Incorporating climate change considerations into agricultural investment programmes

A guidance document

FAO INVESTMENT CENTRE

BEST PRACTICES IN INVESTMENT DESIGN

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Food and Agriculture Organization of the United Nations

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Annexes

ACRONYMS

ADB	Asian Development Bank
AFOLU	Agriculture, Forestry and Land-Use Change
AR	IPCC Assessment Report
CA	Conservation Agriculture
CDM	Clean Development Mechanism
CH_4	methane
CIF	Climate Investment Funds
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CSA	Climate-Smart Agriculture
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EU	European Union
EX-ACT	Ex Ante Carbon-balance Tool
FAO	Food and Agriculture Organization of the United Nations
FAO-Adapt	FAO's Framework Programme on Climate Change Adaptation
FP DRR	FAO Framework Programme on Disaster Risk Reduction
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIZ (ex-GTZ)	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HFA	Hyogo Framework for Action
ICZM	Integrated Coastal Zone Management
IFAD	International Fund for Agriculture Development
IFI	International Financing Institution
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
LDCs	Least Developed Countries
LDCF	Least Developed Countries Fund
MDG	Millennium Development Goal
M&E	Monitoring and Evaluation
MRV	Monitoring, Reporting and Verification
NAMAs	Nationally Appropriate Mitigation Actions
NAPAs	National Adaptation Programmes of Action
N_2O	nitrous oxide
OECD	Organisation for Economic Co-operation and Development
PT	Project/programme Team
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RF	Results Framework
SCCF	Special Climate Change Fund
SLM	Sustainable Land Management
SRI	System of Rice Intensification
UNDAF	United Nations Development Assistance Framework
UNDG	United Nations Development Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UN-REDD	UN Collaborative Programme on REDD in Developing Countries
USAID	United States Agency for International Development
WB	The World Bank
WG	IPCC's Working Group
WOCAT	World Overview of Conservation Approaches and Technologies

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PREFACE

One of the emerging challenges faced by the world's agricultural sectors is a changing climate. Climate change alters the basics of productive ecosystems, impacts on natural resources and affects food security. From a socio-economic perspective, smallholder farmers, forest dwellers, herders and fishers, groups least able to adapt, will be the most affected by climate change. Moreover climate change cannot be effectively addressed without addressing emissions from the agricultural sectors, estimate to contribute some one-third of all greenhouse gases. As a result there is a growing need to ensure that climate change considerations are mainstreamed into agricultural investment projects and programmes with particular interest on the linkages with and among food security and rural livelihoods.

In recent years, different partners have developed tools and guidelines to facilitate the mainstreaming of climate change in specific sectors. However, in order to capture synergies and manage trade-offs among the objectives of adaptation, mitigation, food security and sustainable development, a specific tool is needed for agriculture investment projects / programmes.

This following guidance document aims to assist investment project formulation practitioners in incorporating climate change considerations into agricultural investment projects and programmes. The main focus is on project/programme formulation (i.e. identification and design), although some aspects of supervision and evaluation will also be presented. It is intended for national and international staff and consultants, as well as government staff involved in mobilizing investment for agriculture and rural development, mainly through assistance to project or programme identification, formulation and supervision. It is meant to apply to investment projects or programmes in agriculture and rural development (agriculture in the broad sense, including fisheries, livestock and forestry). It can also be used for stand-alone climate change projects or programmes; however, for most stand-alone climate change projects/programmes, there are specific guidelines provided by their funding agencies and other development partners.

The document is organized as follows: an introductory section (Chapter 1), followed by Chapter 2 which describes the basics of climate change adaptation and mitigation in the agricultural sectors; Chapter 3 suggests approaches and procedures for incorporating climate change considerations into all project/programme stages: conceptualization, preparation, supervision and evaluation; and Chapter 4 briefly describes some options for financing climate change activities. The Annexes offer summary information and pointers/links to more substantial documents or Web sites where they are already available.

This publication is not intended to be a training manual, but rather a guidance document with: (i) references to information (e.g. documents, tools and information systems) available in FAO and other agencies (mainly multilateral partners) which is relevant to agricultural and rural development projects or programmes; and (ii) guidance on rapid assessments, possible options and good practices for mitigation, adaptation and disaster risk reduction (DRR).

It is the authors' hope that this document will help a project/programme team (PT) to: (i) increase its awareness and understanding of the basics of climate change adaptation and mitigation in the agricultural sectors; (ii) identify the relevance of climate change to a proposed agricultural investment project/programme; (iii) identify and use key tools, information sources and methods for climate change adaptation and mitigation in agricultural sectors (to address both technical and institutional aspects); and (iv) incorporate climate change considerations into every stage of the project/programme cycle.

Chapter 1 - Introduction

Context

The world's agricultural sectors, including agriculture, forestry and fisheries,[1] face many challenges in meeting the food requirements of an ever-increasing population – such as intensive competition for land and water resources and a degrading environment – and these are compounded by a changing climate. Climate change alters the basics of productive ecosystems (e.g. temperature and rainfall), impacts on natural resources (e.g. land and water availability) and affects food security, rural livelihoods and sustainable development at global, regional and local levels. Smallholder farmers, forest dwellers, herders and fishers will be the most affected by climate change because of their limited capacity to adapt to its impacts. These groups could immensely benefit from efforts to strengthen their adaptation capacity. Adaptation is needed now. Postponing action increases adaptation costs.

Climate change cannot be effectively addressed without addressing emissions from the agricultural sectors. Agriculture, forestry and land-use change (AFOLU) are responsible for about one-third of global greenhouse gas (GHG) emissions. Agriculture accounts for 13.5 percent of GHG emissions, mainly in the form of methane (CH_4) and nitrous oxide (N_2O) from fertilized soils, enteric fermentation, biomass burning, rice production and manure and fertilizer production. Land-use change and forestry account for 17.4 percent, mainly from deforestation (IPCC, 2007b). About three-fourths of the emissions from agriculture and land-use change originate in developing countries (IPCC, 2007b). Conversion of rangelands and forests to croplands is a major cause of emissions. Recently released figures show an average deforestation rate of 14.5 million ha per year between 1990 and 2005, a large part of which was the result of conversion to agriculture.[2] Good opportunities exist in the agricultural sectors for mitigating climate change through increasing carbon sequestration or reducing GHG emissions.

The overall objective of climate change adaptation and mitigation in the agricultural sectors is to capture the synergies and manage the trade-offs with the priorities of the agricultural sectors in developing countries – food security, rural livelihoods and sustainable development. Adaptation builds resilience to climate change in the agricultural sectors by reducing its negative impacts and promoting its positives ones. Mitigation addresses the root causes of climate change, thereby limiting over time the extent and cost of adaptation. Some options can benefit adaptation, mitigation and food security simultaneously; others may involve trade-offs, some of which can be managed. In these efforts, it is critical to follow the guidelines of national climate strategies, under the framework of integrated planning at the ecosystem level, and pay special attention to smallholder farmers and the most vulnerable groups.

Climate change mainstreaming

Different agencies define "climate change mainstreaming" in different ways. The United Nations Development Group (UNDG) defines it as "the process by which actions to address the causes and consequences of climate change are implemented as part of a broader suite of measures within existing development processes and decision cycles" (UNDG, 2010). This definition is now commonly used by UNDG in country analysis and formulation of United Nations Development Assistance Frameworks. It entails efforts over many years with multiple

1 The agricultural sectors in this publication refer to agriculture (i.e. crop and livestock production), fisheries and forestry as consistent with FAO terminology (Article 1-Functions of the Organization, FAO Basic Texts, FAO, 2011).

2 http://foris.fao.org/static/data/fra2010/RSS_Summary_Report_lowres.pdf

stakeholders at various levels – from national planning to sector strategies and individual development activities. The need to mainstream climate change considerations into agricultural investment projects and programmes has become increasingly apparent with the general recognition of the close linkage among food security, rural livelihoods and climate change.

Adaptation and mitigation in the agricultural sectors can be implemented as stand-alone projects/programmes or included as distinct components of larger ones. More importantly, they need to be incorporated into each individual activity, wherever or whenever possible. All agricultural development activities need to be climate-proofed to avoid doing business as usual. For example, irrigation and agriculture water management activities should assess the impacts of climate change on local water availability and demands and incorporate them into system planning and engineering design.

How to use this guidance document

In recent years, different partners have developed tools and guidelines to facilitate climate change mainstreaming, and some examples are provided in this document. However, in order to capture synergies and manage trade-offs among the objectives of adaptation, mitigation, food security and sustainable development, a specific mainstreaming tool is needed for agricultural investment projects/programmes which can contribute to these objectives and cover all 4 agricultural sectors (i.e. crops, livestock, fisheries and forestry).

This guidance document aims to assist agricultural investment formulation practitioners in incorporating climate change considerations into agricultural investment projects and programmes. It is intended for national and international staff and consultants, as well as government staff involved in mobilizing investment for agriculture and rural development, mainly through assistance to project or programme identification, formulation and supervision. It is meant to apply to investment projects or programmes in agriculture and rural development (agriculture in the broad sense, including fisheries, livestock and forestry). It can also be used for stand-alone climate change projects or programmes; however, for most stand-alone climate change projects/programmes, there

are specific guidelines provided by their funding agencies and other development partners.

This guidance document will help a project/programme team (PT)[3] to:

- increase its awareness and understanding of the basics of climate change adaptation and mitigation in the agricultural sectors;
- identify the relevance of climate change to a proposed agricultural investment project/programme;
- identify and use key tools, information sources and methods for climate change adaptation and mitigation in agricultural sectors (to address both technical and institutional aspects); and
- incorporate climate change considerations into every stage of the project/programme cycle (i.e. project/programme conceptualization, preparation, supervision[4] and evaluation) by:
  - conducting a rapid impact assessment of impacts of climate variability and climate change on agriculture (and people) in the project/programme area;
  - understanding and using climate data sources in project/programme formulation, including national and project/programme area information on climate change vulnerability and impact assessment;
  - identifying mitigation and adaptation options and good practices (and selecting related measures, when applicable); and
  - understanding and using specific indicators to measure progress and achievement of climate change-related project/programme activities and results.

This publication is not intended to be a training manual, but rather a guidance document with:

- references to information (e.g. documents, tools and information systems) available in FAO and other agencies (mainly multilateral partners) which is relevant to agricultural and rural development projects or programmes; and
- guidance on rapid assessments, possible options and good practices for mitigation, adaptation and disaster risk management (DRM).

The main focus is on project/programme formulation (i.e. identification and design), although some aspects of supervision and evaluation will also be presented.

The document is organized as follows:

- Chapter 2 describes the basics of climate change adaptation and mitigation in the agricultural sectors.
- Chapter 3 suggests approaches and procedures for incorporating climate change considerations into all project/programme stages: conceptualization, preparation, supervision and evaluation.
- Chapter 4 briefly describes some options for financing climate change activities.
- Annexes offer summary information and pointers/links to more substantial documents:
  - Annex 1: General questions and detailed guidance, including cross-references to other annexes and a list of sources of useful information
  - Annex 2: Practical guidance on how to identify relevant data and conduct rapid assessments of impacts of climate variability and climate change on agriculture in the project/programme area[5]
  - Annex 3: A list of tools and information sources that have been recently developed by FAO and other partners for climate change adaptation and mitigation in agricultural sectors
  - Annex 4: Options and examples of good practices for climate change adaptation and mitigation
  - Annex 5: Options and examples of good practices for disaster risk reduction (DRR)
  - Annex 6: An illustrative list of climate change-related indicators
  - Annex 7: A list of finance options for climate change activities

3 A project/programme team is usually comprised of international and national consultants, government staff and the project/programme staff. Some international financing institutions (IFIs) are also included on project/programme teams, as well as civil society representatives, notably representative members of producer organizations.

4 This document does not include guidance for incorporating climate change during the implementation phase of agricultural projects or programmes; rather, it provides guidance on how to supervise climate change aspects of their implementation.

5 Annex 2 is meant to be a stand-alone annex. The idea is to keep it as part of the document so that readers can obtain all the necessary information in a single integrated document.

Chapter 2 - Adaptation and mitigation in the agricultural sectors

Basic elements

An ecosystem approach for climate-smart agriculture

Development partners widely accept that climate change adaptation and mitigation in the agricultural sectors should follow the framework of integrated planning at the ecosystem level in order to capture the synergies and manage the trade-offs among food s ecurity, sustainable development, environmental sustainability and climate change adaptation and mitigation (see FAO 2009b, 2011d, 2011f; Branca *et al.* 2011; McCarthy *et al.* 2011).

Agricultural sectors or systems are connected to each other through their common linkage with natural resources. Interventions in one sector or system may have implications for others: upstream water diversion may affect downstream water users; agriculture development may have environmental implications; and bioenergy development may affect food production. The top priority of the agricultural sectors in developing countries is to increase productivity to improve food security and rural livelihoods, and this often involves interventions aimed at infrastructure improvement, sustainable nature resources management, technical innovations and capacity development. Integrated planning ensures that different interventions in individual sectors or areas are consistent with one another. The objective of integrated planning at the ecosystem level is to maximize the synergies and minimize the trade-offs, while maintaining ecosystem functions and services, through proper planning and auditing of natural resources. Tools and methods which can be applied for an ecosystem approach include sustainable land management (SLM), integrated water resources management, integrated mountain development and integrated ecosystem management.

Synergies may be captured at different levels (see Table 1). There may be opportunities for introducing "win-win" options which can benefit both food security and climate change adaptation or mitigation, and also opportunities for introducing "triple-win" options which can benefit all three objectives. A list of synergic options are illustrated and described in Annex 4. "Triple-win" options are also called options for "climate-smart agriculture" (CSA),[6] which is defined as "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation) and enhances achievement of national food security and development goals".[7] For developing countries highly dependent on agriculture and with a large share of food insecure people in the agricultural sector, the main objective of climate smart agriculture is to improve food security, making adaptation of production systems a fundamental necessity. In this context, opportunities for mitigation should be considered as an additional objective that could potentially be financed by external mitigation funding sources (FAO, 2011f).

