as critical to allow individuals and communities to take into account the future value of current decision–making and decide how climate change action affects their food security and livelihoods. *The Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries, and Forests in the Context of National Food Security* (FAO, 2012d) can be used as a tool to improve tenure governance and can contribute to improving the capacity to develop policy, legal and organization frameworks regulating tenure rights over land, fisheries and forests. They can inform countries on tenure policy and legal frameworks as they develop their climate change strategies.
Food–energy nexus	The agriculture sectors and energy are closely intertwined. Consequently, the impacts of climate change on agriculture may also have implications on energy use. For example, reduction in rainfall may result in increasing groundwater pumping for irrigation and greater energy consumption. When analysing adaptation options for the agriculture sectors, it is also valuable to consider energy–related issues. It is necessary to ensure adequate access to energy services at all stages in agricultural value chains. This supports adaptation in two ways: it builds resilience by fostering self–sufficiency in energy; and diversifies incomes when it is possible to sell extra energy generated on farms. It is also advisable to promote adaptation options that decouple the development of agriculture systems from dependence on fossil fuels. Bioenergy is part of a mix of options for addressing energy concerns in the agriculture sectors and addressing climate change. Other options include increasing energy efficiency, using more renewable energy, shifting to local energy sources and adopting new patterns of energy production and consumption. For example, solar–powered irrigation systems have already been tested.

ISSUE	CONSIDERATIONS
Water	In many regions of the world, increased water scarcity under climate change will present a major challenge for climate adaptation. Competition for water and the growing water scarcity are constraining both current availability of water for irrigation and further expansion of the irrigated area. In some cases relying on extraction from non–renewable aquifers, withdrawals can exceed 100 percent of total renewable resources. Certain regions already experience very severe water scarcity, with withdrawals that can exceed renewable resources as a result of groundwater use and recycling. Furthermore, in many parts of the world water tables are declining significantly. Water scarcity aggravates land scarcity. Climate change is adding significant uncertainty to the availability of water in many regions in the future. It will affect precipitation, runoff and snow/ice melt, with effects on hydrological systems as well as on water quality, water temperature and groundwater recharge. Climate change will also significantly impact sea level with potential impacts on the salinity of surface and groundwater in coastal areas. This will intensify competition for water use. The increase in temperature will trigger increased demand for water for evapotranspiration by crops and natural vegetation and will lead to more rapid depletion of soil moisture. Constraints on freshwater availability in heavily irrigated areas, may lead to reductions in the irrigated share of overall agricultural production, amplifying direct climate change impacts and increasing weather–induced variability in these regions. Adaptation to climate change needs to carefully consider competing water uses and their various implications for food security and nutrition (HLPE, 2015). Measures that can mitigate one type of adverse impact could also exacerbate another. For example, increased storage infrastructure to meet the water needs of irrigated agriculture arising from increased crop water demands, higher evapotranspiration and longer or more intense dry spells might exacerbate conflicts in river basins and negatively impact downstream fisheries.
Biodiversity and genetic resources	Biological diversity is important for building resilience and reducing vulnerability. Biodiversity and ecosystem functioning will be affected by climate change and will continue to be shaped by other factors (e.g. land–use change and the introduction of invasive species). Phenological cycles and food webs will be disrupted and modifications in the migratory ability of organisms may change the ecological community. With for instances be changes in pests and diseases. Diversity of genetic resources for food and agriculture allows for greater options when selecting plant and animal species and breeds that can adapt to drought, salinity or diseases. The narrow genetic base of improved varieties or breeds is one of the causes for genetic vulnerability (Khoury *et al.*, 2014). When considering adaptation options, it is important to characterize and prioritize species, varieties, breeds and populations, including wild relatives, for selection and conservation. This should be done on the basis of climate change projections and include species that have direct socio–economic importance and associated species that provide ecosystem services (FAO, 2015d). Specific supplementary NAP guidelines on biodiversity and genetic resources provide additional information on these topics.[20]

20 The UNFCCC Supplementary Materials To The NAP Technical Guidelines, including those related to biodiversity, genetic resources and ecosystems are available at: www4.unfccc.int/nap/Guidelines/Pages/Supplements.aspx

