Food and Agriculture Organization
of the United Nations

Climate change and food security: risks and responses

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In this summary, all references have been omitted to facilitate readability, they can be found in the full paper http://www.fao.org/3/a-i5188e.pdf

INTRODUCTION

In spite of the considerable progress made during the last several decades in reducing hunger, as of 2015 almost 800 million people are chronically undernourished. An estimated 161 million children under five years are stunted. At the same time, 500 million people are obese. Two billion people lack the essential micronutrients they need to lead healthy lives. FAO estimates that, to satisfy the growing demand driven by population growth and dietary changes, food production will have to increase by 60 percent by 2050.

> "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 definition gives rise to four dimensions of food security: availability of food, accessibility (economically and physically), utilization (the way it is used and assimilated by the human body) and stability of these three dimensions.

It is not enough to have sufficient food produced globally to meet demand – enough food is produced globally now but there are still almost 800 million hungry people – but that everybody has access to it, in the right quantity and quality, all the time.

According to the United Nations, in 2015, there are still 836 million people in the world living in extreme poverty (less than USD1.25/day). And according to the International Fund for Agricultural Development (IFAD), at least 70 percent of the very poor live in rural areas, most of them depending partly (or completely) on agriculture[1] for their livelihoods. It is estimated that 500 million smallholder farms in the developing world are supporting almost 2 billion people, and in Asia and sub-Saharan Africa these small farms produce about 80 percent of the food consumed.

[1] Agriculture is to be understood here in its broad sense, covering crops and livestock production as well as forestry, fisheries and aquaculture.

Climate change threatens to reverse the progress made so far in the fight against hunger and malnutrition. As highlighted by the latest assessment report of the Intergovernmental Panel on Climate change (IPCC), climate change augments and intensifies risks to food security for the most vulnerable countries and populations. Four out of the eight key risks induced by climate change identified by IPCC AR5 have direct consequences for food security:

- Loss of rural livelihoods and income
- Loss of marine and coastal ecosystems, and livelihoods
- Loss of terrestrial and inland water ecosystems, and livelihoods
- Food insecurity and breakdown of food systems

The earliest and the more impacted are the most vulnerable countries and populations, including in arid and semi-arid areas, landlocked countries and small island developing states. Climate change will also have broader impacts through effects on trade flows, food markets and price stability and could introduce new risks for human health. Greatly expanded efforts to respond to climate change are needed immediately to safeguard the capacity of food systems to ensure global good security.

This report serves three purposes.

First, to raise awareness that climate change is already impacting the food security and nutrition of the most vulnerable, and that if action is not very quickly taken, climate change will increasingly threaten the achievement of the goal to eradicate hunger. This is one more reason for governments to take ambition action to tackle climate change in all sectors.

Second, to describe precisely the pathways by which climate change finally impacts the food security of people, and to show the range of actions needed. Understanding these pathways and the potential responses, not only technical, but also from social protection to strengthened international cooperation, is indispensable. It grounds FAO's action to eradicate hunger and malnutrition.

Third, it also aims to fuel the ongoing discussions on how to operationalize adaptation to climate change, and to show that food security and nutrition, as well as the agriculture sectors that support it, should be a priority area of intervention. As such, it also aims to answer the adaptation needs and demands conveyed by many countries in their Intended Nationally Determined Contributions for COP21.

This report brings together evidence from the IPCC, updated by the latest scientific findings and enriched by FAO's knowledge and experiences on the ground. It provides an overview of the cascading impacts of climate change on food security and nutrition, from physical impacts on agro-ecosystems to livelihoods and food security. It describes how the cascade of impacts acts on a series of vulnerabilities. It presents ways to adapt and build resilience to climate change to ensure food security and nutrition. It shows the importance to act now on climate change: to eliminate hunger; to enable the agriculture sectors to adapt to climate change. It also recalls the urgency to mitigate climate change in order to keep it at levels where it is still possible to ensure and safeguard everyone's food security and nutrition.

I. RISKS: CLIMATE CHANGE IMPACTS ON FOOD SECURITY – OVERVIEW OF LATEST KNOWLEDGE

The latest IPCC report confirms the main findings of previous IPCC reports on the evolution of the climate as well as its main physical effects, such as consequences for land and ocean temperature change, sea level rise and ocean acidification. It also brings better understanding of potential spatial changes in precipitation, in intensity and seasonal distribution. Moreover, improvements in modelling as well as in data collection and use enable us to improve the projections of climate change impacts in the medium term and at local scales. These improvements are of crucial importance to better understand and project potential impacts on agricultural systems.