In formulating agricultural investment projects/programmes, opportunities for capturing the synergies should be fully investigated and explored. When trade-offs occur in agriculture-based countries, the clear priority is to increase productivity to improve food security; climate change adaptation improves longer-term stabilization and improvement of food security, and climate change mitigation comes as a co-benefit.

6 FAO (in partnership with other agencies) is currently preparing a CSA Sourcebook which covers CSA practices, finance and policies. It is expected to be published by the end of 2012.

7 FAO. Climate-smart agriculture policies, practices and financing for food security, adaptation and mitigation, 2010.

Table 1:
Capturing the synergies[8]

	Increased productivity	Increased resilience	Reduced GHG emissions
Win-win adaptation	√	√	
Win-win mitigation	√		√
Climate-smart agriculture	√	√	√

Source: Adapted from FAO, 2011d

Capturing the synergies among food security, climate change adaptation and mitigation through integrated planning at the ecosystem level will also ensure consistency with the requirements of Greening the Economy with Agriculture (GEA).

The GEA concept suggests aiming to increase food security (in terms of food availability, access, stability and utilization) while using fewer natural resources by improving efficiency, resilience and equity throughout the food value chain, in order to contribute towards the development of a global green economy. Its overall strategy is to apply an ecosystem approach to agriculture, fisheries and forest management in a manner that addresses the multiplicity of social needs and desires, without jeopardizing the options for future generations (http://www.fao.org/rio20). There is no blueprint for CSA; the specific contexts of countries and communities would need to shape how it is ultimately implemented (FAO, 2011f, lesson 3). Indeed, the impacts of climate change vary by region, as summarized in Table 2.

8 For examples of synergies in crop production, see FAO Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production (FAOb, 2011): http://www.fao.org/ag/save-and-grow/

Table 2:
Overview of selected possible regionalized impacts of climate change

	Agriculture	Forestry	Fisheries and aquaculture
Asia and Pacific	• Freshwater availability in Central, South, East and Southeast Asia is likely to decrease. • Temperature increases will lead to a substantial increase in demand for irrigation water for sustained productivity in arid and semi-arid Asia and South and East Asia. • Land suitable for crop cultivation is expected to increase in East and Central Asia, but decrease in other areas, especially in South Asia. • Crop yields could increase in East and Southeast Asia, while they could decrease in Central and South Asia, even considering the fertilization effects of carbon dioxide (CO_2). • There will likely be a northward shift of agricultural zones. • Heat stress and limited pasture availability would limit the expansion of livestock numbers.	• Forest expansion and migration are affected, and biodiversity is threatened by land use, land cover change and population pressure in most of Asia. • In North Asia, forest growth and northward shift in the extent of boreal forests is likely. • The frequency and extent of forest fires and the risk of invasive species, pests and diseases in Asian forests are likely to increase. • Risks for the Pacific include: increased incidence, intensity and impact of extreme weather events such as inundation, storm surge, erosion and other coastal hazards; loss of mangrove forests; severe flooding and cyclones; and increased invasion by non-native species.	• Sea-water intrusion is likely to increase the habitat of brackish water fisheries, but coastal inundation is likely to have serious effects on the aquaculture industry and infrastructure, particularly in heavily populated mega deltas. • Increased frequency of El Niño would cause a general decline in fishery production in the coastal waters of East, South and Southeast Asia. • Warming may make the Arabian Sea more productive. • Small island developing states (SIDS), highly reliant on fisheries and highly exposed to the changes, will probably suffer most.
Europe and Central Asia	• Countries in the more temperate and polar regions are likely to benefit from climate change. • Countries in mid-latitudes will benefit at first but will begin to be negatively affected if temperatures rise by more than 2.5ºC. • The combination of temperature rise and increasing CO_2 concentration will result in slightly positive agricultural development in southeastern Europe, while the Mediterranean area and southwest Balkans will suffer. • Central Asia, dependent on irrigation and with high inter-annual variations in yields, can be affected by climate extremes and a decrease in water availability. • Cattle and small livestock could suffer from increasing heat stress and spread of diseases.	• In northern Europe, the area of tree species' native occurrence will grow and shift northwards. • In the Mediterranean area, forest ecosystems or individual species will start to contract. • The tree species structure will change, e.g. shrubs may increasingly dominate trees in southern Europe.	• Warm water species are likely to spread to the north, with local extinctions occurring at the boundaries. • Higher winter temperature can increase growth, but also cause greater risk of diseases. • Marine productivity is likely to increase in temperate areas.

Near East	• Maize yields in North Africa would suffer first with rising temperatures, followed by yields in western Asia and the Middle East. • Water availability would decrease in most of the region, although it may slightly increase in some areas such as most of Sudan, Somalia and southern Egypt. • Temperature increase may lead to increased pasture production in mid-latitudes, with increases in livestock production. • Warmer winters may benefit livestock, while greater summer heat stress can have negative effects.	• A depletion of soil moisture may cause the productivity of major forest species to decline, increase fire risk and change the patterns of the region's main pests and diseases. • The severe water shortages due to decreasing summer precipitation in western Asia will affect forest growth. • Some countries already have experience in afforestation, using sewage water for irrigation, which will counteract negative effects of climate change.	• Many basins in the region already suffer from lack of water (Mediterranean, Near East), and the usable net water resources are still likely to decline. • In the Mediterranean, there will be changes in fish populations, recruitment success, trophic interactions and migratory patterns of fish populations.
Africa	• The number of extremely dry and wet years is expected to increase in sub-Saharan Africa during this century. • Drying in the Mediterranean area and in much of southern Africa is expected. • There may be an increase in East and West African rainfall. • Some areas, such as the Ethiopian highlands, could benefit from a longer growing season. • Rangeland degradation and more frequent droughts may lead to reduced forage productivity and quality, particularly in the Sahel and southern Africa.	• Mangrove forests protect coastal zones from storms and floods and forests in general regulate water flows and reduce flooding. • Through its impact on forests, climate change also will affect wildlife, bush meat and non-timber forest production, which are important for food security in several parts of Africa. • Availability of water rather than increases in temperature will affect forest growth in Africa. • African forests will generally face deforestation, degradation, increased forest fires and major changes, e.g. in mountain ecosystems.	• Sea level rise poses a threat to coastlands, lagoons and mangrove ecosystems, especially on eastern and western shores of Africa. • Changes in coastal ecosystems and delta areas, such as destruction of coral reefs, will have direct effects on the productivity of fish stocks. • Productivity of the East African lakes could decline. • Temperature increases as such may not affect pond aquaculture in the tropical regions, but the availability of water may become an issue.
Latin America and Caribbean	• In temperate zones, such as southeastern South America, yield of certain crops (such as soy and wheat) will increase. • As a result of increased thermal stress and drier soils, productivity in tropical and subtropical regions is expected to decline. • In arid zones, such as central and northern Chile and northeastern Brazil, the salinization and desertification of agricultural land will possibly increase. • Rainfed agriculture in semi-arid zones will face increasing risks of losing crops. • In temperate areas, pasture productivity may increase, benefiting livestock production.	• Tropical forests are probably affectedmore by (i) changes in the availability of water in the soil and (ii) CO2 fertilizationthan by temperature changes. • There will be a tendency towards "savannization" of eastern Amazonia. • A high risk of forest loss is suggested for Central America and Amazonia, and more frequent wildfires are possible in Amazonia. • More runoff is suggested in northwestern South America, and less runoff will occur in Central America. • Mangrove areas will likely be under threat in several parts of the Caribbean and Central and South America.	• More frequent storms, hurricanes and cyclones will affect aquaculture and fishing in coastal communities, especially in the Caribbean area. • Availability of water for some aquaculture production technologies may be affected by retreating glaciers in some areas of the Andes. • Distributions of some fish species in the tropical and subtropical seas may change southwards. • Primary production in the tropical Pacific may decline because of increased stratification and decreased nutrient supply.

Source: compiled from IPCC, 2007b, for the FAO-Adapt, 2011

Adaptation and mitigation options

Climate change adaptation

Climate change affects agricultural sectors and food security in many ways that vary by region.[9] While farmers in some regions may benefit temporarily from the effect of CO_2 fertilization, longer growing seasons and higher yields, the general consequences of climate change are expected to be adverse, particularly for the poor and marginalized. Climate change affects vulnerable people differently, according to, for example, their gender, age, health or education.[10] People and communities living in fragile environments, such as drylands, mountain areas and coastal zones, will be particularly affected.

Climate change adaptation refers to adjustments in natural or human systems – in response to actual or expected climatic stimuli or their effects – which moderate harm or exploit beneficial opportunities. Proper adaptation can significantly mitigate the negative impacts of climate change and promote the positive ones. Adaptation aims to reduce vulnerability to the impacts and risks of climate change, and to make sure that development initiatives do not inadvertently increase vulnerability. Vulnerability is defined as the degree to which a system is susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes. It is a function of exposure, sensitivity and adaptive capacity (IPCC, 2007):

- ***Exposure*** refers to people, property, systems or other elements present in hazard zones that are subject to suffering potential losses.[11]
- ***Sensitivity*** is the degree to which a system can be affected by climate variability or change.[12] It is determined in part and where relevant by development status.
- ***Adaptive capacity*** is the ability of a human or nature system to adjust to climate change to moderate potential damages, to take advantage of opportunities or to cope with the consequences.[13]

Climate change adaptation can be enhanced by altering exposure, reducing sensitivity and increasing adaptive capacity. Table 3 illustrates some options in each category.

9 FAO's Framework Programme on Climate Change Adaptation (FAO-Adapt) provides detailed analysis about climate-change impacts on different agricultural sectors and food security dimensions. More information is available in the documents listed in **Annex 4**.

10 FAO-Adapt (FAO.a., 2011)

11 UNISDR, Terminology on Disaster Risk Reduction, 2009

12 IPCC, the Fourth Assessment Report, Contribution of Working Group I, Appendix I: Glossary, 2007

13 IPCC, the Fourth Assessment Report, Contribution of Working Group II, Appendix I: Glossary, 2007

Table 3:
Options for climate change adaptation in the agricultural sectors

Altering exposure	Reducing sensitivity	Increasing adaptive capacity
• Assess impacts and map hazard zones • Conduct proper land and water-use planning • Protect watersheds and establish flood retention zones • Resettle humans and restructure agriculture • Change cropping patterns	• Develop or adopt suitable crop, plant and animal varieties • Improve irrigation and drainage systems • Enhance soil nutrition and on-farm water management • Diversify cropping and agricultural activities • Adopt disaster-prevention construction standards	• Develop adaptive strategies and action plans • Diversify sources of household income • Improve water and other infrastructure systems • Establish disaster and crop insurance schemes • Promote technical transfer and capacity building

Adaptation processes need to be location- and context-specific, integrated and flexible. Farmers, forest-dependent people and fishers possess indigenous knowledge which can be a valuable entry point for localized adaptation, such as locally adapted crops, fish and livestock, farming systems, soil, water and nutrient management methods, agroforestry and vegetation fire management systems. Nevertheless, indigenous knowledge needs to be complemented by scientific know-how in efforts to address complex and long-term problems caused by climate change. This can include conducting local impact and vulnerability assessments and engaging and working with stakeholders to develop institutional capacity and identify, evaluate, prioritize and select adaptation options and tools. Annex 2 introduces a detailed approach and methods for conducting rapid climate change impact assessments.

Climate change adaptation seeks ways to deal with various risks induced by climate change, such as increases in temperature and sea level, melting of glaciers, increased frequency and intensity of extreme weather events, alteration of available land and water resources, shifts in cropping zones and changes in pest and disease patterns. Risk management can plan an important role in the process. The United Nations International Strategy for Disaster Reduction (UNISDR) defines risk management as the systematic approach and practice of managing uncertainty to minimize potential harm and loss, consisting of risk assessment and analysis and the implementation of risk control, reduction and transfer.[14] Various methodologies and tools have been developed to focus on DRR. Some information sources are listed in Annex 3.

In developing countries, short-term challenges, including immediate climate risks, are often so great that long-term climate risks cannot be given sufficient attention. Designing responses that acknowledge both short and long-term food security usually requires parallel processes – phased and iterative planning alongside the introduction of short and long-term measures. Because of the uncertainty of climate-change impacts and limited national and local capacities, reliable data and information may not be available at the local level for impact and vulnerability assessments. When it is not possible to make localized projections of climate-change impacts, FAO favours the "no-regrets approach", which assumes that adaptive practices and actions will be beneficial even if future impacts are not certain and climate change threats do not occur exactly as anticipated (FAO, 2009).