ISSUE	CONSIDERATIONS
Landscape approach	A landscape approach expands the focus of sustainable development initiatives from a farming location or specific sector to the broader landscape. It deals with large–scale processes in an integrated and multidisciplinary manner, combining natural resource management with environmental and livelihood considerations. It differs from the ecosystem approaches (see below) in that it may include multiple ecosystems. The landscape approach also factors in human activities and their institutions, viewing them as an integral part of the system rather than as external agents. This approach recognizes that the root causes of problems may not be site-specific and that a development agenda requires multistakeholder interventions to negotiate and implement actions. The landscape approach helps to identify and develop positive externalities (e.g. ecosystem services) and reduce negative impacts, especially from individual land users. Placing human well–being at the centre of the land–use decision–making ensures that the rights and cultural values of communities and minority groups are respected, along with their goals regarding land use. Crops, livestock, forestry, fisheries and aquaculture are often managed in isolation, which can be counterproductive. Coordination among the agriculture sectors at a larger scale facilitates the integrated management of production systems and natural resources and is important for climate change adaptation.
Ecosystem approach	To achieve food security, ecosystems need to remain healthy, functional and productive. They need to continue to provide, regulate and support the ecosystem services that are crucial for crop, livestock, forest and aquatic production systems and rural livelihoods. Productivity depends on ecosystem functioning, and the health and resilience of ecosystems depend to a great extent on biological and genetic diversity. Climate impact and vulnerability assessment and identification of adaptation options may call for widening the scope from the scale of a farm to a system–wide approach. Ecosystem–based adaptation uses biodiversity and ecosystem services in an overall adaptation strategy. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to both current climate variability and climate change (Colls, Ash, and Ikkala, 2009; Lo, 2016). Additional guidance for applying the ecosystem approach in the adaptation planning is available in the supplementary NAP guidelines on ecosystems, biodiversity and genetic resources.
Value chain approach	Some stages of the agriculture value chain are more vulnerable to climate change than others. However, some adaptation actions may be applicable to every step in the value chain and make the entire chain more sustainable. It is often useful for climate impact assessments to examine the whole value chain. This was done, for example in Viet Nam where FAO supported the tea and coffee value chain analysis under climate change (see FAO, 2015f). Failure at the production stage will lead to disruptions in aggregation, processing and distribution. In wine production, for example, warmer nights lead to chemical changes in the grapes, which requires changes in processing to maintain quality (MGAP–FAO, 2013b). Dysfunctional value chains may lead to excessive food losses and waste. In developing countries, food losses and waste often occur at the farm level owing to inappropriate production methods and post–harvest practices. Reducing food losses and waste at all stages of the value chain supports sustainable development and builds resilience to the impacts of climate change (FAO, 2014b). Adding gender and nutrition perspectives to the value chain analysis delivers more sustainable results.

Annex 3. Examples of adaptation actions

TABLE A. OPTIONS FOR ADAPTATION TO CLIMATE CHANGE AT THE FARM LEVEL FOR CROP SYSTEMS

RISKS	RESPONSES
Changing climate conditions and climate variability and seasonality	Participate in monitoring schemes when available. Optimize planting schedules (e.g. sowing data), including for feedstock and forage. Plant different varieties, species and cultivars. Use short–duration cultivars. Use varieties of breeds capable of producing under different environmental extremes or those with broader environmental tolerances. The use of currently neglected or rare crops and breeds should be considered. Practice early sowing, which can be made possible by improvements in sowing machinery or the adoption of dry sowing techniques. Increase the diversity of varieties or crops to hedge against risk of individual crop failure. Practice intercropping. Use integrated systems involving livestock and/or aquaculture to improve resilience. Change post–harvest practices (e.g. the time required for drying grain and post–harvest storage procedures). Consider the effect of new weather patterns on the health and well–being of agricultural workers.
Change in rainfall and water availability	Participate in monitoring schemes when available. Change irrigation practices. Adopt enhanced water conservation measures. Use marginal water resources and wastewater. Make more use of rainwater harvesting and capture. In some areas, increased precipitation may allow irrigated or rain–fed agriculture in places where previously it was not possible. Alter agronomic practices. Reduce tillage to lessen water loss and incorporate manures and compost, and plant cover crops to increase soil organic matter to improve water retention.
Increased frequencies of drought, storms, floods, wildfire events, sea level rise	Participate in monitoring schemes where available. Adopt general water conservation measures, particularly during drought. Use flood–, drought– and/or saline–resilient varieties. Improve drainage, increase the amount of organic matter in the soil and strengthen farm design to avoid soil loss and gullying. Consider, where possible, increasing insurance coverage against extreme events.
Pest, weed and diseases, disruption of pollinator ecosystem services	Participate in risk–monitoring and risk–prevention schemes where available. Use expertise in coping with existing pests and diseases. Build on natural regulation and strengthen ecosystem services.