Climate change generates considerable uncertainty about future water availability in many regions. It will affect precipitation, runoff and snow/ice melt, with effects on hydrological systems, water quality and water temperature, as well as on groundwater recharge. In many regions of the world, increased water scarcity under climate change will present a major challenge for climate adaptation. Sea-level rise will affect the salinity of surface and groundwater in coastal areas.

Climate change is likely to affect the frequency and intensity of extreme events. The magnitude of impacts of extreme events on agriculture is already high. FAO's recent analysis of 78 post-disaster needs assessments in 48 developing countries spanning the 2003–2013 period shows that 25 percent of all economic losses and damages inflicted by medium- and large-scale climate hazards such as droughts, floods and storms in developing countries affect the agriculture sectors.

Climate change is profoundly modifying the conditions under which agricultural activities are conducted

Climate change has both direct and indirect impacts on agricultural production systems. Direct impacts include effects caused by a modification of physical characteristics such as temperature levels and rainfall distribution on specific agricultural production systems. Indirect effects are those that affect production through changes on other species such as pollinators, pests, disease vectors and invasive species. These indirect effects can play a major role. They are much more difficult to assess and project given the high number of interacting parameters and links, many of which are still unknown.

The projected impacts of climate change on major crop yields are now well documented, based on two decades of research. Globally, negative impacts are more commonly found than positive ones. Observations of the effects of climate trends on crop production indicate that climate change has already negatively affected wheat and maize yields in many regions, as well as globally.

According to results from major agricultural model inter-comparison projects, despite remaining uncertainties related to how models account for the representation of combined carbon dioxide fertilization, ozone stress and high temperature effects, there is agreement on the direction of yield changes in many major agricultural regions at both low and high latitudes, with strong negative impacts especially at higher levels of warming and at low latitudes. IPCC has expressed high confidence for crop production to be consistently and negatively affected by climate change in the future in low-latitude countries, while climate change may have positive or negative effects in northern latitudes. Although some high-latitude regions may become more climatically viable for crops, soil quality and water availability might constrain sustained agricultural production increases in these locations.

A recent multi-model study using IPCC's highest scenario of warming found a mean effect on yields of four crop groups (coarse grains, oil seeds, wheat and rice, accounting for about 70 percent of global crop harvested area) of minus 17 percent globally by 2050 relative to a scenario with unchanging climate. The hypothesis for this multi-model assessment combined the most extreme radiative forcing scenario with an assumption of limited CO_2 fertilization effects in 2050, but has not included the deleterious effects of increased ozone concentrations and biotic stresses from a range of pests and diseases, nor the likelihood of increased occurrence of extreme events. After 2050, the risk of more severe impacts increases. Overall, findings indicate that climate change will also increase crop yield variability in many regions. Potential impacts on other crops than major cereals have been less studied.

The models used to make projections of crop yields generally do not take into account the impacts of climate change on the functioning of ecosystems, such as the balance between crops, weeds and pests, nor the effects on pollinators. Pests and diseases are likely to move, following climate change, affecting areas

previously immune, and thus less prepared, biologically and institutionally, to manage and control them, with potentially higher negative impacts. These changes may also counter-balance direct positive effects of climate change. For instance, in high-latitude regions, climatic conditions will become more favourable to crops, but also to weeds and pests.

Climate change affects livestock production in multiple ways, both directly and indirectly. The most important impacts are experienced in animal productivity, and health as well as yields of forages and feed crops. In various countries in sub-Saharan Africa, 20 to 60 percent losses in animal numbers were recorded during serious drought events in the past decades. In South Africa, dairy yields may decrease by 10 to 25 percent because of climate change. Increased temperatures and reduced precipitation can cause important drops in forage production, such as the 60 percent deficit of green fodder during the 2003 summer in France.