Climate change mitigation

Climate change mitigation means implementing policies to reduce GHG emissions and enhance carbon sinks[15], and the agricultural sectors have great potential in these areas. Agriculture has the technical potential to mitigate between 1.5-1.6 GtC eqv/yr (5.5–6 Gt of CO_2 eqv./yr (IPCC 2007)) by 2030, mainly through soil carbon sequestration in developing countries, while the biophysical mitigation potential of forestry is estimated to average 1.5 GtC eqv./yr (5.4 Gt CO_2 eqv./yr (IPCC 2001)) up until 2050. About 70 percent of the mitigation potential in the agriculture sectors

14 UNISDR, Terminology on Disaster Risk Reduction, 2009.

15 IPCC, the Fourth Assessment Report, Contribution of Working Group II, Appendix I: Glossary, 2007.

Table 4:
Options for climate change mitigation in the agricultural sectors

Reducing emissions	Avoiding or displacing emissions	Removing emissions
• Increase feed-use efficiency to reduce CH_4 emissions • Increase fertilizer and water-use efficiency • Reduce emissions from deforestation and forest degradation (REDD) • Decrease fishmeal use and reduce excess fishing capacity • Lower post-harvest losses and increase waste recycling	• Replace fossil fuel energy with bioenergy from wood, agricultural feed stocks and residues • Improve energy use efficiency in the agricultural sectors • Undertake forestry conservation activities to help avoid emissions • Substitute materials with wood products	• Practise afforestation, reforestation and forest restoration • Engage in sustainable forest management (SFM) • Improve cropland and grassland management • Engage in agroforestry • Restore degraded land

exists in developing countries. Without realizing a substantial part of this potential, climate change mitigation targets cannot be met.[16] Climate change mitigation in the agricultural sectors can be realized by:

- reducing emissions through efficient management of carbon and nitrogen flows;
- avoiding or displacing emissions by improving energy use efficiency or replacing fossil fuel energy with clean energy; and
- removing emissions by enhancing soil carbon sequestration above and below the ground[17] and reducing deforestation and forest degradation.

Table 4 presents some options.

Agriculture mitigation practices (e.g. crop and grazing land management, agroforestry and restoring cultivated organic soils) generate great additional benefits for smallholders, such as increasing their productivity, household food

16 Ibid.

17 Smith, P, D., Martino, Z., Cai, D., Gwary, H., Janzen, P., Kumar, B., McCarl, S., Ogle, F., O'Mara, C., Rice, B., ScholesO. Sirotenko, 2007: Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

security, resilience and ecosystem services. Because these synergies differ across localities, it is necessary first to identify where the synergies and potential trade-offs may occur, considering the possible implications of bioenergy development for food security and poverty reduction.

A major challenge is to design financing mechanisms to remunerate environmental services in smallholder agriculture. These mechanisms need to offer an incentive for providing and safeguarding ecosystem services such as watershed protection, carbon sequestration and biodiversity provision. For smallholders to be able to participate and benefit from financial rewards and adopt mitigation practices, mechanisms need to cover up-front investment costs. Proper monitoring, reporting and verification (MRV) models need to be developed to aggregate the mitigation reductions across smallholders in order to reduce monitoring and transaction costs.

Some agencies advocate using a life cycle assessment (LCA) approach to monitor the carbon footprints of agricultural production systems along the food chain and value chain. This approach is currently being used in the environment sector to identify, understand and reduce the environmental impacts of material inputs throughout the entire life cycle of a product, technology or process. In an agricultural investment programme, GHG mitigation gains realized in one area may be lost in other areas. For example, gains from reforestation interventions may be lost because of the need to use many vehicles to monitor and manage forests; gains from increased water-use efficiency as the result of introducing pressurized irrigation may be offset by the increased use of industrial products and fossil fuel energy. Therefore, to assess and reduce the overall carbon footprint of investment programmes, it is necessary to conduct whole programme carbon-performance evaluation. FAO developed a carbon-balance analysis tool which could be used to make *ex ante* estimations of the impact of agriculture and forestry development projects/programmes on GHG emissions and carbon sequestration, indicating the effects on the carbon balance (FAO EX-ACT Webpage, 2011).

Good practices

This section provides a brief introduction to some widely accepted practices in the agricultural sector for climate change adaptation and

Table 5:
Good practices and concepts for climate change adaptation and mitigation

Agricultural sector/subsector good practices and concepts	Adaptation	Mitigation	Climate-smart agriculture
Crop			
Conservation agriculture	x	x	x
Integrated pest management	x	x	x
System for rice intensification	x	x	x
Livestock			
Improved pasture management	x	x	x
Improved grazing management	x	x	x
Improved manure management	x	x	x
Forestry			
Agroforestry	x	x	x
Sustainable forest management	x	x	x
Afforestation, reforestation and forest restoration	x	x	x
Fishery			
Decreased use of fish meal and fish oil feeds		x	
Reduced excessive fishing capacity		x	
Species diversification	x		
Land management			
Sustainable land management	x	x	x
Improved crop and grassland management	x	x	x
Restoration of degraded lands and organic soils	x	x	x
Water management			
Irrigation modernization	x	x	x
Rainwater harvesting	x	x	x
Cross-sector			
Efficient energy use	x	x	x
Reduced post-harvest losses and waste recycling	x	x	x
Disaster risk management	x		
Adoption of suitable crop, plant and animal varieties and strengthening of seed systems	x		

mitigation, including conservation agriculture, integrated coastal zone management (ICZM), agroforestry, rainwater harvesting, improved rice cultivation, irrigation modernization and rangeland management. Detailed information is provided in Annex 4, while Table 5 illustrates some typical examples of good practices.

Conservation agriculture

Conservation agriculture is an approach to managing agro-ecosystems to improve and sustain productivity and increase profits and food security while preserving and enhancing the resource base and the environment.[18] It has been

18 FAO Conservation Agriculture Web site: http://www.fao.org/ag/ca/1a.html

adopted in large areas in Brazil, China and North America, among other places, and is characterized by three linked principles: (1) continuous minimum mechanical soil disturbance; (2) permanent organic soil cover; and (3) diversification of crop species grown in sequences and/or associations. It can enhance soil and water conservation, increase crop tolerance to climate variations, stabilize and improve agriculture productivity, reduce use of fossil fuel and mineral fertilizer, mitigate GHG emissions and minimize run-off and soil erosion. Major disadvantages are the high initial costs of specialized planting equipment and the new dynamics of farming systems, which require advanced management skills and a learning process.

Integrated coastal zone management

ICZM is an integrated approach for managing the coast, including geographical and political boundaries, in an attempt to achieve sustainability. The concept of ICZM was born in 1992 during the Earth Summit in Rio de Janeiro, and it is set out in the proceedings of the summit within Agenda 21, Chapter 17. In near-coastal areas, ICZM calls for considering the needs of fisheries, and marine species in general, when designing coastal zone management plans or specifications to cope with a changing climate. For example, if coastal protection measures against a rising sea include coastal dams, there can be no inland movement of beaches and marshes which are critical to many species' reproduction. Careful planning is necessary to meet the needs of marine life and coastal infrastructure and agriculture.

An ecosystem approach to fisheries and aquaculture

Implementing an ecosystem approach to fishery and aquaculture can help to respond more effectively to expected changes in water surface temperature, pH levels, sea levels and extreme events and to improve the resilience of aquatic ecosystems and fisheries production systems. In the mean time, implementing an ecosystem approach can reinforce the sector's move to environmentally friendly and fuel-efficient fishing, mainly through energy conservation across the fishery and aquaculture supply chain (e.g. including the subsectors of catching, producing, farming, processing, packaging and distributing) and also with the consumption and disposal of fishery products, while reducing

possible negative impacts on aquatic systems, such as mangroves and seagrasses. Carbon sequestration potential can be better exploited, such as by enhancing carbon management in semi-intensively managed pond aquaculture (e.g. fish farming) – which constitutes one of the most widespread farming systems in Asia – and by replanting mangroves in many aquaculture and fisheries areas around the world. Enhanced carbon retention (although not carbon burial) and capture in coastal ecosystems could be achieved by conducting extractive aquaculture operations with seaweeds and filter feeders (e.g. molluscs). Cultivating seaweed can enhance primary production in coastal waters and contribute to carbon sequestration.[19]

Sustainable forest management

Sustainable forest management is enabled by policies, laws, institutions and practices that ensure the stewardship and use of forests and forest lands in a way that maintains forest biodiversity, productivity, regeneration capacity, vitality and potential to fulfil, now and in the future, ecological, economic and social functions at local, national and global levels. Forest policy-makers have to address trade-offs between production and conservation objectives; cater to intergenerational equity; and make sure that forests provide ecological, economic and social benefits. Sustainably managed forests can potentially store up to one-tenth of the global carbon emissions projected for the first half of this century.[20]

Around 350 million people are considered to be highly dependent on forests (World Bank 2008), and therefore sustainable forest management will play a core role in poverty reduction as well.[21] Forest management therefore has profound political, environmental, economic and social implications. In addition to the other objectives of forest management, forest policy-makers and managers need to consider their role in helping forests and forest-dependent people adapt to new conditions created by climate change and in enhancing forests' contribution to climate change mitigation. Improved forest management practices for climate change mitigation and adaptation

19 FAO 2011. Fisheries and aquaculture in our changing climate. COFI Working Paper 6

20 FAO Forestry and climate change Web site: http://www.fao.org/forestry/climatechange/53459/en/

21 http://siteresources.worldbank.org/EXTFORSOUBOOK/Resources/01-FSB-Ch01.pdf

would best be planned and implemented in tandem, as they are closely linked. (FAO 2011: Managing Forests for Climate Change).

Agroforestry

The World Agroforestry Centre (ICRAF) defines agroforestry as a collective name for land-use systems and technologies where woody perennials (e.g. trees, shrubs, palms, bamboos) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence (ICRAF, 1993). Agroforestry systems have great potential to diversify food and income sources, improve land productivity and stop and reverse land degradation through their ability to provide a favourable microclimate, supply permanent cover, improve organic carbon content, improve soil structure, increase infiltration, decrease soil erosion and enhance fertility and biological activity of soils. A wide variety of agroforestry systems are found throughout the world, including tree crops, orchards (i.e. fruit trees), home gardens, boundary plantings, on-farm timber or fuelwood lots, shelterbelts, parkland systems, multistrata forest gardens, mixed tree and livestock systems, alley croppings and shifting cultivation. The World Bank (2008) estimates that 1.2 billion people are dependent on agroforestry throughout the world.[22]

Rainwater harvesting

Rainwater harvesting refers to all technologies where rainwater is collected to make it available for agricultural production or domestic purposes. A rainwater harvesting system usually consists of three components: (1) a catchment area which produces runoff; (2) a conveyance system through which the runoff is directed (e.g. bunds, ditches or channels); and (3) a storage system where water is accumulated or held for use (e.g. in soil, pits, ponds, tanks or dams). A special form of rainwater harvesting is *in situ*, which enables the soil to completely infiltrate rainfall through deep reaching vertical biopores; this results in only marginal surface runoff.

Rainwater harvesting is applicable in humid, semi-humid and semi-arid areas with common seasonal droughts. In an extreme form, rainwater harvesting can be used in arid regions to concentrate the rainfall from a larger surface area to obtain

22 Ibid

sufficient water to grow a crop on a smaller area. It is mainly used for supplementary watering of cereals, vegetables, fodder crops and trees, but also provides water for domestic and stock use and sometimes for fish ponds. Rainwater harvesting can increase water availability, reduce risk of production failure, enhance crop and livestock productivity, reduce soil erosion, improve groundwater recharge and enhance carbon sequestration above and below ground.

Improved rice cultivation

Rice is grown in more than 100 countries as the staple food for more than half of the human population. Traditional rice production systems are a major contributor to GHG emissions. Improved rice cultivation, through the combination of breeding new varieties, using fertilizer efficiently, alternating wet and dry irrigation and properly using crop residues, can reduce GHG emissions while increasing productivity and building climate resilience.

The system of rice intensification (SRI) is a methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. It involves careful planting of young seedlings, keeping the soil moist but well-drained and well-aerated and adding compost or other organic material to the soil as much as possible. During the past ten years, this methodology has been adopted in many countries and has shown good results in increasing rice yield while reducing the needed quantity of seeds, irrigation water and chemical fertilizers and pesticides. Further improvements can be achieved by combining SRI with conservation agriculture, in which the SRI agronomy is applied on no-till land with residue retention and no flooding. The rice crop is irrigated to field capacity only, maintaining, as in SRI, aerobic soil conditions.

Irrigation modernization

Water is the primary medium through which climate change influences the earth's ecosystems, agriculture production and people's livelihoods. Adaptation to climate change is mainly about better water management, and in the agricultural sectors, irrigation modernization is considered a good option. Irrigation modernization aims to improve resource utilization and water delivery service to farmers by upgrading the technical and managerial

aspects of irrigation schemes and making institutional reforms.[23] It highlights the need for systematic strategies to address institutional, physical and technical issues coherently through participatory approaches. The concept, technologies and tools have been disseminated and piloted in many countries in recent years, especially in Asia, and have proven to be effective in building climate resilience in agriculture water management and increasing resource use efficiency, especially water productivity. Combining this technical approach with water-saving crop and land management concepts, such as conservation agriculture, leads to further increases in efficiency.

Grazing land management

Degraded or overgrazed land can be restored to produce more biomass by selectively planting grasses, adding phosphate fertilizers and alternating grazing with rest periods for the land. Increased biomass productivity enhances soil cover, increases moisture availability and increases the overall amounts of stable organic matter in the soil. These will benefit livestock production and herders' livelihoods while decelerating grazing land desertification.

Core principles

In addition to integrated planning at the ecosystem level and mainstreaming climate change considerations into development activities, some core principles on climate change adaptation and mitigation in the agricultural sectors have been identified by various stakeholders.

Focus on food security

Climate change is likely to severely threaten people's ability to achieve food security, and thus it will impact the international community's ability to achieve its foremost Millennium Development Goal (MDG1) to reduce extreme poverty and hunger. In agriculture-based countries, where agriculture is critical for economic development, increasing productivity to achieve food security is clearly a priority, and that is projected to entail a significant increase in emissions from the agricultural sectors in developing countries (IPCC 2007).[24] Therefore, climate change adaptation

23 FAORAP, the future of large rice-based irrigated systems in Southeast Asia, Bangkok, 2007.

24 Ibid

in the agricultural sectors will focus on actions which can reduce vulnerability and ensure food and nutrition security.