TABLE B. CLIMATE CHANGE ADAPTATION OPTIONS FOR LIVESTOCK

ANIMALS	FORAGE AND FEED CROPS	LABOUR FORCE AND CAPITAL
Water management (e.g. boreholes) Breeds resistant to drought, heat and harsh environments Shifts in species, breeds and/or production systems (e.g. small ruminants, poultry) Disease control and animal health Cooling for indoor systems or shading (e.g. trees)	Irrigation Purchase feed supplementation Breed feed crops and forages for water use efficiency and resistance to drought, salinity and waterlogging Improve grazing management Change the cropping calendar Practice agroforestry Increase mobility for resources	On– and off–farm diversification Insurance schemes Reconversion in the context of national and regional production zoning Institutional changes (e.g. trade, conflict resolution, income stabilization programmes)

TABLE C. EXAMPLES OF OPTIONS FOR INCREASING FOREST RESILIENCE TO VARIOUS IMPACTS OF CLIMATE CHANGE

RISKS/IMPACTS	SOCIAL, ECONOMIC AND ENVIRONMENTAL IMPLICATIONS	RESPONSE MEASURES FOR RISK REDUCTION AND INCREASED RESILIENCE
Decreased forest vitality and productivity	Reduced revenue from wood and non–wood forest products; reduced forest ecosystem services	Adjust silvicultural practices, change composition of species and varieties; increase forest biodiversity; implement forest restoration measures
Increased forest pests and diseases	Reduced forest revenue; reduced forest ecosystem services	Implement and intensify pest and disease management measures; adjust silvicultural practices.
Increased wildfires	Loss of life; damage to infrastructure; reduced forest revenue and ecosystem services; wildlife losses	Implement and intensify wildfire management; adjust silvicultural practices.
Increased water erosion and landslides	Damage to forest and infrastructure (towns, roads, dams); reduced water quality	Undertake watershed management measures, including protecting and increasing vegetation cover; reduce intensities of harvesting and other uses
Drought–induced forest and tree dieback and land degradation	Reduced availability of forest products; increased wind damage; reduced grazing values	Plant windbreaks; maintain tree cover; change composition of species and varieties
Increased storm damage	Reduced forest revenue and ecosystem services; increased risk of pests and disease	Change species to adjust tree spacing to reduce risk; salvage harvesting; pest and disease control
Reduced extent and vitality of mangroves and coastal forests	Increased exposure of land to storm damage; reduced productivity of coastal fisheries	Increase protection, restoration and enhancement of mangroves and other coastal forests
Changes in species ranges and species extinctions	Reduced forest ecosystem functions; loss of forest biodiversity	Restore or increase forest connectivity and wildlife corridors; assist migration; take *ex–situ* conservation measures

21 Some autonomous adaptations to declining and variable yields may directly risk exacerbating the overexploitation of fisheries by increasing fishing pressure or impacting habitats.