Climate change and climate variability are impacting forests and their capacity to deliver the wide range of goods and environmental services on which an estimated 1.6 billion people fully or partly depend for their livelihoods and resilience. Evidence shows that in various regions climate change is contributing to decreased productivity and dieback of trees from drought and temperature stress, increased wind and water erosion, increased storm damage, increased frequency of forest fires, pest and disease outbreaks, landslides and avalanches, changes in ranges of forest plants and animals, inundation and flood damage, saltwater intrusion and sea-level rise, and damage from coastal storms. This can jeopardize the contribution of forests to the resilience of agricultural systems, such as for instance the water and temperature regulation at landscape level and the provision of habitats for important species like pollinators.

Climate change affects capture fisheries and the development of aquaculture in marine and freshwater environments. Impacts occur as a result of both gradual atmospheric warming and associated physical (sea and inland water surface temperature, ocean circulation, waves and storm systems) and chemical changes (salinity content, oxygen concentration and acidification) of the aquatic environment. Increased occurrence of coral reef bleaching has been observed, threatening habitats of one out of four marine species. Various fish species are already migrating poleward, resulting in the rapid "tropicalization" of mid- and high-latitude systems. A large-scale redistribution of global marine fish catch potential is forecast, with a decrease of up to 40 percent in the tropics, and an increase of 30 to 70 percent in high-latitude regions. In the Mediterranean, it has been observed that invasive species from lower-latitude regions have arrived in recent years at the rate of one new introduction every four weeks. Abundance and species diversity of riverine fish are particularly sensitive to disturbances in the quantity and timing of water flows, and especially to lower water levels during dry seasons. Pressures on river flows may be exacerbated by human action to retain water in reservoirs and irrigation channels.

Favourable conditions for all production will move geographically. Optimizing these conditions will thus require changes in crops, livestock, trees, and aquatic species breeding and management. To benefit from potential positive effects, such as longer growing seasons in some cold regions, would, in most cases, require significant changes in agricultural systems and practices, to adapt to new conditions and counteract potential negative changes, such as proliferation of pests, in order to effectively translate into production growth.

Impacts on production translate into economic and social consequences, affecting food security

Impact translates from climate to the environment, to the productive sphere, to economic and social dimensions, bringing a range of

