

Agriculture

Introduction

Purpose: This annex to the Climate Risk Screening and Management Tools is designed to provide you with more information on climate change¹ implications for agriculture (including terrestrial agriculture, pastoralism, and fisheries). The information is grouped into the following sub-sections, with the corresponding step from the Tool shown in parentheses:

- Climate Risks to Agriculture (Step 2)
- Adaptive Capacity Related to Agriculture (Step 3)
- Opportunities Related to Climate Risk Management of Agriculture (Step 5)
- Climate Risk Management Options for Agriculture (Step 6)
- Additional Key Resources Related to Agriculture

The questions and examples provided in this annex are illustrative and designed to stimulate thinking about climate risks, adaptive capacity, opportunities, and climate risk management options. Actual climate risks will depend on the context and anticipated climate changes for particular geographies.

Sectoral focus: The material in this annex aligns with EG.3 Agriculture in the Standardized Program Structure. Note, to the extent your design involves multiple sectors, you may want to consult other relevant annexes. In particular, if any new construction or rehabilitation² is anticipated, referring to the [Infrastructure, Construction, and Energy Annex](#) is highly recommended. Please note, *activity*-level climate risk management (CRM) for engineering design **must** be conducted by the Engineer of Record.³ See the [Infrastructure, Construction, and Energy Annex](#) for solicitation language.

¹ In this document, the term “climate change” refers to both climate variability and climate change. “Climate variability” refers to variations in climate (including the normal highs and lows, wet and dry periods, hot and cool periods and extremes) and can refer to month-to-month variability, year-to-year variability, and even decadal scale variability. In this document, “climate change” refers to those variations as well as persistent change in climate over decades or longer (USAID, 2014. Climate-Resilient Development: A Framework for Understanding and Addressing Climate Change).

² USAID Implementation of Construction Activities, A Mandatory Reference for ADS Chapter 303, defines “construction” as: “construction, alteration, or repair (including dredging and excavation) of buildings, structures, or other real property and includes, without limitation, improvements, renovation, alteration, and refurbishment. The term includes, without limitation, roads, power plants, buildings, bridges, water treatment facilities, and vertical structures.” Construction at USAID almost always occurs within another primary programming area (e.g., school building for education, hospital/clinic construction for health).

³ An appropriately qualified engineering firm under contract or subcontract with USAID for the purpose of completing the engineering design.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Tool Step 2: Climate Risks to Agriculture – Illustrative Examples and Questions

Once you have reviewed this section, you can navigate back to the Tool by clicking on the relevant hyperlink in the header.

Productivity	Food Security	Nutrient Quality, Dietary Diversity, and Food Safety
<ul style="list-style-type: none"> ● Damage to crops and reduced productivity due to heat stress and changes in rainfall. ● Damage to crops, reduced productivity, and increased economic losses due to increased flooding in river basins. ● Earlier greening, leaf emergence, and fruit set in temperate and boreal climates due to changes in seasonality. ● Increased prevalence of parasites and diseases that affect livestock due to changing climate conditions. ● Reduced animal feeding and decreased growth rates due to higher temperatures. ● Reduced fertility, and reduced milk production due to prolonged heat stress. ● Reduced water availability for crops and livestock due to increased evaporative demand from higher temperatures. ● Reduced water availability for crops and livestock due to reduced snow cover and receding glaciers in mountainous areas that feed rivers. ● Reduced yields due to crop damage and field waterlogging from floods. ● Reduced crop yields in the near term from drought and lost topsoil and reduced soil fertility in the future from prolonged drought and extreme events. ● Reduced amount of quality forage for grazing livestock due to drought. 	<ul style="list-style-type: none"> ● Reduced yields of staple cereal crops (wheat, rice, and maize) due to higher temperatures. ● Reduced food availability due to increased climate variability and the changed frequency and intensity of extreme weather events. ● Increased food price fluctuations due to variation in temperature and precipitation. ● Price volatility and price spikes due to increasing climate variability and extremes including floods and droughts. ● Disproportionately negative effects of price volatility on poor consumers, who spend most of their income on food. ● Reduced willingness of farmers to invest in productivity-enhancing assets such as fertilizer due to price volatility and greater uncertainty about future prices. 	<ul style="list-style-type: none"> ● Lower protein content in grains due to elevated temperature and CO₂. ● Long term loss of health, productivity, and incomes of poor consumers due to prioritization of calorie-rich but nutrient-poor foods. This decrease in dietary quality and quantity is due to reduced food consumption caused by reduced food supplies from climate extremes.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Productivity	Food Security	Nutrient Quality, Dietary Diversity, and Food Safety
<ul style="list-style-type: none"> ● Dramatic decreases in productivity of coastal agricultural areas due to increased salinization from sea level rise, greater storm surge, and ocean acidification. ● Reduced harvests and lower incomes from nearshore fisheries and aquaculture due to sea level rise and greater storm surge.⁴ ● Increased catches of warm water aquatic species at higher latitudes and decreased catches of subtropical species in the tropics due to higher ocean temperatures. ● Reduced availability of fish and shellfish important for many tropical coastal fisheries due to damage to coral reef habitat caused by higher temperatures and ocean acidification. ● Reduced labor productivity due to impacts to health and wellbeing of the workforce caused by extreme heat events. 		