TABLE D. OVERVIEW OF OPTIONS TO REDUCE VULNERABILITY TO CLIMATE CHANGE IN FISHERIES AND AQUACULTURE

IMPACT AREA	POTENTIAL RESPONSES
Capture fisheries	
Reduced yield	Access higher–value markets; shift and widen targeted species; increase fishing capacity and efforts;[21] reduce costs, increase efficiency, diversify livelihoods; abandon capture fisheries
Increased yield variability	Diversify livelihoods; implement insurance schemes; promote adaptive management frameworks
Change in distribution	Migrate fishing efforts and strategies and processing and distribution facilities; implement flexible allocation and access schemes
Sea level rise; flooding and surges	New and improved physical defences; managed retreat and accommodation; rehabilitation and disaster response; integrated coastal management; early warning systems and education
Increased dangers of fishing	Weather warning systems; improved vessel stability, safety and communications
Social disruption/new fisher influx	Support existing local management institutions and develop new ones; diversify livelihoods
Aquaculture	
Extreme weather events	Improve farm siting and design; individual and cluster insurance; use indigenous or non–reproducing stocks to minimize biodiversity impacts
Temperature rise	Better water management; feeds; handling; selective breeding and genetic improvements; adjust harvest and market schedules
Water stress and drought conditions	Improve efficiency of water usage; shift to coastal aquaculture; culture–based fisheries; select for short–cycle production; improve water sharing; improve seed quality; efficiency
Sea–level rise and other circulation changes	Shift sensitive species upstream; introduce marine or euryhaline species (wide saline tolerance); use hatchery seed; protect broodstock and nursery habitats
Eutrophication, upwelling, and harmful algal blooms	Better planning; farm siting; regular monitoring; emergency procedures
Increased virulence of pathogens, new diseases	Better management to reduce stress; biosecurity measures; monitoring; appropriate farm siting; improved treatments and management strategies; genetic improvement for higher resistance
Acidification impact on shell formation	Adapt production and handling techniques; move production zones; species selection
Limits on fish and other meal and oil supplies and price	Fish meal and fish oil replacement; better feed management; genetic improvement for alternative feeds; shift away from carnivorous species; culture of bivalves and seaweed
Post–harvest, value addition	
Extreme event effects on infrastructure and communities	Early warning systems and education; new or improved physical defences; accommodation to change; rehabilitation and disaster response
Reduced and more variable yields; supply timing	Wider sourcing of products; change species; add value; reduce losses and costs; more flexible location strategies to access materials; improve communication and distribution systems; diversify livelihoods
Temperature, precipitation and other impacts on processing	Better forecasting, information; change or improve processes and technologies
Trade and market shocks	Better information services; diversify markets and products

Source: FAO, 2016

Annex 4. Examples of indicators for monitoring adaptation actions

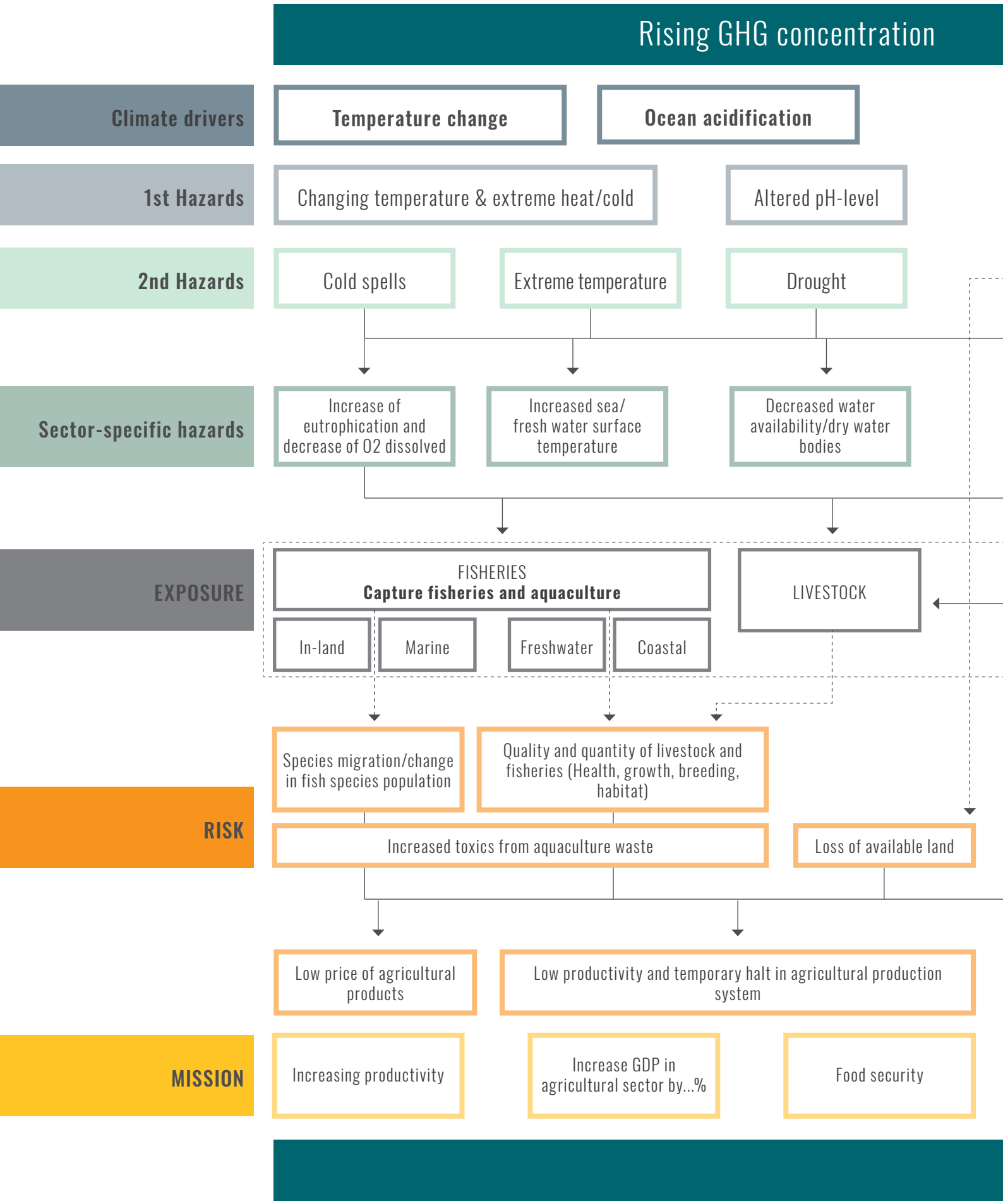
Examples of indicators of common outputs, outcomes and impacts in monitoring and evaluation for adaptation programmes and projects (adapted from FAO, 2014b; 2015c)