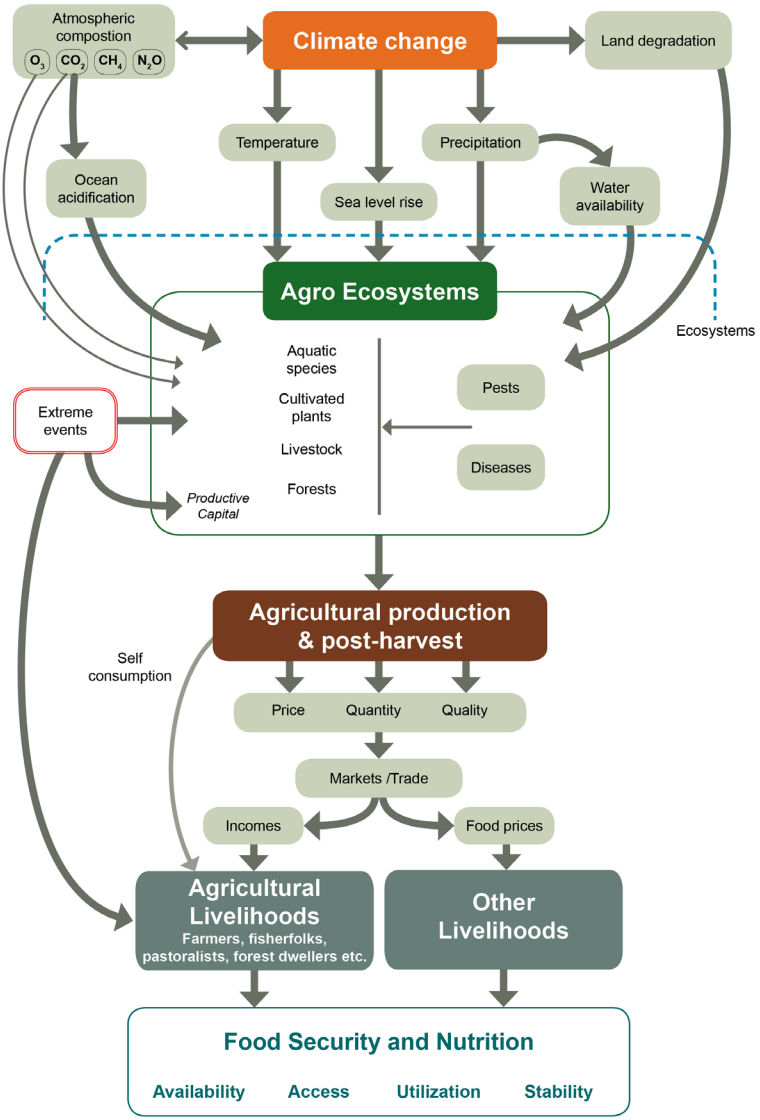

Figure 1. Schematic representation of the cascading effects of climate change impacts on food security and nutrition.

additional risks on availability of food, on access to food and utilization of food, as well as on the stability of these characteristics, for both farm and non-farm households (Figure 1).

At the farm/household level, climate change impacts may reduce income level and stability, through effects on productivity, production costs or prices. Such variations can drive sales of productive capital, such as cattle, which reduces long-term household productive capacity. Exposure to risks lowers incentives to invest in production systems, often with negative impacts on long-term productivity, returns and sustainability. Reductions and risks to agricultural income have also been shown to have effects on household capacity and willingness to spend on health and education. Evidence from recent analyses of the impacts of various types of weather anomalies on farm income indicates that the impacts are greatest for the poorest farmers.

At national level, exposure to climate risks can trigger shocks on agricultural production and food availability, with risks of market disruptions, effects on supply and storage systems, as well as increases in agricultural commodity prices (food and feed), impacting accessibility and stability of food supplies for the entire population, particularly in countries with significant shares of the population spending a large part of their income on food. This triggers macro-economic effects for countries for which agriculture is an important part of GDP and/or constitutes an important source of employment. Climatic risks can also hinder agricultural development by discouraging investments.

At global level, climatic shocks impacting areas of global importance for food supplies can have remote impacts through effects on: (i) supply flows and food price spikes, with increased market volatility; and (ii) impacts on bilateral contracts and/or import/export behaviour, with disruption of trade patterns. **Food price volatility** is likely to be exacerbated by climate change. Trade is expected to play a major role in adjusting to climate-change-driven shifts in agricultural and food production patterns.

Recent experience indicates that climate change effects on food price volatility are greatly influenced by domestic policies, with export bans contributing to price fluctuations. Ultimately, global markets will not be accessible to the poorest countries and the poorest populations without sufficient purchasing power.

Climate change affects food security in all its dimensions: access, availability, utilization and stability

As shown above, climate change affects food production, and thus food **availability**. Climate change will impact the livelihoods and income of small-scale food producers and also, through food price increases and volatility, the livelihoods of poor net food buyers, restricting **access** to food. Impacts of climate change on **nutrition** have been much less studied. Studies point to potential changes in the nutritional quality of some foods (e.g. reduced concentration in proteins and in some vitamins and minerals), due to elevated CO_2, particularly for flour from major cereals and cassava. Climate change can have a variety of impacts on the **quality of drinking water**, which is key to the good absorption of nutrients. Climate change has been found to have an impact on **food safety**, particularly on incidence and prevalence of food-borne diseases. Increased climate variability, increased frequency and intensity of extreme events as well as slow ongoing changes will affect the **stability** of food supply, access and utilization.

Net effects of climate change on food security depend on vulnerabilities of affected systems

The net impacts of climate change on food security and nutrition depend on the magnitude of the climate change effects themselves, and on the underlying vulnerabilities of food systems. At each stage of the "cascade of impacts", vulnerabilities exacerbate net impacts. In addition, vulnerability can increase over time if systems/households face repeated shocks that steadily erode their asset base and capacity to respond.

The populations at greatest risk are those that are dependent on agriculture and natural resources, with livelihoods that are highly exposed to climate change impacts, and who have very limited capacity to respond. In regions with high levels of food insecurity and inequality, increased frequency of droughts will particularly affect poorer households and may disproportionately affect women, given their vulnerability and restricted access to resources. Gender and social differences discriminate people's access to adaptation options, or even information, such as weather and climate data. Indigenous peoples, who depend on the environment and its biodiversity for their food security and nutrition, are at high risk– especially those living in areas where significant impacts are expected such as the Arctic, mountain areas, the Pacific islands, coastal and other low-lying areas. Fishers, fish farmers, post-harvest workers and their dependent communities and infrastructure are particularly exposed. In some cases, to cope with risks and changes, the only option can be to migrate, nationally or internationally, with a range of implications.