Illustrative questions by climate stressor:

Temperature:

- How will higher temperatures affect crop yields? Will some crops be favored more than others in certain regions and locations?
- How will higher ocean temperatures and ocean acidification affect fisheries and aquaculture operations?
- How will increases in temperature extremes affect agricultural productivity?
- How will increases in temperature extremes affect water availability?
- How may very high or very low temperatures affect workforce productivity?

Flooding:

- What are some of the direct and indirect effects of floods on crops? Are some effects likely to persist over the medium- to long-term?

⁴ A temporary sea level rise associated with a storm.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

- Are there locations where livestock are vulnerable to flooding? Are some types of livestock more vulnerable (e.g., pigs compared to cattle)? How significant is mortality during flooding?
- How may coastal flooding due to sea level rise increase liability costs for the insurance/reinsurance sectors?

Drought:

- How will drought affect livestock? How will drought affect the quantity and quality of pasture?
- How will drought affect the productivity of croplands?
- Does drought disrupt supply, transport, and distribution chains, increasing costs of trade?

Sea level rise and storm surge:

- Where are coastal areas vulnerable to sea level rise and storm surge? What agricultural activities are vulnerable to flooding and saltwater intrusion?
- How vulnerable are nearshore fisheries and aquaculture operations to sea level rise and/or storm surge?

Illustrative questions by programming or system element:

Productivity:

- How will changing temperature ranges, extremes, and/or shifts in seasonal onsets affect drivers of agricultural productivity? Those drivers may include soil quality and fertility, vegetative cover, fodder quality, water availability, temperature regulation, aquatic thermoclines, etc. Do these changes differ by agro-ecological zone? For instance:
 - Are changes in precipitation patterns expected to change crop suitability or reduce the number of harvests?
 - Are changes in seawater temperatures expected to change fish distributions and migration patterns along the coast?
- Is climate change expected to result in significant changes to the timing of key seasonal events such as pollination or fish spawning?
- Is it possible that because of climate changes some crops or targeted fish species are no longer economically viable?
- Is climate change likely to interact with non-climate threats to agricultural production, such as loss of soil nutrients or salinization of crop lands?
- How are the impacts of climate change on human systems expected to affect agricultural productivity? For instance:
 - Are sea level rise and coastal flooding likely to increase conversion of uplands to cropland?
 - How is climate change expected to affect the productivity of the workforce (due to reduced water availability, heat stress, changes in disease incidence, etc.)?

Food Security

- How will climate change affect food prices and price volatility? How will climate change interact with economic policies such as food subsidies?
- How are staple crops likely to be affected?

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

- Is the commercial⁵ sector equipped to respond to changes in the supply and demand for goods and services?
- To what extent do banks take into consideration climate risk? How might climate change cause banks to become more risk averse in their lending decisions?
- How might changes in climate stressors affect equitable access to financial markets? Would women, the elderly, at-risk youth, LGBTI individuals⁶, and other marginalized populations⁷ be disproportionately affected regarding access to financial markets?
- How might climate change affect the value of land or otherwise put pressure on property rights?

Nutrient Quality, Dietary Diversity, and Food Safety

- How will climate change affect food quality?
- How might impacts of climate change alter the dietary diversity available to populations?
- How might extreme climatic events (heat waves, floods, etc.) or climatic considerations during storage and transport impact food safety?