1. Poverty and household impacts (where possible these data should be disaggregated by gender or by male– and female–headed household)
   - percentage of population that is food insecure
   - percentage of population below the poverty line
   - household income, income vulnerability and diversification
   - proportion of food and income coming from climate–sensitive sources
   - farmgate and market prices
   - amount of time spent collecting firewood
   - amount of time spent collecting water.
2. Outcomes in terms of adaptation–related changes in production
   - agricultural productivity (e.g. yield and its stability)
   - changes in land use (area)
   - changes in soil biophysical characteristics (e.g. organic matter content)
   - diversification of climate–sensitive income sources
   - marketing chains that are adapted to changing conditions
3. Outcomes in terms of adoption of resilient systems
   - number and/or coverage of irrigation systems that improved farmers' resilience to drought
   - number and coverage of climate change resilient crop varieties, livestock breeds, forest species and aquaculture strains
   - number and/or coverage of soil and water conservation works
   - area of farmland that adopted climate-resilient practices (e.g. conservation agriculture, legume intercropping, agroforestry)
   - number and/or coverage of easily accessible national and transnational transhumance corridors for allowing livestock mobility
   - forest and rangeland areas where sustainable management practices are adopted
   - number of fisherfolk who adopted climate-resilient technologies (men and women)
   - number of aquaculture producers who adopted climate–resilient technologies (men and women)
4. Outcomes related to capacity development and services
   - number of men and women who are applying new knowledge gained from capacity development interventions
   - number of male– and female–headed households that have gained direct benefits from more climate–resilient agricultural and fisheries infrastructure
   - proportion of women beneficiaries participating in capacity–development activities
   - number of officials and/or extension workers trained in climate change adaptation issues
5. Outcomes in terms of vulnerability and risk assessment
   - magnitude of impacts
   - timing of impacts
   - persistence and reversibility of impacts
   - likelihood (estimate of uncertainty) of impacts and vulnerabilities and confidence
   - potential for adaptation
   - distributional aspects of impacts and vulnerabilities
   - importance of the system (s) at risk
   - sensitivity indicators, including rainfall volume, average typhoon and wind speed, plant growth stage during, duration, return periods and timing of drought events due to temporal decrease of precipitation, river discharge, soil moisture, groundwater and water stored in lakes and dams below threshold levels
   - exposure indicators (e.g. affected production

areas, affected farmers, damaged farm equipment, houses and other infrastructure and frequency of typhoons)