II. RESPONSES: ENSURING FOOD SECURITY AND GOOD NUTRITION IN THE CONTEXT OF CLIMATE CHANGE

The second part of the report focuses on a range of the most important adaptation actions in the face of climate change, from a food security and nutrition perspective. The section shows how ensuring food security and good nutrition in a changing climate relies on the mobilization of a wide range of instruments targeting different levels, from social protection to international instruments, in order to improve resilience from households to agricultural and food systems. The analysis focuses, in each category of instruments, on some emblematic tools.

Mobilize social protection to increase resilience of livelihoods in the face of climate change

A major and urgent area for intervention is increasing the resilience (and thus reducing the vulnerability) of livelihoods, particularly among the poor who are highly dependent on natural resources and exposed to climate risks

Social protection programmes are essential in this effort, with proven effectiveness in breaking the vicious cycle of poverty and hunger. Social protection covers a wide array of instruments and objectives, encompassing both safety nets and "safety ropes", i.e., mechanisms that enhance income-generating abilities and opportunities for the poor and vulnerable. Adequate, well-designed social protection would tackle some of the main vulnerabilities of households to climate risks. Income provided to the poor and hungry through social protection can enable them to access sufficient food to meet their basic nourishment needs, without compromising the future productivity of their livelihoods. Such actions will be particularly efficient if targeted to the needs of women.

In a recently released report, FAO, IFAD and the World Food Programme (WFP) showed that it would be possible to end extreme poverty and hunger by 2030, by combining public investment in social protection with public and private efforts to raise investment levels in productive sectors, – especially in rural areas and particularly in agriculture sustaining pro-poor and gender-inclusive growth. The overall required effort would amount to an estimated average of USD267 billion per year during 2016–2030. Climate change makes these investments even more necessary. It also challenges the long-term realization of the objective of eradicating hunger, requiring the maintenance of significant safety nets and safety ropes, as well as additional investments to cope with additional risks.

These actions will need to be supplemented by **disaster risk reduction and disaster risk management** (DRR/DRM) strategies to address the risks of extreme events. A change in the approach to disaster risk reduction is required, in order to prioritize the reduction and proactive management of risks rather than reacting to events. Field-based evidence shows that DRR is cost-effective: for every USD1 spent on DRR, USD2–4 are returned in terms of avoided or reduced disaster impacts.

Build resilience of agricultural systems

Agricultural systems can be made more resilient, by implementing measures that are very system- and local-specific. To adapt to climate change individual farmers, forest dwellers, fisherfolk and those along the supply chain will need to adopt a suite of measures, the details of which will be contingent on individual circumstances. Broad adaptation strategies can be identified.

Increasing the efficiency of scarce resource use in productive systems, particularly water, is an important aspect of building resilient livelihoods. Climate change is altering rainfall and water availability patterns, making capacity to deal with water scarcity (or overabundance) essential to maintaining productivity levels. Adaptation measures can include water harvesting and storage, access to irrigation, improved irrigation technologies, as well as agronomic practices that enhance soil water retention such as minimum tillage and increase in soil carbon and organic matter, among others.

Adaptation measures for crops can include the use of adapted varieties or breeds, with different environmental optima and/or broader environmental tolerances, including currently neglected crops, also considering that increased diversification of varieties or crops is a way to hedge against risk of individual crop failure. Adaptive changes in crop management – especially planting dates, cultivar choice and sometimes increased irrigation – have been studied to varying extents and are generally estimated to

have the potential to increase yields by about 7–15 percent on average, though these results depend strongly on the region and crop being considered. Changes in post-harvest practices may also be needed, for example the extent to which grain may require drying and how products are stored after harvest.

A range of adaptation options is available for livestock production at different scales: animals, feeding/housing system, production system and institutions. They differ between small-scale livestock production with low market integration and large-scale production with high market integration. In particular, breeding livestock but also feed crops and forages is a major component of building resilience to climate change. Many livestock breeds are already well adapted to high temperatures and harsh environments, but their wider diffusion is restricted by the limited extent to which they have been characterized and improved in structured breeding programmes and by trade constraints. Adaptation-related traits are more difficult to study and to record than production traits, have lower heritability, higher levels of non-additive genetic variation and phenotypic variance, and are more susceptible to genotype-by-environment interaction.