Smallholder farmers, forest dwellers, herders and fishers who are already food insecure will be the most affected. It is therefore imperative to provide more targeted financial and technical assistance to the most vulnerable groups. Another focus of adaptation measures is to ensure environmental sustainability (MDG7), which is essential to achieving food security and poverty alleviation over the long term. Food security will be difficult, if not impossible, to achieve in most countries suffering from natural resource degradation. Many examples of such adaptation measures are found in the forest sector, such as watershed protection, agroforestry for more stable, diversified farming systems and forest protection of coastal areas and inland waterways.

Support a country-driven process

Mainstreaming of climate change considerations into agriculture and rural development activities largely depends on local awareness, political willingness, obligations within global climate change frameworks and technical and economic conditions. Climate change adaptation and mitigation interventions must be formulated and implemented in response to a country's specific demands and needs and must be in line with national and local climate change strategies and action plans, especially National Adaptation Programmes of Action (NAPAs) and Nationally Appropriate Mitigation Actions (NAMAs).

Design participatory, gender-sensitive and local activities

Climate change is global, but its impacts are individual. Interventions for climate change adaptation and mitigation must be tailored to specific local conditions to ensure their relevance and effectiveness. Multi-stakeholder consultations are needed to jointly prioritize options and make decisions. It is therefore important to adopt demand-driven, location-specific approaches and participatory modalities that consider gender-specific vulnerabilities, needs and capabilities as well as the priorities of indigenous people and vulnerable communities.

Proper social analysis enables planners and practitioners to put the human dimensions

– stakeholders, target groups, intended beneficiaries or other affected people – at the centre of development interventions. Various manuals and user guides on social analysis are already available. In 2011, FAO developed three guides – a Manager's Guide, a Practitioner's Guide and a Field Guide – in the series "Social analysis for agriculture and rural investment projects". These guides can be used by project/programme practitioners to help design and implement participatory, gender-sensitive and local-specific climate change-related activities.

Build partnership among stakeholders
Good partnership among stakeholders helps to build joint efforts towards climate change adaptation and mitigation. Partnerships could be built among governments departments, the UN system, international and national research institutions, donor agencies, civil society and the private sector. Within the UN system, available partnership platforms include the "Delivering as One" UN initiative in pilot countries and the UNDAF.

Support transboundary collaboration
Transboundary collaboration is already required when countries address ecosystem approaches, shared resources (e.g. fish stocks) and climate-change impacts (e.g. pests and diseases, water shortages, rising seawater levels and melting glaciers). Interdependence and collaboration will become even more important because countries will need to access genetic resources to adapt to new climatic conditions. Some good examples of this are national and regional cooperation networks established in recent years to manage natural disasters, control animal and plant diseases and monitor food risks.

Priority areas

Even though climate change interventions vary for different types and locations of agriculture and rural development activities, there are some common high-priority issues that need to be addressed in developing countries.

Data and knowledge generation and sharing
To conduct scientific planning and make informed decisions, it is necessary to have reliable data and information on climate-change impacts, local vulnerability and GHG emissions from different production and agro-ecosystems; however, needed data and information often are not available at local or national levels. This can be remedied by improving relevant data monitoring and processing systems; adopting suitable methodologies and technologies for climate change modelling and downscaling; and applying practical methods and tools for impact and vulnerability assessments. Where it is not feasible to generate localized data and information for technical or financial reasons, alternative options could be explored to share climate modelling information through subregional or regional cooperation or to use reference data and information from neighbouring areas or countries. It is also important to collect and analyse socio-economic information for different climate change adaptation and mitigation interventions.

Institutions, policies and financing for capacity development
Coping with climate change in the agricultural sectors requires adjusting institutional structures and arrangements. This includes defining adequate national policy and legislative frameworks and assigning and coordinating responsibilities within the governance structures of countries and regions. Agriculture is currently excluded from the major global climate financing mechanisms; a few financing windows are available mainly for mitigation. As a result, it is necessary to have innovative financing mechanisms and investment policies to support agriculture, reward synergistic actions and address specific needs of smallholder farming. Proper mechanisms are needed to: (1) realize iterative planning through participatory, integrated approaches and strong stakeholder engagement; and (2) better reflect agriculture-related aspects in NAPAs and NAMAs. Institutions and decision-making must remain flexible in order to deal with the uncertainties of potential climate-change impacts.

Sustainable land and water management and biodiversity

Maintaining biological and genetic diversity is necessary for the health and resilience of ecosystems. To maintain and increase the resilience of agricultural systems to climate change, it is crucial to engage in sustainable and adaptive natural resources management, especially land and water resources management. Since the specific threat of climate change is new, the response strategy may require major qualitative changes in natural resource management, not just fine-tuning certain ongoing practices. It is important to better understand and sustain the ecosystem services furnished by agricultural, aquatic and forest biodiversity.

Development and dissemination of technologies, practices and process

Development and dissemination of relevant technologies, practices and processes is urgently needed to improve national and local capacities in developing countries. Crucial technical issues to be addressed include: generating more reliable climate-change models and projections; developing and adopting suitable crop and plant varieties and animal species; strengthening seed systems; efficiently using agriculture inputs; engaging in proper waste management; and conducting MRV of mitigation interventions in smallholder farming. Capacity building should be designed for different groups based on proper needs assessments. The Farmer Field School method is a good approach for capacity development at the community and farmer levels. The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), jointly initiated by FAO, the UNDP and the UNEP, is a good model for sector capacity development.

Disaster risk reduction

DRR is considered to be a good entry point for climate change adaptation in countries suffering from frequent disaster threats and expecting increased frequency and intensity of extreme weather events as a result of climate change. The UNISDR defines DRR as 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 and improved preparedness for adverse events.[25]

A comprehensive approach to reduce disaster risks is set out in the United Nations-endorsed Hyogo Framework for Action (HFA), adopted in 2005. The UNISDR system provides a vehicle for cooperation among governments, organizations and civil society actors to assist in the implementation of the Framework. The FAO Framework Programme on Disaster Risk Reduction (FP DRR) reflects the HFA and strives to assist member states to implement its five priorities for action in the agricultural sectors. It promotes integrated implementation of four major pillars: (i) institutional strengthening and good governance; (ii) information and early warning systems; (iii) preparedness for effective response and recovery; and (iv) prevention, mitigation and building resilience with technologies, approaches and practices.[26] Four cross-cutting priorities are identified, including: capacity development, knowledge management and communication, strategy partnerships and gender equity. Annex 5 introduces the details of DRR framework and options.

25 UNISDR, Terminology on Disaster Risk Reduction, 2009

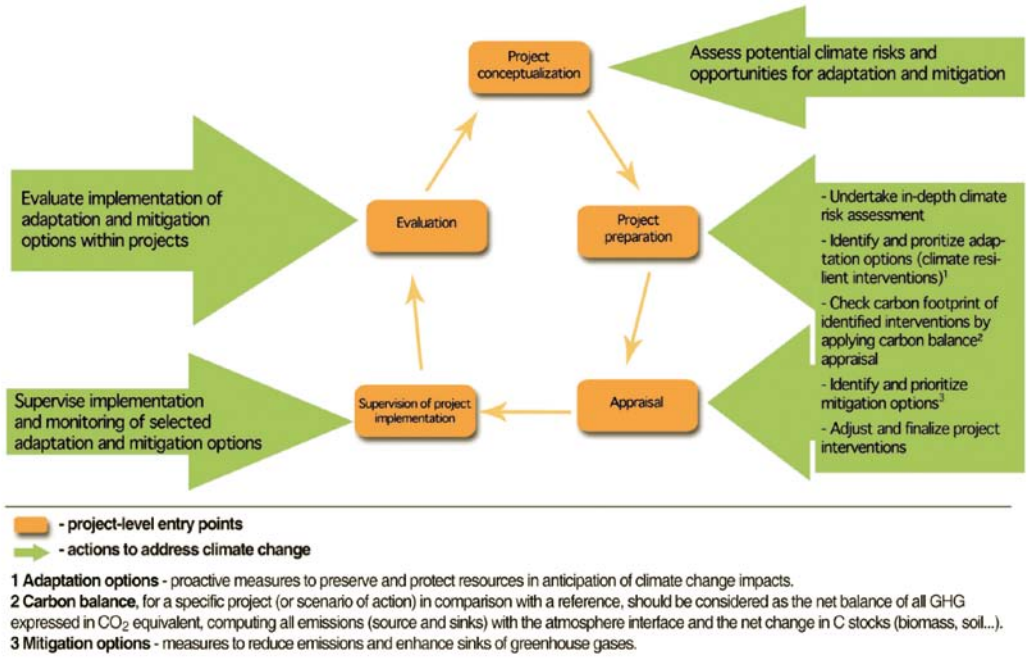
26 Resilient Livelihoods–disaster risk reduction for food and nutrition security–an FAO framework programme, 2011.

Chapter 3 - Incorporating climate change considerations into agricultural investment projects/programmes

Most activities in agricultural investment projects/programmes are rarely designed to specifically address climate change adaptation or mitigation strategies; however, they are often relevant to climate change issues and could be adjusted to enhance climate change-related measures. Even when project/programme objectives do not include climate change adaptation and/or mitigation, steps should be taken to ensure that the project/programme does not reduce the potential to realize climate change objectives in the future.

This chapter details approaches and procedures for incorporating climate change in each of the four commonly recognized phases[27] of the project/programme cycle: conceptualization, preparation, supervision[28] and evaluation (see Figure 1). Table 6 presents a list of relevant questions to consider throughout a project or programme. The entry points presented in this chapter are supported by annexes which include summary information and pointers or links to more substantial documents or Web sites where they are already available.

Figure 1
Incorporating climate change considerations into agricultural development programmes and projects



1 Adaptation options - proactive measures to preserve and protect resources in anticipation of climate change impacts.
2 Carbon balance, for a specific project (or scenario of action) in comparison with a reference, should be considered as the net balance of all GHG expressed in CO_2 equivalent, computing all emissions (source and sinks) with the atmosphere interface and the net change in C stocks (biomass, soil...).
3 Mitigation options - measures to reduce emissions and enhance sinks of greenhouse gases.

27 These phases are often equivalent to the following widely recognized terms: (i) identification (conceptualization stage), (ii) formulation and appraisal or detailed design (preparation stage) and (iii) supervision and evaluation (of implementation).

28 This document does not include guidance for incorporating climate change during "implementation and monitoring" phases of agricultural projects/programmes; rather, it provides guidance on how to supervise climate change aspects during those phases.

Table 6:
Questions to guide incorporating climate change throughout the project/programme

Subject	Question*
A. Questions which are relevant to both the **conceptualization** and **preparation** stages	
A.1Policy aspects and country priorities (applicable to both mitigation and adaptation)	
National and local strategies and priorities	1) Is there any available climate change and DRR or DRM strategy or action plan at the national, subnational or local level? If so, what are the priorities for the agricultural sectors? Which are relevant to the project/programme concept? 2) In least developed countries (LDCs), which priorities have been identified in the NAPAs that are relevant to the project/programme concept? 3) If NAMAs have already been formulated and submitted, which priorities, targets or actions have been included?
A.2 Institutional aspects (applicable to both mitigation and adaptation)	
Stakeholder identification and engagement	1) Which are the major institutions coordinating and implementing climate change-related actions at the national and project/programme levels, and how could they contribute to the project/programme with data and/or specific actions? Are additional efforts needed to ensure coordination? 2) Is a stakeholder consultation process in place, including an appropriate delivery strategy (to be used in the consultation events), that allows capturing key climate change-related issues? 3) Which local stakeholders (e.g. local governments, communities, civil society, producer associations and businesses) could have a key role as project/programme partners?
Barriers, constraints and capacity development needs	1) Which constraints, gaps and related financial, technical and other capacity development needs have been identified at the national and project/programme levels?
A.3. Adaptation	
Impacts of climate change and climate variability on agricultural sectors	1) What are the expected impacts of climate change on the country's agriculture sectors? 2) How can existing data and related assessments on the impacts of climatic variability on agriculture in the project/programme area be identified?Should a rapid assessment be conducted?
Impacts of climate change and climate variability on people	1) How are these impacts affecting the project/programme beneficiaries[1] and other potential stakeholders?
Adaptive capacity of the project/ programme-supported activities	1) How can the project/programme become more climate-resilient (i.e. how can it be improved to increase the resilience of the agricultural systems and livelihoods to climate change impacts)?
Options for disaster risk reduction (DRR)	1) Is there a DRR framework in place to protect beneficiaries' livelihoods from shocks and strengthen their capacity to absorb the impact of, and recover from, disruptive climatic events (when applicable)? If not, how can the project/programme help with that?
A.4. Mitigation	
Impacts	1) What are the possible impacts of the project/programme on climate change in terms of increasing/reducing/avoiding GHG emissions? 2) Which anticipated impacts on climate change could come from improved agricultural systems or from changes in land use? 3) Which other types of project/programme activities (other than production) have a potential impact on the project/programme's carbon balance?
Mitigation potential of the project/ programme	1) Which activities/practices/technologies proposed by the project/programme have mitigation potential? 2) What is the climate change mitigation potential of the project/programme?
Win-win opportunities that include mitigation	1) Based on the project/programme's climate change mitigation potential, are there agricultural technologies and practices which would reduce/remove GHGs (mitigation) and, at the same time, sustainably increase productivity, resilience (adaptation) and enhance achievement of national food security and development goals, or at least two of these?