Tool Step 3: Adaptive Capacity Related to Agriculture – Illustrative Questions

Once you have reviewed this section, you can navigate back to the Tool by clicking on the relevant hyperlink in the header.

Information Capacity

- What is the level of capacity for research and development for climate-resilient seeds, livestock, or fishes, and for research and development about sustainable land and aquatic management practices?
- What is the level of capacity to collect and use information about climate impacts to agriculture?
 - Are early warning systems in place to provide farmers and markets with information about severe weather events? How effective are they?
 - Is accurate and timely weather/seasonal forecasting available to community members? How accessible and usable is it for agricultural decision-making?
 - Are there monitoring systems in place that will provide place-based information on changes to agricultural systems (e.g., reporting on trends in yields or food access in each locality)? How well is monitoring information used to adjust agricultural practices?

⁵ Commercial sector is defined as non-manufacturing business establishments, including hotels, restaurants, wholesale businesses, retail stores, warehouses, storage facilities, and health, social and educational institutions.

⁶ LGBTI individuals refers to lesbian, gay, bisexual, transgender, or intersex individuals. Further information can be found in the LGBT Vision for Action, <https://www.usaid.gov/sites/default/files/documents/1874/LGBT%20Vision.pdf>.

⁷ Marginalized populations are groups of people who are excluded, based on their identity, from political, social, and economic power and participation. Often they include women and girls, at-risk youth, the elderly, LGBTI individuals, persons with disabilities, people in linguistic minorities, indigenous people, and/or a combination of any of these identities.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Social and Institutional Capacity

- What is the level of capacity of institutions and civil society to rapidly deploy new means of coping with more rapidly changing ecological and other stresses?
- Are there national and community-level policies that can enable more gradual adaptation?
 - How effective are institutions and leadership at supporting the planning and implementation of actions to address potential climate impacts and opportunities regarding agriculture?
 - To what extent are systems and policies in place that support effective adaptation, such as secure land tenure and effective land use planning?
 - To what extent are government agencies able to respond to changes in climate that affect agricultural productivity?
 - How effective are civil society organizations and/or government actors in promoting effective responses to impacts from both severe weather events and incremental climate change on agriculture and food security?
 - To what extent do linkages between national and sub-national governments exist and work to promote responses around climate change impacts on the agriculture sector?
 - What is the current state of awareness/knowledge within government fiscal and monetary policy systems about risks and/or opportunities of climate change to agriculture?
 - How is the capacity to carry out commercial activities (trade and investment, financial services, GDP, and employment) expected to be affected by climate change?
 - Are the general public and marginalized populations sufficiently protected by inclusive economic laws and property rights?
 - What risk reduction strategies have been implemented by the private sector?
 - To what extent are economic planning systems able to take into account both gradual changes (e.g., droughts) and rapid onset events (e.g., floods)?

Human Capacity

- What is the level of capacity of individuals to respond to climate impacts on agriculture and to adopt climate-smart practices?
- Are there established pathways to build human capacity (of individuals and groups) through extension and training?
 - To what extent do those within the agriculture sector recognize the potential impacts and/or opportunities from climate stressors? This includes stakeholders all along the value chain, from farmers to buyers to processors to financiers.
 - Are technical and research organizations in place to train and support those along the agriculture value chain on responding to impacts? How effective are they?
 - Is there evidence that farmers are incorporating new information and techniques into their agricultural management practices to reduce climate risk, such as integrated pest management, control of soil erosion, and soil health management? Are other stakeholders incorporating new information and techniques into their agricultural activities to reduce climate risks relevant to their sector?
 - Are agriculturalists enabled or able to adjust farming/livestock/fisheries practices *in anticipation* of climate changes where current production and marketing patterns are likely to become unprofitable or unsustainable due to climate change? Why or why not?
 - To what extent have traders and investors considered climate risks and opportunities?
 - Are technical and research organizations in place to train and support workforce development?

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

- o To what extent are key economic actors able to incorporate new information and techniques into production and distribution of goods and services, procurement practices, workforce training, or business operations to reduce climate risks to productivity?
- o To what extent will marginalized populations that are most likely to be disproportionately affected by climate change be included in workforce training or other efforts to build adaptive human capacity?