Healthy, diversified forest ecosystems are more resilient: they are better able to cope with stress, recover from damage and adapt autonomously to change. Healthy ecosystems are more resilient to negative biotic and abiotic influences than are ecosystems under stress whose ecological processes are impaired. Best practices include integrated pest management, disease control, forest fire management, employment of reduced impact logging in production forests, limitation of gathering of non-wood forest products or livestock grazing in forests at sustainable levels, and forest law enforcement. Restoring degraded forests to healthy states, thereby re-establishing ecosystem functions, is a major strategy for increasing resilience.

Fishing and fish-farming practices and management will need to adapt to changing species composition and location and increased risks at sea. Changes in the distribution of fish, will

require to adapt fishing effort, with flexible allocation and access schemes. Adaptation options to declining or variable yields in terms of fisheries technologies and management will need to be carefully assessed, to avoid exacerbating the overexploitation of fisheries or impacting habitats. For aquaculture, a set of adaptive practices has been identified, such as diversified and integrated aquaculture systems, water quality monitoring, species selection, selective breeding, genetic improvement, site selection, and improved cage and pond construction.

Increasing the diversity within production systems will help spread risks. This can take many forms: combining different types of production (crop, forest, fish and animal) in different ways; increasing the numbers of different species, populations, varieties or breeds; increasing the use of materials that are themselves genetically diverse such as crop multilines.

Adaptation action can be conducted at landscape level, for instance watershed protection and management, fire management, erosion control, coastal zone management, and pest and disease control. Adopting a landscape approach to management includes taking into consideration the physical and biological features of an area as well as the institutions and people who influence it. Landscape-level adaptation will require appropriate institutions and policies to improve coping capacities of communities.

Invest in resilient agricultural development

Resilient agricultural development, and related investment, can support adaptation. Farmers, fisherfolk and forest dwellers need support from governments and from the private sector, and there is also an important role for civil society organizations.

Investments in agriculture, and especially in smallholder agriculture, are key to eradicating poverty. As shown by the World Bank, growth in agricultural GDP from investments in agriculture is three times more effective than growth in any

other sector for reducing poverty in countries highly dependent on agriculture. As shown by the High Level Panel of Experts on Food Security and Nutrition, agricultural development strategies should put smallholder and family farming at the centre. Such strategies, emphasizing access to markets and value addition shall also be part of broader rural development.

Rural and R&D investments needed to eradicate hunger could, to take into account climate change effects, be reoriented or complemented by additional investments and appropriate measures. Climate change adaptation investment could be joined-up with regular agricultural investment programmes to scale-up effects. Public investment can help guide, enable and increase returns to private investments, such as for instance public investment in research, support to water management facilities and user associations, land restoration and extension services.

Investments of farmers, fishers and forest dwellers need to be supported by increased capacity to take collective action, including for investments, and by strengthening the evidence base. For instance, mutualized systems to assess risks, vulnerabilities and adaptation options can help orient individual decisions and actions. Weather observations at stations and by satellites, weather forecasts, climate projections, yield response models, environmental monitoring tools and vulnerability assessments can help determine how local climate conditions will change in the future, and what will be their impact on production. Integrated packages of tools for facilitating an interdisciplinary assessment of impacts of climate change on agriculture are already available. They are key to ground the set-up of early warning systems and of adaptation option assessments.

Managing genetic resources is another key means of adaptation. This requires large collective investments to preserve, characterize and valorize genetic resources, and also to revise the goals of breeding programmes. Breeding programmes take

time to attain their goals and therefore need to start many years in advance. In some places the introduction of new varieties and breeds is likely to be needed. Improvements to in-situ and ex-situ conservation programmes for domesticated species, their wild relatives and other wild genetic resources important for food and agriculture, along with policies that promote their sustainable use, are therefore urgently required.

Enable adaptation through policies and institutions

Appropriate policies and institutions at national and international levels are needed to enable, support and complement the economic and technical options presented above, to enable adaptation of food producers, and especially to support small-scale food producers in their efforts to adapt to climate change.