Subject	Question*
Mitigation options	1) What specific mitigation interventions could be proposed in view of local natural, social and economic conditions in the project/programme areas? 2) How would you prioritize these possible interventions in the order of CSA, win-win options and mitigation interventions, based on the government's willingness?
Funding source	1) Are there any financing sources, in addition to the project/programme fund, that can be used for the identified mitigation opportunities?
B. Questions which arerelevant to the **preparation** stage (i.e. after concept note development)	
Project/programme technical strategy and approaches	1) Has a strategy been defined to respond to climate change issues? 2) Which integrated planning approach is being proposed at the landscape or ecosystem level to ensure the future sustainable development of rural communities in the project/programme area? 3) Is the project/programme seeking to capture synergies and manage trade-offs among food security, climate adaptation, mitigation and sustainable development?
Climate change-related activities	1) Have the climate change-related activities been identified? Should these activities be bundled under a stand-alone climate change component/subcomponent or integrated (mainstreamed) into one or more project/programme components?
Project/programme results framework and monitoring and evaluation (M&E) arrangements	1) Have climate change considerations been incorporated into the project/programme's results framework? Have climate change-related indicators been identified?
Institutional aspects	1) What are the implementation arrangements to ensure that climate change activities will be properly executed?
Governance	1) Is there any governance risk which could jeopardize the implementation of project/programme activities including those related to climate change?
Intersectoral coordination	1) Have intersectoral linkages been properly addressed?
C. Questions which are relevant to the **supervision** stage	
Supervision at project/programme start-up	1) Is consultation with project/programme beneficiaries and partner institutions – including those partners responsible for climate change-related activities – planned for this stage? 2) Which subjects and documents should be reviewed by the supervision team?
Project/programme supervision	1) Were all the climate change considerations (i.e. impact, adaptation and/or mitigation) addressed in project/programme design? If not, are stakeholders raising any climate change issues which could affect the achievement of the project/programme's objective?What can be done to reduce this risk? 2) Have field visits and discussions with relevant institutions (directly or indirectly involved in the implementation of climate change-related activities) been planned? 3) Which climate change-related subjects and documents should be reviewed by the supervision team? What adjustments are needed?
D. Questions which are relevant to project/programme **evaluation**	
Baseline information and baseline survey	1) What should be assessed during *ex ante* evaluation in terms of climate change?
Mid-term review (MTR)	1) What should be assessed during MTR in terms of climate change?
Project/programme completion and final evaluation	1) What could be included in the evaluation to generate lessons learned on achievements related to incorporating climate change considerations in the project/programme?

(*) For each question, Annex 1 provides detailed guidance and a list of useful sources of information.

29 Project/programme beneficiaries are not a distinct group of stakeholders but comprise different categories of people who will likely be affected in different ways.

Project/programme conceptualization stage

Overview

Project/programme conceptualization and the preparation of a concept note represent the initial phase of project/programme design and occur before the project/programme is placed in the financing pipeline of a donor or international financing institution (IFI). In most countries, each donor agency should have an up-to-date country support strategy or programme[30] that includes mutually agreed opportunities to address key national priorities and, in some cases, specific regions of the country. The concept note is prepared to be fully consistent with the existing donor strategy (when available) and the government development strategy for the country. While specifics vary with different IFIs, the main objective at the concept stage is to identify the critical issues, potential underlying causes (or "drivers") and solutions, strategic rationale for the donor agency's involvement and potential project/programme risks. From the donor's perspective, it is crucial to obtain early guidance and agreement on the approach to project/programme preparation and issues that need to be addressed. This an excellent time to begin analysing and incorporating climate change considerations into the project/programme design.

Identifying entry points

The PT, including the project/programme proponent, should identify the main entry points for climate change mitigation and/or adaptation in relevant interventions so that they can be incorporated into the project/programme concept note.[31] The PT can review the illustrative list of possible entry points which is provided in Table 6 and detailed actions which are suggested in Annex 1. During all project/programme stages, the project or programme manager should ensure that all PT members are aware that mitigation and adaptation cannot be achieved with disconnected alternative activities, but require a conceptual systems approach tied into a coherent strategy.

30 In a number of countries, donors and governments aim to increase the harmonization of donor efforts through a Joint Assistance Strategy (JAS).

31 This assumes that a project idea already exists and warrants discussion between the IFI and the client.

The PT should complete a screening of potential climate change issues by addressing two interrelated questions presented in Table 6:

- What are the impacts of climate change and climate variability on agriculture in the project/programme area?
- What are the possible impacts of the project/programme on climate change (i.e. how will the project/programme affect GHG concentrations in the atmosphere in terms of carbon dioxide equivalent (CO_2e)?[32]

Annex 2 offers detailed guidance on how to address these questions. Depending on the level of information available for the project/programme area, it may only be possible at the identification stage to address impact assessment questions in qualitative terms. If this is the case, the PT should try to support activities to collect additional data and information in order to be able to include quantitative aspects in the formulation stage.

Box 1: **Climate change screening**

Climate change screening is a key step in the conceptualization phase. According to the UNDP (2010), climate change screening (often simply termed "climate screening") is "a way of establishing information on the impacts of climate change on development activities, and of how these linkages are or can be taken into account in development activities as well as in the national planning and decision-making processes".

A number of IFIs, other funding sources and potential partners have developed climate change screening methodologies and tools. Examples include the World Bank Climate Change Portal – which contains a mapping visualization tool displaying key climate variables data and a computer-based prototype screening tool for assessment and design for adaptation to climate change (ADAPT) – and the UNDP (2010) "Tools and Guidelines to Mainstream Climate Change Adaptation –A Stocktaking Report", which presents climate risk screening methods, tools and guidance.

Box 2: **Climate risk screening**

Where there is evidence of increasing frequency and/or intensity of extreme weather events in the project/programme area, the screening process should include climate risk screening. Climate risk screening is defined by the Asian Development Bank (ADB) as "analysing project concepts, with a view to identifying:

- whether climate risks have been taken into consideration;
- whether [concepts are] vulnerable to climate change;
- whether plans could lead to increased vulnerability; and
- what steps taken in project design are needed to reduce risks and associated costs."

(ADB, 2009, p. 67)

An illustrative list of references for identifying possible entry points in different agricultural sectors is provided in Box 3. For a more detailed list, see Annex 3 (under its section 2.1)

Climate change mitigation challenges

The following challenges may arise when addressing climate change mitigation during a project/programme identification mission:

Challenge: The client (i.e. government partner or project proponent) is not familiar with or interested in considering mitigation measures as part of project/programme design.
Recommendation: Most countries now have a national strategic framework in place that addresses climate change-related issues. In rare cases, some governmental agencies may not be familiar with these policies, and it can be assumed that there may be a need for more information about how these policy issues can be addressed in their respective sectors. New projects/programmes often represent ideal opportunities to promote the integration of new climate change policies. The PT should analyse, discuss and advise the government on these national policies and how they relate to the proposed project/programme. The PT should describe the possible benefits that could accrue to smallholders and/or other project/programme stakeholders from including mitigation actions.

32 A carbon dioxide equivalent is the unit used to report GHG emissions or reductions. GHGs are converted to CO2e by multiplying emissions by their respective global warming potential (GWP). The CO2e allows for reporting of overall GHG emissions in one standardized value and aids in GHG emission comparisons.

Box 3: **References for entry points in different agricultural sectors**

There are many sources for information on climate change in agricultural sectors. The illustrative list below presents some publications from FAO and its partners by sector.

Crop production
- Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production. FAO, 2011 http://www.fao.org/ag/save-and-grow/
- Food security and agricultural mitigationhttp://www.fao.org/docrep/012/i1318e/i1318e00.pdf

Livestock
- Greenhouse gas emissions from the dairy sector – a life cycle assessment. FAO, 2010 http://www.fao.org/docrep/012/k7930e/k7930e00.pdf

Forestry
- Strategic framework for forests and climate change. Collaborative Partnership on Forests (CPF) http://www.fao.org/forestry/16639-064a7166b1dd027504bbfbb763878af99.pdf

Fisheries
- Fisheries and aquaculture in our changing climate (FAO brochure) ftp://ftp.fao.org/FI/brochure/climate_change/policy_brief.pdf
- Climate change implications for fisheries and aquaculture. FAO, 2009
- See other relevant documents at http://www.fao.org/fishery/topic/13788/en

Agricultural water management
- Climate change, water and food security. FAO, 2011 http://www.fao.org/docrep/014/i2096e/i2096e00.htm

Examples of "win-win" opportunities include: (1) investments that increase organic material to improve land productivity also enhance the ability to sequester CO_2; and (2) integrated crop-livestock production that includes ecological sustainability criteria increases environmental resilience and contributes to climate change adaptation and mitigation.[33]

Challenge: The client is unaware that key agricultural issues addressed by the project/programme will also produce climate change-related benefits (e.g. enhance the ability to sequester GHGs).
Recommendation: When climate change mitigation is a national priority that is described in national policies or strategies and when there is opportunity in the project/programme area, the PT could advise the government about how to capitalize on this opportunity by making climate change mitigation more explicit in the project/programme proposal.[34]

Challenge: The client is interested in introducing climate mitigation solutions, but does not know how best to go about it.
Recommendation: The PT could undertake a number of actions to guide the client, such as applying existing tools (e.g. the FAO EX-ACT Tool) to assess the carbon balance and mitigation potential of the project/programme. For further details, see Annex 3.

Challenge: Not all key actors are involved in the project/programme.
Recommendation: The PT should urge the project/programme proponent to reach out to potential partners. Past experiences have shown that bringing other partners on board early in the project/programme preparation process contributes to advancing the climate change agenda in the project/programme area and often reduces delays in obtaining all the necessary project/programme approvals. Potential partners might include a climate change body or national agency responsible for leading the formulation of national climate change strategy and actions plans; research institutions generating climate data and/or undertaking downscaling scenarios; and existing "champions" such as key civil society members, NGOs, specific forums, etc. For more information on institutions to be contacted, see Annexes 1 and 2 and the section below on working with partners and stakeholders.

In all four situations above, the PT should also endeavour to identify, discuss and advise the government and donor representative on possible

33 See FAOb, 2011. Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production: http://www.fao.org/ag/save-and-grow/

34 For example, by establishing a climate change adaptation and mitigation awareness activity in the project and introducing specific climate change mitigation activities and indicators in the project's results framework.

additional sources of funding. See the section below on finance options for climate change activities.

Climate change adaptation challenges

Government partners are usually receptive to incorporating climate change adaptation considerations in agricultural investment projects and programmes, providing that they are in line with national priorities. Nevertheless, there are a number of challenges that the PT should be ready to address if they arise. Some of the more common ones are listed below.

Challenge: Funding for adaptation is limited.
Recommendation: Even in cases where the client has requested loans for projects/programmes that include activities that address (either directly or indirectly) adaptation issues, funding for climate change adaptation activities in most cases is sought through grants serving as co-financing to the loan. Whenever needed, the PT should advise the client and donor representative about possible additional sources of funding (e.g. bilateral cooperation, the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF) and the global Adaptation Fund). See the section below on finance options for climate change activities.

Challenge: There are limitations to achieving adaptation in a single intervention.
Recommendation: Adaptation objectives are rarely achieved through a single intervention (FAO-Adapt, 2011). Adaptation should be viewed more as a continuum, requiring an overarching approach that incorporates interventions that range from those that address underlying drivers of vulnerability to those designed exclusively to respond to climate change impacts (ODI, 2010). Such interventions may include establishing a climate change adaptation and mitigation awareness activity in the project/programme and introducing climate change mitigation indicators in the project/programme's results framework.

Challenge: There are limited data to guide effective decision-making.
Recommendation: The PT should make efforts to identify relevant data (or conduct a rapid assessment) of impacts of climatic variability on agriculture in the project/programme area. Climate change adaptation can be enhanced through: (i) altering exposure, (ii) reducing sensitivity of the system and/or (iii) increasing the adaptive capacity of the system. Having relevant data can help identify which approach(es) are relevant to the project/programme concept and which climate change adaptation activities are appropriate (for details on the assessment of impacts, see Annex 2).

Challenge: Local characteristics must be considered when identifying adaptation measures.
Recommendation: Adaptation is location- and context-specific, and needs to be integrated and flexible (FAO-Adapt, 2011). If impact and vulnerability assessments are not available for the project/programme area, a rapid assessment should be completed either during the identification or preparation phase. Based on the results of the assessments, the PT should engage stakeholders to determine any needed capacity-building activities and identify, evaluate, prioritize and select available adaptation options and tools to be supported by the project/programme.

Challenge: The project/programme concept should identify where synergies exist among food security, sustainable development, adaptation and mitigation.
Recommendation: The PT should coordinate well with relevant national agencies. Further, it should screen project/programme-relevant development and sectoral policies, strategies and plans through a climate lens to determine whether they might lead to maladaptation or miss important opportunities arising from climate change (adapted from UNDP, 2010).

Challenge: Not all key actors are involved in the project/programme.
Recommendation: As stated above, it is critical to reach out to potential partners. This topic is addressed in more detail below and in Annexes 1 and 2.

Working with partners and stakeholders

A project/programme cannot be successful without the active participation of those involved

in or affected by the project/programme. To ensure widespread participation, an initial stakeholder analysis is often conducted during project/programme conceptualization.[37] Usually there are many sector players undertaking adaptation and mitigation actions in a project/programme area (or in neighbouring locations), and they should be considered as potential stakeholders. These include line ministries, climate bodies, research and meteorological organizations, sector-specific commissions or environmental commissions, parliamentary committees focused on sectoral or environmental issues, donor agencies and NGOs with a sectoral or environmental focus (for further guidance, see Annex 1). Among these players are those responsible for leading the formulation of national and subnational climate change strategies and actions plans (usually a line ministry), such as the National Communications to the UNFCCC, NAMAs, NAPAs, UNFCCC National Adaptation Programme of Actions and the Global Environment Facility (GEF) National Portfolio Formulation Exercise (NPFE). In addition, existing "champions" (e.g. NGOs, grassroots and specific forums) are also key potential partners. Although some of these players may not be directly involved in adaptation or mitigation actions in agriculture, the scope of this list demonstrates the need to coordinate climate change-related actions in a project/programme area (particularly in adaptation) in order to increase the efficiency of the project/programme and avoid duplication of efforts (see Section A.2 of Annex 1 for more detailed guidance).