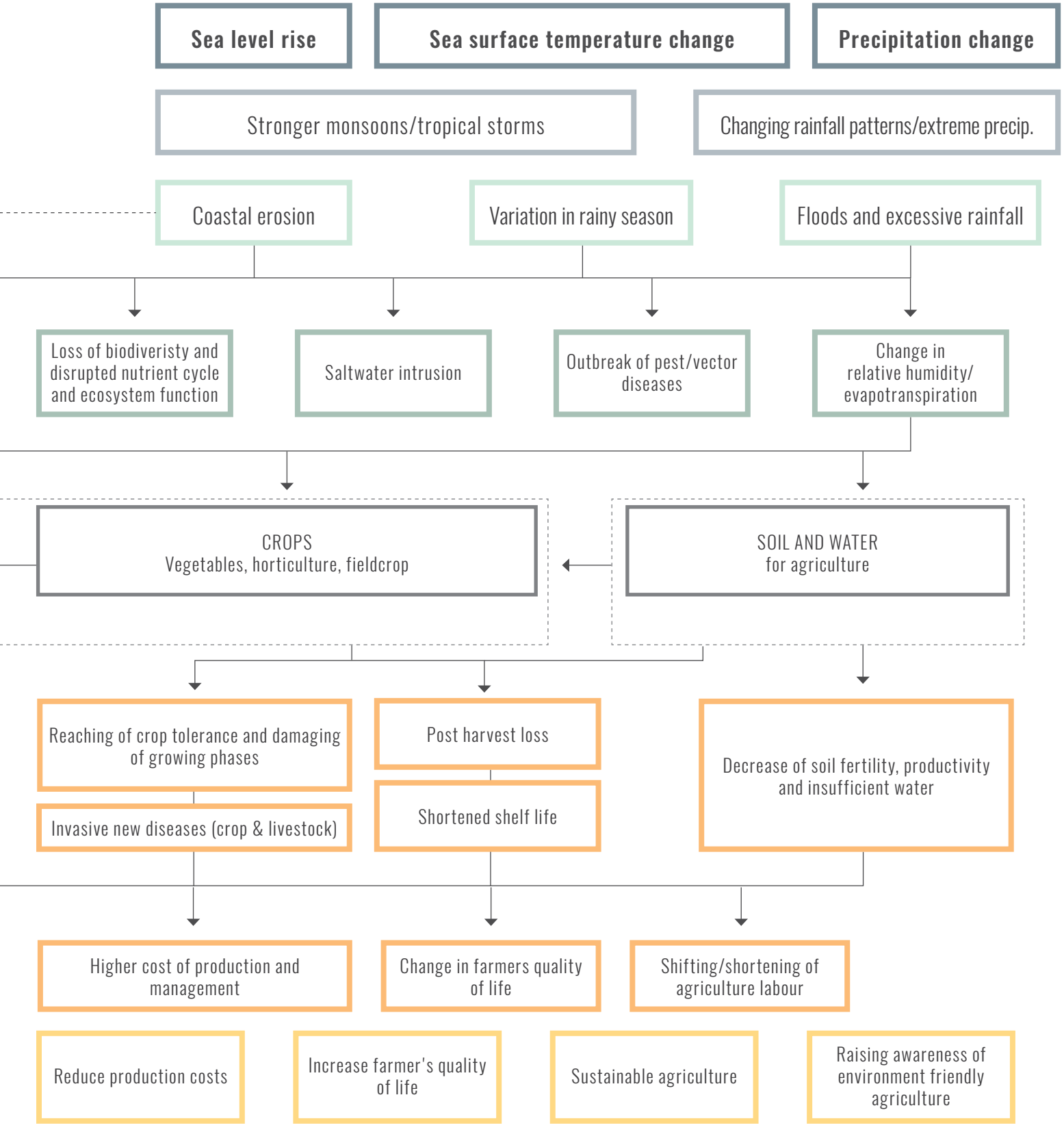
6. Institutional and organizational outputs and outcomes
   - effective cross–sectoral coordination mechanism among relevant ministries and organizations
   - strategies, policies and regulations formulated for adaptation
   - risk management institutions and policies (including pests and diseases) established
   - inclusion of climate change in agricultural and biodiversity policy frameworks
   - actions identified and planned by local authorities to address climate–related vulnerabilities and opportunities
   - effective multistakeholder consultation platforms in place
   - public commitments made to identify and manage climate–related risks
   - amount of budget allocated to support adaptation in the agriculture sectors
   - amount of budget allocated to research in all agricultural sectors and
   - increase in the number of women participating in local, subnational and national dialogues on climate change

Annex 5. Sector–based climate change impact chain for agriculture in Thailand



Source: *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*

in the atmosphere



Agriculture sector

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ADDRESSING AGRICULTURE, FORESTRY AND FISHERIES IN NATIONAL ADAPTATION PLANS

[*Supplementary guidelines*]

*The **Addressing agriculture, forestry and fisheries in National Adaptation Plans – Supplementary guidelines** (NAP–Ag Guidelines) provide specific guidance for national adaptation planning in the agricultural sectors. They are intended to be used by national planners and decision–makers working on climate change issues in developing countries and authorities and experts within the agriculture sectors who are contributing to climate change adaptation and NAP formulation and implementation.*

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