Institutions that generate and manage public goods are key, as well as those that generate and channel public investments. Dedicated policies and institutions are needed for the prevention and management of specific risks and vulnerabilities that can be modified by climate change, such as water scarcity, plant pests, animal diseases, invasive species and wild fires. Many of these policies and instutions are local and national. They can be effectively supported by international cooperation and tools, particularly to manage transboundary pests and diseases. Securing access of smallholder and family farmers, pastoralists and women to such public goods and services is essential.

Securing land tenure is paramount to enable farmers to benefit from the value added on the land and to encourage them in adopting a long-term perspective. The *Voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security* adopted in 2012 by the Committee on World Food Security promote secure tenure rights and equitable access to land, fisheries and forests as a

means of eradicating hunger and poverty, supporting sustainable development and enhancing the environment. They can play an important role.

Collective management of natural resources, including land and water, is particularly important for adaptation, especially at landscape level. It requires specific institutions, often at local level. Policies and institutions need to account for the specificities and needs of pastoral systems and indigenous peoples in terms of management of natural resources, and their particular needs in terms of adaptation to climate change.

Improving land use and management, or changing farming systems can bring long-term adaptation benefits but often imply significant up-front costs either in inputs or labour, and/or reduced income during the transition period. **Specific policies and instruments will be needed to enable those investments and facilitate the transition.**

Gender-specific support services are needed, recognizing the differentiated roles of household members in production, consumption and the reproduction of the family unit over time. Government intervention is important to bridge gaps in economic and political power that can exist between smallholders and family farmers, their organizations and other food chain actors in accessing adaptation support, institutions and finance.

Market development and better linkages of smallholder and family farmers to domestic, national and regional markets are important to support adaptation actions, to enable food producers to get the inputs needed to adapt, and to sell new products from a diversification of activities. Developing these market linkages also requires investment in small- and medium-size food processors, and small-scale traders at the retail and wholesale levels.

Policies will be needed to reduce financial risks, especially those related to price volatility, which is a major disincentive for smallholder and family farmers investment. Policies will also be needed to lower transaction costs, facilitate monetary

transactions, enable access to financial services and facilitate long-term investments, such as safe savings deposits (with incentives to save), low-priced credit (such as through joint-liability group lending) and insurance (such as index-based weather insurance). Smallholder and family farmers' financial needs for both working capital expenditures (fertilizers, seeds) and medium- and long-term investments, have to be addressed and supported.

The agriculture sectors are the most impacted by climate change of all economic sectors with, as this report shows, a range of food security implications. This calls for **better recognizing, in climate policies and tools, the importance and the specificities of the agriculture sectors and of food security**, and for integrating climate change concerns in food security and agricultural policies. Specific national climate-related instruments like adaptations plans, national adaptation plans of action (NAPA), prepared by least developed countries, and national adaptation plans (NAPs), aim to identify vulnerabilities to climate change and actions to be implemented. Most countries have also integrated agriculture and land use in their intended nationally determined contributions (INDCs). The countries that have included adaptation in their INDCs generally insisted on the importance of food security and of the agriculture sectors.

Enhance markets and trade's contribution to stability of food security

Global markets and trade can play a stabilizing role for prices and supplies and provide alternative food options for negatively affected regions. Climate impacts on future food supply suggest an enhanced role for trade given the modification of production patterns, and climate shocks. Attention has focused on three possible measures that could help reduce market volatility, namely limiting trade restrictions, widening and deepening markets, and improving the flow of information. A lack of **reliable and up-to-date information on crop supply, demand, stocks and**

export availability contributed to recent price volatility on food markets. An agricultural market information system (AMIS) has been set up to monitor global markets of wheat, maize, rice and soybeans (production, utilization, stocks and trade) in order to detect situations that could require international policy action and, if necessary, bring together the main exporting and importing countries to identify and implement appropriate solutions.

Strengthen regional and international cooperation

With climate change, we are likely to see a "migration" of some production systems, including from one country to another. **Strengthened regional and international cooperation will be needed** to facilitate exchanges of knowledge on production systems and on adaptation options, undertake vulnerability assessments, exchange and value genetic material and practices, manage fish stocks and other transboundary resources, as well as to prevent and manage transboundary risks, like plant pests and animal diseases.