Social analysis is instrumental in designing and implementing successful pro-poor policy and institutional reforms and poverty-targeted investment programmes and projects, including those addressing climate change issues. It is fundamental to understand the complexities of social diversity, gender and the various dimensions of poverty (e.g. low income, lack of assets, vulnerability, exclusion, powerlessness, lack of voice and an inability to withstand shocks). A social analysis perspective enables planners and practitioners to put the human dimensions – stakeholders, target groups, intended beneficiaries or other affected people – at the centre of development interventions. Many manuals and user guides on social analysis exist already,[35] although they do not necessarily apply to climate change and agriculture investment projects/programmes. In the context of project/programme development and implementation, FAO has recently developed three guides in the series "Social analysis for agriculture and rural investment projects" – a Manager's Guide, a Practitioner's Guide and a Field Guide – which can be used by project/programme practitioners when designing and implementing participatory, gender-sensitive and local-specific climate change-related activities.

Incorporating climate change mitigation and adaptation in concept notes

A project/programme concept note should be short; it typically averages between five and eight pages. It is important that it reflect the potential mitigation and adaptation issues of the proposed project/programme to ensure their full integration into project/programme design and to the extent possible, opportunities to address those issues. In particular, that could include CSA, which maximizes synergies and minimizes trade-offs among food security, climate change adaptation and mitigation.

Once data collection, discussions and analysis have been done and key questions from Table 6 have been addressed, the PT should incorporate climate change considerations into the project/programme's draft concept note. The note should explicitly address relevant climate change issues, propose possible activities to be supported by the project/programme (including scaling up climate change mitigation and/or adaptation measures), identify potential outputs and outcomes and provide a list of possible partners.

Table 7 provides an illustrative annotated outline of a concept note with examples of climate-related information to be included. Each donor or IFI has its own template or outline for a concept note, so the exact content will vary. Depending on the situation, writers may give more emphasis to certain aspects over others while addressing the questions from Table 6.

35 For references on how to conduct stakeholder and social analysis in project design, see Section A.2 of Annex 1 (under stakeholder identification and engagement).

Table 7:
Illustrative outline of a concept note focusing on climate change mainstreaming

Section	Typical information to be provided
Background, context and rationale	*Background and context:*
	This subsection provides the background and basis for the project/programme rationale. In terms of climate change, it would benefit from: (i) a short paragraph briefly describing the geography, climate, population of the project/programme area and, if available, the estimated number of people at risk from the consequences of climate change; and (ii) a second paragraph with an overview of national climate change issues and related priorities (with emphasis on the project/programme area), based on existing or easily generated information. Most of the information required at the national level (and eventually the subnational level) would be available in the Country National Communications to the UNFCCC or other national reports (when available) such as NAPAs, NAMAs and NPFE (links to these reports are included in **Annex 1** under "policy aspects and country priorities"). Hints on how to identify climate change impacts and related issues in the project/programme area are available in **Annex 2**. This section also summarizes the agricultural and institutional context in which the project/programme will be implemented. For this, the PT may refer to government institutions responsible for climate change on issues relevant to the project/programme (e.g. meteorological agencies providing drought forecasts). Finally, this section could include information on the relation between the proposed project/programme and the country's donor programme or strategy (assuming that a donor has already been identified) and the donor's objectives and policies or strategies. A sentence should describe the climate change-related priorities and policies and how the project/programme would support them.
	Project/programme rationale and reasoning for mainstreaming climate change (and for funding):
	Based on the information provided in the background and context, this section: (1) justifies the proposed project/programme investments; (2) specifies why additional (or adjusted types of) climate change-related investments are needed; and (3) describes the kind of interventions that would be best suited to address existing climate change circumstances. An analysis should contrast the likely scenario without the proposed climate change actions (i.e. what would happen if the project/programme were implemented without climate change considerations, or what would happen if the project/programme were not implemented) with the scenario of a project/programme incorporating the proposed climate change actions.
Proposed project/ programme objectives and main results	*The development objective and results:*
	The development objective states which needs the project/programme will address and focuses on the impact/outcome for which the project/programme can be held accountable. Since most agricultural and rural development projects/programmes are not designed specifically as climate change adaptation or mitigation strategies, they do not necessarily reflect climate change considerations in their statement of objectives. However, after conducting participatory forums and identifying the climate change issues which need to be addressed by the project/programme, the PT should try to make climate change explicit in one or more of the project/programme's intermediary results/outcomes (or outputs to these outcomes), in order to contribute to the achievement of the project/programme's objective. A list of output and outcome indicators is provided in **Annex 6**. The PT should facilitate the preparation of the project/programme's results framework (or M&E framework). While that task is usually undertaken after concept approval, some IFIs require a draft results framework at this stage.

Section	Typical information to be provided
Concept brief	*Concept description:*
	This section describes the project/programme concept and how its proposed design would address the project/programme objective. Depending on the donor, a specific component description may not be required. Nevertheless, the PT should attempt to link each component with one or more of the expected results/outcomes identified above. While it is not necessary to refer to all of the climate change problems presented in the background and context, the issues that will be directly addressed by the project/programme should be included in this section. If preliminary descriptions of the proposed components are included, the PT should identify the entry points for climate change. It is also desirable to include a brief description (or estimation) of the global mitigation and national adaptation benefits of the project/programme.
	Project/programme stakeholder analysis:
	This section briefly summarizes the stakeholders in the country and sector, their roles and their potential contribution to the project/programme. It should identify and describe those government or private-sector partner agencies which may not necessarily execute the project/programme but which could provide climate change-related information, training or funding. It should also specify (if appropriate) the role of the climate change lead institutions (e.g. supervision, project/programme steering committee).
	Executing/implementing agency:
	This section names the local or national government agency(ies) that will execute the project/programme. It should include a preliminary description of the project/programme implementation and M&E arrangements, including those for executing and assessing progress on climate-related activities. If significant climate change action is proposed at this stage, this section could include feedback from the project/programme into the formulation or revision of a broader climate change strategy or larger programmes (this information may fit better during the further preparation stage).
	Indicative financing:
	Depending on the donor agency, it may be necessary to provide an overall idea about project/programme cost and financing, although not necessarily with a detailed breakdown by component. Any potential additional climate change financing that has been identified should be mentioned here.
Project/ programme risks	This section indicates the risk(s) that might prevent the project/programme objective from being achieved, such as design, capacity, quality, delivery and fiduciary and safeguard issues. While many may not be identified, the PT should flag those which are relevant for the project/programme.

Source: Adapted from GEF and other IFIs' guidelines.

Project/programme preparation stage

Project/programme preparation may be started following the approval of the concept note by the government and the donor. The project/programme proposal is detailed at this stage, and it represents a critical entry point for incorporating climate change considerations through key actions that will ensure the delivery of climate change-related outputs and outcomes.

Preparing for detailed project/programme design

Before getting into detailed project/programme preparation, it is best to identify the resources needed to prepare the project/programme. The PT usually identifies and proposes the following information:

- The required technical composition of the team: Is specific climate change expertise needed? If so, prepare terms of reference and estimate the amount of effort required (usually in person-weeks). It would also be prudent to discuss and obtain commitment from the project/programme proponent (government or other agency) about who on their staff would be made available to compose a project/programme formulation task team, including experts from specialized agencies working with climate change, and the timing for their involvement.

- The project/programme preparation budget: Are additional costs involved to incorporate climate change activities? Prepare a financing plan summary, particularly when there is more than one source of financing for (i.e. cofinancing sources).
- An estimate of the project/programme preparation timeframe: This should also specify whether climate change activities will require additional time.
- Proposed project/programme preparation activities: Identify, and if required by the donor agency, justify the main project/programme preparation activities.

Moving from concept note to project/programme proposal

At this stage, the PT should consider the following important actions to ensure the delivery of climate change-related outputs and/or outcomes and should include this information in the final project/programme document:

- Assess whether questions posed in Table 6 have been properly addressed (see detailed guidance for each question in Annex 1). As mentioned earlier, it is likely that questions related to impact assessment (including vulnerability) may have been addressed only in qualitative terms during the conceptualization stage. The PT should try to obtain additional information or carry out studies to be able to include some quantitative aspects where possible in the formulation of responses to those questions.
- Conduct preparation studies and/or assessments. Studies or assessments which were agreed upon during the project/programme conceptualization stage should be conducted to facilitate the incorporation of climate change considerations into project/programme design. The PT should also conduct an institutional mapping study to identify appropriate approaches to address cross-cutting themes while incorporating climate change (e.g. environmental assessment, gender inclusion, youth, vulnerable groups and promotion of local ownership to enhance sustainability). If there is insufficient time or resources to undertake studies or assessments during project/programme preparation, the PT should make sure that: (1) the studies will be included in one of the project/programme components to be carried out during the first year of implementation (or between project/programme approval and effectiveness); and (2) the project/programme design is flexible enough to allow the identification and selection of eligible options and practices after the completion of studies (in PY1). This will ensure that effective climate change adaptation and/mitigation activities will be properly identified.
- Define the objectives and strategy that will respond to the climate change issues identified during the conceptualization phase. If climate change issues were not properly identified during the conceptualization phase, go back to the questions posed in Table 6 to assess in more detail: (1) the impacts of climate change and climate variability on agriculture in the project/programme area (i.e. adaptation); and (2) the possible impacts of the project/programme on climate change (i.e. mitigation).
- Identify climate change-related indicators to be incorporated in the project/programme's results framework or the M&E framework):
  - Indicators: Identifying and selecting project/programme indicators may be complex for a number of reasons, including the following: (1) challenges in distinguishing adaptation interventions from development activities (only necessary if the project/programme targets adaptation funding); (2) uncertainty of climate change impacts; (3) difficulty in monitoring and evaluating long-term impacts; (4) complexity of climate change issues; and (5) gaps in MRV of climate mitigation interventions in agriculture, especially in smallholder farming systems. Table 6.1 of Annex 6 presents an illustrative list of climate change-related indicators in agricultural investment projects or programmes, and Table 6.2 summarizes some indicators collected from project/programme documents in a number of

organizations. Annex 6 also includes general information on project/programme indicators and results frameworks.

– **M&E plan:** Incorporate climate change considerations in the project/programme's M&E plan, based on the project/programme's M&E framework (which may also be referred to as the results framework or results management framework, depending on the IFI). The PT must ensure that the targets and indicators for monitoring the climate change outcomes and outputs are clearly defined in the project/programme monitoring plan. The PT should also identify the necessary tools and arrangements needed to monitor realistic climate change-related indicators included in the project/programme's results framework.

- **Review capacity of the collaborating institutions and identify required actions to set up the institutional framework for climate change mainstreaming**. This will include discussions and agreement about the implementation arrangements. The PT must reassess whether the appropriate partnerships have been identified and negotiated to implement the climate-related activities. If not, the PT needs to work with the project/programme proponents to ensure that this aspect of the project/programme is fine-tuned before the project/programme document is finalized.
- The PT must identify which institutions within the project/programme executing agency and implementing partners will be responsible for executing, monitoring and evaluating the project/programme activities. This should include an assessment of the executing agency's capacity-development needs to ensure effective inclusion of climate change considerations and participatory implementation of the climate change activities. It may be necessary to define reporting links to key national climate change institutions and determine what kind of support (e.g. advisory or quality control) they could provide to the project/programme. These implementation arrangements should address decentralized and community-based operational matters.
- **Review the project/programme proponent's (or proposed executing agency's) processes for multistakeholder consultation, coordination and/or cooperation during the project/programme.** These processes should enable the inclusion of a climate change agenda during project/programme preparation and implementation.
- **Define activities/options to address climate change issues and challenges, including inputs (e.g. who, when, how much) and outputs. Depending on the relevance of adaptation and/or mitigation to** the project/programme, the PT should focus on identifying one or more of the following:
  – Technical options:
    1. Stand-alone adaptation activities to minimize the impacts of climate change and climate variability on agriculture (e.g. crop, livestock, fisheries and/or forestry sectors) in the project/programme area;
    2. Stand-alone mitigation activities to reduce emissions or remove GHGs, hence minimizing the impacts of the project/programme on climate change; and
    3. CSA (win-win options) to address food security, adaptation and mitigation.
  – Cross-cutting themes which can be considered in identifying activities to incorporate climate change considerations:
    1. Strategy and policy advice (e.g. formulation or harmonization and implementation of relevant strategies, policies and regulations – conducted through studies, workshops, etc.);[36]
    2. Institutional strengthening (e.g. establishment and functioning of

36 These guidelines put more emphasis on field projects/programmes supporting on-the-ground investments in agriculture, forestry and fisheries. They are less relevant to projects focused specifically on policy and institutional reform. However, policy and institutional issues can be (and are often) addressed as specific components or outcomes of agricultural and rural investment programmes/projects.

mechanisms, institutions, networks and organizations);

3. Science and technology development (e.g. studies, research for development and adaptation of new varieties, adaptation and mitigation options and MRV techniques);
4. Data and information generation (e.g. for climate modelling, impact and vulnerability assessment and decision-making);
5. Capacity development for climate change mainstreaming at national, local and farm levels; and
6. Information management and knowledge sharing.

- **Ensure that activities are properly placed or clustered into the various project/programme components/outcomes**. This should follow the logic of the project/programme's results framework.
- **Estimate costs for adaptation and mitigation options to be incorporated in the project/programme budget.** The PT should estimate the costs for each identified climate change-related activity, include them in the project/programme components/outcomes and incorporate them in the project/programme cost table (such as Costab).[37] The source of funding for these activities can be the project/programme itself (e.g. an IFI loan) or an additional climate change grant or loan identified by the PT during the preparation phase (for additional finance options for climate change activities, see section 4 below). Depending on the size, scope and cost of climate change adaptation and/or mitigation actions, as well as on the type of finance available for these actions, the project/programme proponent (e.g. a national government) and the IFI may consider having a round of discussions to decide whether to incorporate these actions into the project/programme or whether to develop a separate, but linked, project/programme for climate change adaptation and mitigation.
- **Assess whether there are any governance risks**. Corruption may adversely affect the degree to which target groups can participate in and benefit from the proposed project/programme activities, including those related to climate change mitigation and adaptation. Consider whether any measures are required to mitigate against the envisaged governance risk.
- **Determine whether the possible intersectoral linkages have been properly addressed.** If they have not, identify how the project/programme could be fine-tuned in this respect.