Financial Capacity

- Are there adequate financial resources to support the agricultural sector in preparing for climate impacts?
 - o To what extent are investments being made in research and technical development to reduce climate risks to agriculture? How effective are they?
 - o How sufficient are funding sources to address heightened risk management needs to maintain preparedness for agriculture losses and new investments?
 - o How sufficient are financial or in-kind resources to re-capitalize losses of farmers/pastoralists/aquaculturalists after a climate-related disaster?
 - o What financial products and services are currently available to address increasing risk (e.g., insurance, credit and savings)?

Tool Step 5: Opportunities Related to Climate Risk Management for Agriculture – Illustrative Examples⁸

The need to address climate risks to agriculture may provide a range of additional opportunities. For strategic elements, projects, and activities with moderate/high climate risks, the important types of opportunities to discuss are climate change mitigation,⁹ potential co-benefits for non-climate development objectives, and leveraging political will. For strategic elements, projects, and activities with low climate risks, and those based in Washington opportunities should focus more on how to support resilience more broadly.

Once you have reviewed this section, you can navigate back to the Tool by clicking on the relevant hyperlink in the header.

Enhance food production and food security

- Encourage farmers to take advantage of changes in temperature or precipitation that will extend the growing season and allow for additional harvests.
- Increase training and investment in more sustainable agricultural practices.
- Promote new public-private partnerships that will strengthen agriculture value chains.
- Promote programs to improve the security of property rights and land tenure in order to incentivize agricultural investment, including climate-smart agriculture (CSA).
- Train farmers to optimize irrigation through enhanced storage and access to irrigation water; more efficient water delivery systems; improved irrigation technologies such as deficit irrigation; more effective water harvesting; and agronomy that increases soil water retention through practices, such as minimum tillage and canopy management.
- Encourage adoption of innovations in food processing, packaging, transport, and storage.

⁸ We also recommend that you refer to “Tool Step 5 for Economic Growth” for additional illustrative opportunities of direct relevance to agriculture.

⁹ In this document “climate change mitigation” refers to efforts to reduce greenhouse gas emissions.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Improve the nutrient quality, dietary diversity, and safety of food supply

- Promote markets for foods that are particularly important for nutrition and that smallholder farmers' produce.
- Discourage monoculture planting to reduce susceptibility to catastrophic losses from pests and disease. Polyculture can diversify farm income and can reduce the need for inputs such as nitrogen fertilizers that result in nitrous oxide emissions, a greenhouse gas.
- Increase soil organic carbon to improve soil fertility and release nutrients for plant growth. Storing more organic carbon in the soil sequesters carbon from the atmosphere and helps to mitigate climate change. Many management practices that increase soil organic carbon also improve crop and pasture yields.

Take advantage of synergies with other development objectives

- Provide timely weather information to farmers using results of monitoring from early warning systems.
- Construct/retrofit agricultural infrastructure for changing climate conditions when it is necessary to rebuild following extreme events.
- Promote management approaches and policies that maximize resilience of exploited fish species (e.g., no-take zones).
- Support municipal composting of organic waste to improve waste management and public health, and to reduce greenhouse gas emissions from the decomposition of organic matter in landfills, which produces methane, a greenhouse gas.

Use public finance mechanisms to mobilize and leverage private capital for promising technologies for adaptation and climate change mitigation

- Carbon finance can be used to monetize future cash flows from the advanced sale of carbon credits to finance investment costs for climate resilience investment (e.g., resilient infrastructure) or renewable energy and energy efficiency projects.
- Develop financial services for underserved and marginalized populations.
- Mobile banking, Village Savings and Loan Associations (VSLAs), and microfinance can help build the adaptive capacity of smallholders who otherwise lack access to financial services.
- Community supported agriculture provides up front financing for farmers at the start of or prior to a growing season, and can distribute farm income more evenly throughout the year, which can help smaller growers and cooperatives. With more predictable revenue, growers may be better positioned to implement climate-smart agricultural practices.

Achieve climate change mitigation co-benefits while increasing agricultural productivity

- Adopt agroforestry techniques or other methods of climate-smart or regenerative agriculture to increase production while also enhancing carbon sequestration.
- Sequester soil carbon and nitrogen through conservation agriculture (e.g., low till rotations).
- Introduce nitrogen-fixing crops and trees.
- Generate clean energy from biodigesters of agriculture byproducts, including animal manure and crop residues.
- Plant sustainable palm plantations on degraded lands that do not displace food crops or force relocation of inhabitants.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

- Increase fertilizer efficiency through mulching, soil fertility improvements, microfertilizer placement, etc.
- Use low-methane-producing feeds for livestock.