It is likely that climate change will necessitate more **international exchanges of genetic resources** as countries seek to obtain well-adapted crops, livestock, trees and aquatic organisms. The prospect of greater interdependence in the use of genetic resources in the future underscores the importance of international cooperation in their management today and of ensuring that mechanisms are in place to facilitate exchanges of these resources internationally, through fair and equitable – and ecologically appropriate – mechanisms. For plant genetic resources, the International Treaty on Plant Genetic Resources for Food and Agriculture, provides useful dispositions for the conservation of genetic resources, exchange of information, transfer of technology, capacity building and benefit sharing. Also, **global cooperation to prevent and manage transboundary pests and diseases will be increasingly important**. The International Plant Protection Convention, provides an example of a useful instrument to be mobilized. It

promotes action to protect plants and plant products from the spread of pests, and sets out measures to control plant pests while minimizing interference with the international movements of goods and people.

ACTING NOW ON CLIMATE CHANGE, TO ENSURE FOOD SECURITY FOR ALL, NOW AND IN THE FUTURE

Climate change brings a cascade of risks from physical impacts to ecosystems, agro-ecosystems, agricultural production, food chains, incomes and trade, with economic and social impacts on livelihoods and food security and nutrition.

The people who are projected to suffer the earlier and the worst impacts from climate change are the most vulnerable populations, with livelihoods depending on agriculture sectors in areas vulnerable to climate change. Understanding the cascade of risks, as well as the vulnerabilities to these risks, is essential to frame ways to adapt. Reducing vulnerabilities is key to reducing the net impacts on food security and nutrition and also to prevent long-term effects.

Increasing resilience of food security in the face of climate change calls for multiple interventions, from social protection to agricultural practices and risk management.

The changes on the ground needed for adaptation to climate change in agriculture and food systems for food security and nutrition need to be enabled by investments, policies and institutions in various areas. To be the most effective such interventions have to be part of integrated strategies and plans. Such strategies should be gender-sensitive, multiscales, multisectors and multistakeholders. They should be elaborated in a transparent way and consider the different dimensions (social, economic, environmental) of the issues and different time scales by which the changes will need to be implemented and supported. They should be based on assessments of risks and vulnerabilities, learn from experience and progress, and be regularly monitored, assessed

and updated. Middle- and high-income countries are increasingly carrying out regular assessments but countries without this capacity will need specific support. The National Adaptation Plan process set up under the United Nations Framework Convention on Climate Change (UNFCCC) provides the opportunity to integrate food security and nutrition as a key objective. Such national strategies and plans need also to be supported by enhanced regional and international cooperation.

Actions by different stakeholders are needed in the short term to enable responses in the short, medium and long term. Some medium- and long-term responses will need immediate enabling action and planning, and immediate implementation of investments, especially those investments that require longer time frames to be developed and arrive in the field: forestry, livestock breeding, seed multiplication, R&D, innovation and knowledge transfer to enable adaptation.

For the world's poor, adapting to climate change and ensuring food security go hand in hand.

A paradigm shift towards agriculture and food systems that are more resilient, more productive, and more sustainable is required.

The world needs to act now.

To eliminate hunger and malnutrition.

To enable the agriculture sectors to adapt to climate change.

To mitigate climate change in order to keep it at levels where it is still possible to ensure and safeguard everyone's food security and nutrition. In that effort, agriculture has also a role to play, keeping in mind that food security is the priority.

By adopting the sustainable development goals, the world has committed to ending hunger, achieving food security and improving nutrition by 2030. But climate change is already undermining the livelihoods and food security of the most vulnerable populations. Ensuring food security and good nutrition in the face of climate change is among the most daunting challenges facing humankind.

The report *Climate change and food security: risks and responses* brings together evidence from the Intergovernmental Panel on Climate Change (IPCC), updated by the latest evidence and scientific findings as well as by results from experience on the ground, on the impacts of climate change on food security and nutrition. It shows how a cascade of impacts from ecosystems to livelihoods interacts with a series of vulnerabilities, undermining food security and nutrition, especially of the most vulnerable populations. The report presents ways to adapt, to reduce vulnerabilities and to build resilience to climate change. It shows the importance of acting now to address climate change, to ensure food security and good nutrition for all, now and in the future.

For the full report: http://www.fao.org/3/a-i5188e.pdf

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