Finally, the PT should ensure that the wording of climate change mainstreaming and, when applicable, climate change measures are properly captured in the legal instrument signed between the donor and the client (e.g. member country or project/programme proponent).

Project/programme supervision and evaluation

Supervision

Supervision missions attempt to review the progress of project/programme implementation against the annual operating plan and budget. A supervision mission is also an opportunity to discuss with PT experts how to improve operations and how to adapt interventions. It is critical to engage the full project/programme team and have sufficient exchange and consultation with a wide range of implementing actors and key beneficiaries. If possible, a climate change expert should be part of project/programme supervision missions.

During the project/programme launching stage, it is important to build local ownership of the activities and the link to sustainability. At this time,the donor's task team (i.e. the PT responsible for the first supervision mission) and the project/programme coordination team should dialogue with project/programme beneficiaries and partner institutions to assess their awareness

37 Costab is software for preparing, organizing and analysing project costs. The first version was originally designed by the World Bank. The current version is used by various IFIs. Costab data can be printed or displayed in a Microsoft Excel spreadsheet. Various reports can be prepared, such as financing plans and tables for costs and disbursements.

of climate change-related activities and outcomes foreseen by the project/programme and the inclusion of these activities in the project/programme's first year implementation plan, budget and procurement plans. In addition, the PT should discuss and review the project/programme's monitoring plan and certify that the tools to be employed include ways to measure climate-related indicators. The dialogue with key representatives from farmer and producer groups and other community leaders should be linked back to the project/programme design, where the same people or representatives identified these climate change interventions as critical to their future livelihoods.

During all supervision missions, procedures similar to those described for the project/programme launching stage should be applied. In addition, field visits should be conducted to supervise on-the-ground achievements of climate change-related activities (e.g. at the household, community, watershed, ecosystem or municipal levels). Discussions and reviews on climate change activities should be minimally based on the following reference documents and systems (depending on the donor, the terminology may change): (1) annual implementation plan (including budget); (2) project/programme's operational manual; (3) project/programme's M&E plan; (4) procurement plan; and (5) project/programme document and legal agreement.

During the first year of implementation, discussions may be necessary to fine-tune the methodology to measure the project/programme's climate-related indicators. Special attention should also be given to examine whether the capacity-development activities on climate change have been well-designed and implemented. It may be necessary to plan additional climate change training, policies or other types of activities (after jointly identifying them with the executing agency). This should be documented in the missions' Aide Memoir, including provisions to allocate a budget, identify a source of funding (e.g. reallocation of project/programme budget or leveraging new resources) and determine timing for these additional activities.

Evaluation

Baseline information and baseline survey

If sufficient baseline information has not been obtained during project/programme preparation, it may be necessary to collect baseline data at the beginning of the implementation phase to support climate change-related indicators identified during project/programme preparation. These data serve as a reference point for M&E and provide the basis for measuring progress in achieving project/programme objectives, outcome and outputs. If specific numbers are not available or if it is too costly and/or complex to collect data, rough approximations can be used instead. During a baseline assessment, team members should survey existing data to see if they fit their needs.

A detailed baseline survey may also be necessary prior to the development intervention. This can include data on individual primary stakeholders and is usually linked to the project/programme's impact evaluation process. The PT should assess whether data needed to monitor the project/programme climate change indicators are available and sufficient, or whether they need to be collected in the baseline survey. The results of such a survey can also serve as an important reference for the completion evaluation.

Mid-term review (MTR)

The MTR review will determine:

- whether climate change-related issues to be addressed by the project/programme are being effectively mainstreamed;
- if the foreseen outputs and outcomes are in line with the climate adaptation and/or mitigation activities of the project/programme;
- whether there is a need to adjust or redirect the project/programme because of any weakness in incorporating climate change considerations in project/programme design; and
- the extent to which the expected outcomes of the project/programme will be realized.

Particular attention should be given to: (1) the adequacy of the climate change-related indicators and whether there is any need to adjust them; and (2) the efficacy of the methodology used to measure them. A climate change expert should be part of the mid-term review or the independent evaluation team hired by the project/programme should include such an expert. The independent mid-term evaluation team's report should be reviewed and discussed in detail with the project/programme management team and partner institutions and verified through interviews with project/programme beneficiary groups and other relevant stakeholders during field visits.

Project/programme completion evaluation

The final project/programme evaluation and its completion report should be used to generate lessons learned about incorporating climate change considerations into the project/programme and about institutional capacities, strengths and weaknesses. It is also an opportunity to assess if the project/programme has been linked to larger national processes – including if project/programme approaches or lessons have been communicated – such as NAPAs, NAMAs and other climate change strategies and action plans. It should also identify opportunities for scaling up, if possible. The following issues should be taken into consideration by the PT while conducting missions and analysis that will support the preparation of the final evaluation report:

- Include a climate change expert if climate change links are significant.
- Verify whether baseline information (or a survey, when applicable) and an MTR provided feedback on the project/programme's climate change mitigation and/or adaptation aspects, and adjust activities and policy, when required, based on M&E results.
- Assess the achievement of climate change-related outcomes foreseen in project/programme design (if any). To do this, the PT must collaborate closely with the project/programme's M&E Team (and, if applicable, institutions or departments involved in measuring climate change-related indicators) and hold meetings with project/programme beneficiaries and partner institutions.

- Identify the lessons on climate change mainstreaming in agricultural and rural development projects/programmes which might be learned from the project/programme.
- Examine whether the incorporation of climate change has received attention at all stages of the project/programme cycle.
- Assess (e.g. by reviewing the mission's aide memoirs) whether the project/programme supervision team took time to supervise progress against climate change-related activities throughout the life of the project/programme, including field visits.
- Assess whether project/programme beneficiaries directly benefit from the project/programme's mitigation and/or adaptation measures.
- Check whether the project/programme design facilitated the collection of climate change-related data to update the baseline data and support the adjustment of the project/programme's climate change strategy when necessary.
- Identify lessons to strengthen the design of any future similar projects/programmes, in particular those related to whether the project/programme's outcomes that should have contributed to climate adaptation and mitigation were achieved.
- Assess whether links have been established with institutions responsible for climate change and related knowledge networks.

Chapter 4 - A few words on finance options and economic and financial analyses

Financing options for climate change activities

Regular private and public sector funds in support of agricultural development provide most of the funding to support CSA, and these need to be oriented towards adopting a climate lens. Public funding must create a conducive enabling environment and reduce barriers to transitioning to more sustainable agricultural systems, leveraging much larger flows of private investment to embrace adaptation and mitigation opportunities. Because LDCs are often considered high risk areas for investors, the UNFCCC has a role to play in finding new ways to attract private investment for adaptation and mitigation projects/programmes.

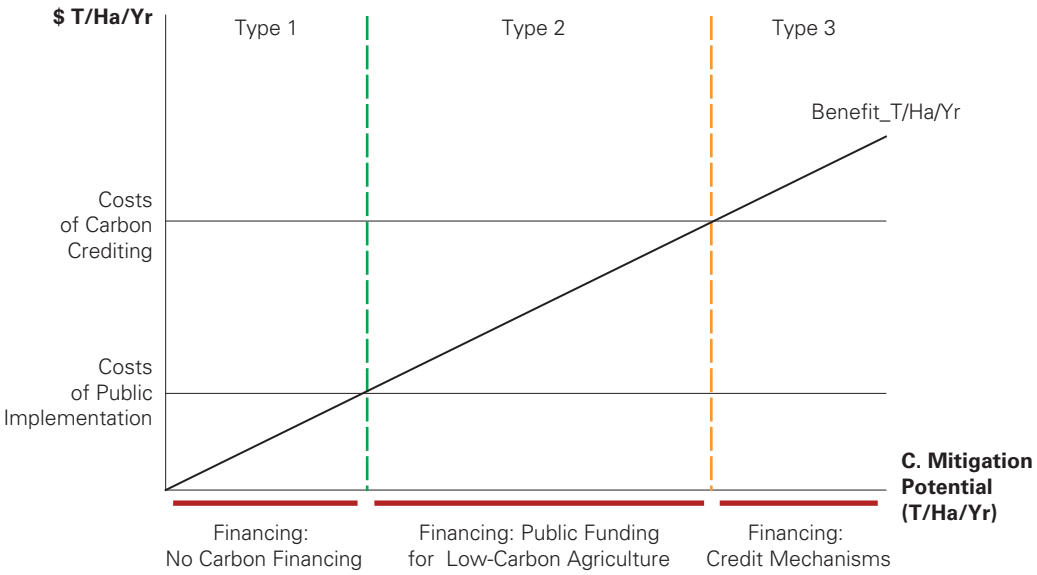
Traditionally within the UNFCCC negotiations, mitigation and adaptation have been separated, which has resulted in different financing streams. However, it is not so easy to distinguish adaptation and mitigation benefits in agriculture, and this presents challenges in identifying the appropriate funding source. In these situations, the type of activities supported by the project/programme (e.g. afforestation, reforestation, REDD, energy efficiency, renewable energy, soil management, fisheries, agroforestry) can help identify opportunities to tap into finance sources for mitigation and adaptation.

Finance options for climate change activities can be differentiated between: (1) finance sources for mainstreaming climate change interventions into agricultural investment projects or programmes; and (2) stand-alone climate projects or programmes. Climate-specific finance provides resources to support low-carbon and climate-resilient development. To date, 21 dedicated bilateral and multilateral public climate finance initiatives are in place, in addition to dozens of carbon funds and development initiatives with a climate change focus. This raises hope that additional funding will be made available to tackle climate change. The main actors dealing with climate change mitigation and adaptation funding are developed country governments working through a number of bilateral initiatives, the World Bank through its administration of the Climate Investment Funds (CIF) and the Global Environmental Facility (GEF) and the Kyoto Protocol Adaptation Fund. Moreover, the multilateral development banks are playing an increasing role in scaling up climate finance.

Annex 7 provides a list of climate finance initiatives designed to help developing countries address the challenges of climate change. Funding for climate change mitigation is available through a number of sources (e.g. market-based climate change mitigation instruments to meet defined emission reduction targets that involve emissions trading between developed and developing countries). The voluntary carbon market represents complementary funding sources for climate change mitigation in agriculture. Funding for climate change adaptation is also available through many financing mechanisms. The four multilateral adaptation finance instruments that have disbursed funds to date are: the LDCF and the SCCF, both administered by the GEF; the Pilot Program for Climate Resilience (PPCR), which is a programme under the CIF; and the Adaptation Fund (AF).

Because institutions are important vehicles to channel global sources of funds to those most in need, climate finance also faces issues of governance. It is essential that the money goes to those who are most vulnerable to devastating climate change impacts and is not lost to corruption or poor governance. The Institute for Security Studies (ISS, 2011) has monitored the governance of climate finance realities and funding arrangements across developing countries.

Figure 2:
Financing options for agriculture development and mitigation projects/programmes



Source: Adapted from FAO 2009b

Reflecting climate change aspects in economic and financial analysis[38]

Models such as the FAO EX-ACT Tool[39] can be used to estimate the mitigation potential of rural development projects/programmes. Such estimates would be of great relevance for accounting for GHG emissions reductions and carbon sequestration and providing a basis for seeking climate finance – either public or market-based and integrated with existing official development assistance (ODA official development assistance) – which can increase investment flows to the agricultural sector of developing countries.

It is possible to classify projects/programmes which are of interest for agricultural development (Branca *et al.*, 2010):

- Type 0 – no mitigation potential
- Type 1 – low mitigation potential
- Type 2 – medium mitigation potential
- Type 3 – high mitigation potential.

Type 0 projects/programmes are a net source of GHG emissions, and they are not taken into consideration here because they cannot benefit from any additional climate financing. Types 1, 2 and 3 projects/programmes show mitigation potential since their activities are able to increase biomass above and below ground and/or soil organic carbon, albeit with a different intensity (see Figure 2).

Type 1 projects/programmes have low mitigation potential so that the mitigation benefits are smaller than the costs of MRV of the mitigation activities. There would be no space for additional support from climate finance sources; ODA public funds remain the main financing source for this category of projects/programmes.

For Type 2 projects/programmes, the benefits of pursuing low-carbon agricultural strategies may be greater than the costs associated with the adoption of basic MRV for public implementation. In this case, public climate funding may be a possible financing source which could integrate ODA funds, as project/programme offsets are considered public goods and therefore purchased by a public institution. An example would be a project/programme implementing agricultural practices that improve agricultural

38 Text adapted by G. Branca (Agricultural Development Economics Division, FAO) from the FAO Investment Centre publication on "Estimating Mitigation Potential of Agricultural Projects: an Application of the Ex-Ante Carbon-balance Tool (EX-ACT) in Brazil", FAO, Rome, 2010.

39 See: http://www.fao.org/tc/exact/en/

productivity and resilience and thus contribute to food security in developing countries. In the future, with climate change considerations being mainstreamed into public sector global development objectives, it is plausible that these agriculture multipurpose projects/programmes will become increasingly important.

For Type 3 projects/programmes, mitigation benefits are greater than the costs of adopting and meeting stringent MRV requirements (in most cases, they are higher than MRV for publicly financed options). For this category of projects/programmes, market-based climate financing mechanisms (e.g. carbon crediting on voluntary or mandatory markets) are a viable source of financing.