Tool Step 6: Climate Risk Management Options for Agriculture – Illustrative Examples

Once you have reviewed this section, you can navigate back to the Tool by clicking on the relevant hyperlink in the header. Some **illustrative options** for reducing climate risks to agriculture are outlined below.

Increase Efficiency and Cost-Effectiveness of Agricultural Production

- Train farmers in basic techniques of sustainable agriculture, such as improving soil health, integrated pest management (IPM), and crop rotation.
- Train farmers in use of drip and micro-irrigation techniques for more efficient irrigation.
- Provide farmers with new cultivars that are drought and heat-tolerant.
 - Ensure equal opportunity access to such technologies for all farmers, especially marginalized populations.
- Encourage mixed crop-livestock systems and water, feed, and animal management to increase livestock productivity.
- Promote adoption of breeds better adapted to the prevailing climate.
 - Promote analysis of climate risks and assessment of climate impacts taking into account crop–weather interactions.
 - Integrate economic models, linear and non-linear optimization methods, and risk perception by farmers.
 - Develop and provide advice to farmers and access to modern information and communication technologies.
 - Support optimization of farm management practices conditioned by climate (for early and late onset of rainfall, good, average, and bad seasons).
 - Provide farmers with information on crops for which climate change has favorable effects.
 - Earlier flowering and maturity have been observed worldwide in grapes, apples, and other perennial horticultural crops.
 - Cassava (manioc) is likely to benefit from an elevated optimum temperature, for photosynthesis and growth, and a positive response to CO² increases.
- Implement activities to enhance the natural resource base.
 - Address point and non-point pollution of agricultural landscapes and freshwater and marine systems.
 - Implement laws and policies to prevent overexploitation.
 - Promote land tenure and property rights reform to strengthen local natural resource management.
 - Restrict harmful agricultural practices such as slash and burn agriculture that increases erosion and reduces soil fertility.
 - Encourage farmers, pastoralists, and fishers to manage natural regeneration of trees, grasslands, and fish stocks.

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Strengthen Food Security

- Build awareness of climate change implications for food security.
- Help farmers adapt cropping practices to help ensure food production, food security, and sustainable livelihoods (e.g., altering cultivation and sowing times and crop cultivars).
- Support improvements in processing, marketing, and distribution of agricultural products.
- Help develop value chains for new agricultural products.
- Support investments in new technologies and management practices that will increase returns to land, labor, and capital.
- Provide extension services and training in climate-smart agriculture and sustainable fishing practices.
- Expand access to markets and credit to encourage farmers to adopt new, climate-resilient crops and agricultural practices.

Improve Nutrient Quality, Dietary Diversity, and Food Safety

- Encourage planting of crops with high nutrient value that are suitable for changing climatic conditions.
- Help smallholders to diversify crops to increase resilience to variable climate conditions and to promote dietary diversity.
- Develop storage practices to protect food supplies under conditions of heat stress or excess moisture.

Improve Risk Management

- Develop new insurance instruments to address climate risks.
- Make financial markets more inclusive to help build the adaptive capacity of marginalized populations.
- Encourage new development away from high-risk locations (e.g., the coastal zone, river floodplains).

NAVIGATION

1. [Introduction](#) | 2. [Climate Risks](#) | 3. [Adaptive Capacity](#) | 5. [Opportunities](#) | 6. [Climate Risk Management Options](#)
[Additional Resources](#) | [Climate Risk Screening & Management Tool](#)

Additional Key Resources Related to Agriculture

The following **resources** provide additional information related to climate risks to agriculture and corresponding climate risk management options.

Title	Author(s)	Organization	Date	Length	Intended Audience	Unique Value
<i>Food security and food production systems. (In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change)</i>	J.R. Porter et al.	IPCC	2014	49 pp.	Development practitioners, food security experts, policymakers	Provides more detailed information on food security than the tools and includes numerous examples of effects of climate change on food security.
<i>Climate Smart Agriculture Sourcebook</i>	FAO	FAO	2013	570 pp.	Development practitioners, farmers	Provides detailed and in-depth, practical guidance on best practices.