It is not easy to estimate the transaction costs related to the accounting of agricultural mitigation activities at public or market levels, given the lack of information and the fact that data available are not in a standard format to allow accurate comparison. Therefore more research is needed. Nevertheless, for the purpose of this document, it is assumed that the transaction costs for public implementation are equal toUS$4/t CO_2e ha^{-1} yr^{-1} which is an arbitrary but plausible value based on literature (Cacho *et al.*, 2005; Lipper *et al.* 2010; Mooney *et al.*, 2004). The transaction costs for selling carbon credits on the market will be obviously higher, given the number and type of requirements (e.g. establish baseline and carbon flows of the project/programme, design monitoring plan, establish permanent sampling plots, prepare project/programme design document, design individual farm plans, monitor carbon stocks reported by farmers, verification and certification) (Cacho and Lipper 2006).

FAO has tested the application of the EX-ACT Tool on various occasions, including two rural development projects in Brazil, the Santa Catarina Rural Competitiveness (SC Rural) project and the Rio de Janeiro Sustainable Rural Development (Rio Rural) project. Based on the test, both SC Rural and Rio Rural projects can be classified as Type 1 projects without any feasible option of receiving climate finance. Average mitigation potential of the SC project amounts to 0.92 t CO_2e ha^{-1} per year. It could be valued using a price of US$3 per t CO_2e, which is the average carbon price for agricultural soil carbon at the retail level on the voluntary market in 2008 (Hamilton *et al.*, 2009). Therefore, the value of the average mitigation potential of the project amounts to US$2.76 per t CO_2e (per hectare and per year), which is below the level of transaction cost for public implementation (US$4 per t CO_2e). Similarly, the average mitigation potential of the Rio Rural project is equal to 0.19 t CO_2e ha^{-1} per year, i.e. US$0.57 per t CO_2e (per hectare and per year), well below the level of transaction cost for public implementation.

However, it is interesting to note that a relatively small change in the design of the SC Rural project could slightly increase its mitigation potential and expand climate financing opportunities. For example, the mitigation potential of the project in the "optimistic scenario" considered during the EX-ACT text is equal to 1.1 t CO_2e ha^{-1} per year. Clearly, if the project is designed with explicit multiple objectives and specific mitigation activities, and if the corresponding mitigation potential value exceeds the level of transaction costs for public implementation, the project could then be potentially considered for public financing for low-carbon agriculture. In this case, since yearly mitigation potential of the SC Rural project would be equal to 0.6 Mt CO_2e, mitigation benefits would be worth US$1.8 million per $year^{-1}$ at the price ofUS$3 per t CO_2e. Given that the total average project cost is US$31.5 million per $year^{-1}$, public carbon finance would therefore potentially cover about 6 percent of these costs.

Essential reading and glossaries

The following resources offer additional guidance. See Box 4 below for a number of key climate change glossaries.

General context and overall guidance (for a description of each publication, see Annex 3):

IPCC fourth assessment report: Climate change 2007 (AR4). The following sections are of particularly relevance to agriculture:

- Food and agriculture: Chapter 5 with contribution ofIPCC Working Group II to AR4: Impacts, adaptation and vulnerability http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch5.html
- Mitigation in agriculture: Chapter 8 with contribution of IPCC Working Group III to AR4: Mitigation of climate change http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch8.html
- Mitigation in forestry: Chapter 9 with contribution of IPCC Working Group III to AR4: Mitigation of climate change http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch9.html
- AR4 synthesis report: http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

FAO profile for climate change. FAO, 2009. http://www.fao.org/docrep/012/i1323e/i1323e00.htm

FAO framework programme on climate change adaptation. FAO, 2011. http://www.fao.org/docrep/014/i2316e/i2316e00.pdf

FAO framework programme on disaster risk reduction (FP DRR). FAO, 2011. http://www.fao.org/docrep/015/i2540e/i2540e00.pdf
Climate-smart agriculture – policies, practices and financing for food security, adaptation and mitigation. FAO, 2010. http://www.fao.org/docrep/015/an177e/an177e00.pdf

Mainstreaming adaptation to climate change in agriculture and natural resources management projects. World Bank Web site: http://www.worldbank.org/adaptnotes
Mainstreaming climate change adaptation into development planning: A guide for practitioners. UNDP and UNEP, 2011. http://www.cakex.org/sites/default/files/Guide%20Mainstreaming%20Climate%20Change%20Adaptation%202011.pdf

Carbon climate change mitigation finance for smallholder agriculture. A guide book to harvesting soil carbon sequestration benefits.
http://www.fao.org/climatechange/29763-0daebeae838c70f713da780982f16e8d9.pdf

Climate-smart agriculture: Smallholder adoption and implications for climate change adaptation and mitigation. FAO, 2011. http://www.fao.org/docrep/015/i2575e/i2575e00.pdf

Publications by sector (for a description of each publication, see Annex 3):

Water: Climate change, water and food security – FAO water reports No. 36. FAO, 2011. http://www.fao.org/docrep/014/i2096e/i2096e00.htm

Energy: "Energy-smart" food for people and climate: Issue paper. FAO, 2011. http://www.fao.org/docrep/014/i2454e/i2454e00.pdf

Crops:

- Climate-smart agriculture: A synthesis of empirical evidence of food security and mitigation benefits from improved cropland management, FAO, 2011: http://www.fao.org/docrep/015/i2574e/i2574e00.pdf
- Save and grow: A policymaker's guide to the sustainable intensification of smallholder crop production. FAO, 2011: http://www.fao.org/ag/save-and-grow/

Forestry: Climate change for forest policy-makers – An approach for integrating climate change into national forest programmes in support of sustainable forest management. FAO, 2011. http://www.fao.org/forestry/climatechange/64862/en/

Fisheries: Strategy for fisheries, aquaculture and climate change. Framework and aims 2011-2016. FAO, 2011. ftp://ftp.fao.org/fi/brochure/climate_change/stragegy_fi_aq_climate/2011/climate_change_2011.pdf

Livestock: Greenhouse gas emissions from the dairy sector – a life cycle assessment. FAO, 2010. http://www.fao.org/docrep/012/k7930e/k7930e00.pdf

Box 4: **Climate change glossaries**

Many climate change glossaries are available in the literature and on the Web. These references can assist project/programme practitioners who may not necessarily be fully familiar with technical terms used in climate change discussions.

FAO climate change glossary: http://termportal.fao.org/faocc/main/start.do
Available in English, French, Spanish and Chinese.

Intergovernmental panel on climate change glossaries http://www.ipcc.ch/publications_and_data/publications_and_data_glossary.shtml

United Nations Framework Convention on Climate Change (UNFCCC) glossary of climate change acronyms: http://unfccc.int/essential_background/glossary/items/3666.php

Glossary of CDM terms: http://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf

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FAO. 2009b. Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies: http://www.fao.org/docrep/012/i1318e/i1318e00.pdf

FAO. 2010a. "Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation, FAO, Rome. http://www.fao.org/docrep/013/i1881e/i1881e00.htm

FAO. 2010b. Estimating Mitigation Potential of Agricultural Projects: an Application of the Ex-Ante Carbon-balance Tool (EX-ACT) in Brazil. Working Paper LAC/03/10. http://www.fao.org/docrep/012/k7846e/k7846e.pdf

FAO. 2011a. FAO-Adapt: Framework Programme on Climate Change Adaptation. http://www.fao.org/climatechange/27594-03ecd7bd225b93086e7dca3944de64307.pdf

FAO. 2011b. Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production: http://www.fao.org/ag/save-and-grow/

FAO. 2011c. Social analysis for agriculture and rural investment projects: Manager's Guide, Practitioner's Guide, Field Guide http://www.fao.org/docrep/014/i2816e/i2816e00.htm

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ANNEX 1
Incorporating climate change mitigation and adaptation in project formulation, supervision and evaluation

ANNEX 1
Incorporating climate change mitigation and adaptation in project formulation, supervision and evaluation

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
A. Questions, sources and guidance relevant to both the conceptualization and preparation stages			
A.1. Policy aspects and country priorities (applicable to both mitigation and adaptation)			
National and local priorities	1. Is there any national climate change (CC) and DRR/DRM strategy or action plan available? If so, what are the priorities for the agricultural sectors? Which are relevant to the project concept? 2. In least developed countries (LDCs), which priorities have been identified in the NAPAs that are relevant to the project concept? 3. If Nationally Appropriate Mitigation Actions (NAMAs) have already been formulated and submitted, which priorities, targets or actions have been included?	• National/subnational policy documents, action plans and priorities on CC – NAPAs, NAMAs, National Communications to the UNFCCC, etc. – can usually be found on the Web sites of the UNFCCC and the national ministry or organization responsible for overall CC coordination (usually the national UNFCCC Focal Point). • The National (Operational) GEF Focal Point coordinates the formulation of the National Portfolio Formulation Exercise (NPFE) (including priorities for CC funding) and endorses project proposals before submitting to the GEF Secretariat for funding in mitigation (GEF Trust Fund) or adaptation (LDCF and SCCF). • The Ministry of Environment may not be the focal point for GEF or UNFCCC, but in many countries it is responsible for national environmental strategies covering CC aspects, while the Minister of Foreign Affairs covers the country's international commitments on CC. • National development strategies and reports relevant to CC (from agricultural, environmental, scientific, disaster risk management (DRM) and meteorological organizations) are usually available (or referenced) at the official Web site of the concerned ministry or department. • It is recommended to assess whether information provided in the aforementioned documents may or may not be fully relevant to your project, in view of location, scope and other project characteristics. They should give an overview of the major priorities which are relevant to CC and agriculture (including fisheries and forestry) within the country.	• For a description and links to national policy documents and action plans, see **Annex 3** (under its **section 2.2** on "National policies and priorities"). For national information and documents relevant to conducting a rapid assessment, see **Annex 2** • National Focal Points to the UNFCCC: http://maindb.unfccc.int/public/nfp.pl • National GEF Focal Point: http://www.thegef.org/gef/focal_points_list • "From NAMAs to low-emission development in agriculture" can be downloaded from the FAO EasyPol Web site: http://www.fao.org/easypol/output/AbsLanguage.asp?id=881&langa=EN • Various tools and other sources of information relevant to questions posed here are presented and briefly described in **Annex 3**

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
		A.2. Institutional aspects (applicable to both mitigation and adaptation)	
Stakeholder identification and engagement	1. Which are the major institutions coordinating and implementing CC-related actions at the national and project levels, and how could they contribute with data and/or specific actions to the project? 2. Is the stakeholder consultation process in place, including an appropriate delivery strategy that allows capturing key CC-related issues? 3. Which local stakeholders could have a key role as project partners?	• National institutions coordinating CC activities are usually ministries/organizations responsible for environment management and/or foreign affairs. Other organizations with specific coordinating mandates are ministries/departments of meteorology, DRM, science and technology and space exploration. Key actors to be consulted include focal points for UNFCCC and GEF, national offices of UN agencies and bilateral development institutions and national and international NGOs. • Main national CC implementing institutions can be line ministries/organizations, universities, etc., although not necessarily with a CC-specific mandate. For instance, a national/subnational department of forestry or agriculture may be implementing key activities related to REDD, and a national/subnational weather service may be generating data and providing key climate information relevant to rural producers and development programmes. • Review the process adopted by the project proponent for multistakeholders consultation, coordination and cooperation. An appropriate delivery strategy (to be used in consultation events) should be designed to allow capturing key CC-related issues. Linking up with existing "champions" (e.g. key civil society members, NGOs, specific forums in the country) could be very useful for forwarding the CC agenda in the project area. • Depending on the governance structure (i.e. the division of responsibilities between central and provincial/state governments), key institutions may include those at the subnational level. • Many guidelines (not specific to CC) are available on how to conduct stakeholder and social analysis (see adjacent column).	• Key stakeholders are mentioned in national and subnational policy and strategy documents and action plans presented in **Annex 3** (under its **section 2.2** on "National policies and priorities") • Examples of stakeholder analysis guidelines: • 1) FAO (2011) Social analysis for agriculture and rural investment projects: Manager's Guide, Practitioner's Guide, Field Guide http://www.fao.org/docrep/014/i2816e/i2816e00.htm • 2) FAO (2006) A rapid guide for missions, Analysing local institutions and livelihoods http://www.fao.org/sd/dim_pe4/pe4_060401_en.htm • 3) World Bank (2007) Tools for Institutional, Political and Social Analysis of Policy Reform: A Sourcebook for Development Practitioners http://siteresources.worldbank.org/EXTTOPPSISOU/Resources/1424002-1185304794278/TIPs_Sourcebook_English_PartI.pdf?&resourceurlname=TIPs_Sourcebook_English_PartI.pdf • 4) FAO (2003) Local Institutions and Livelihoods: Guidelines for Analysis, by Norman Messer & Philip Townsley http://www.fao.org/docrep/006/y5084e/y5084e00.HTM • 5) LEAD/FAO/GTZ/IPTRID (2006): A stakeholder analysis section in the manual"Project Design and Management: Training Programme for Professionals in the Water Sector" http://pdm.lead.org/docs/participants_manual.pdf

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
Barriers, constraints and capacity development needs	1. Which constraints, gaps and related financial, technical and other capacity development needs have been identified at the national and project levels?	• NAPAs and NAMAs should provide information on main issues and underlying causes of constraints and gaps and related financial, technical and capacity needs/priorities. • To identify barriers and opportunities specific to the project area: - Apply a methodology to diagnose barriers to CC adaptation and mitigation. For adaptation, for instance, one can apply the framework developed by Moser and Ekstrom (2010), which includes a useful table with diagnostic questions by the stage in the adaptation process and the adaptation system components. - Include/mainstream the aforementioned methodology (or another) in the project preparation diagnostic study of the current situation (i.e. without project/ programme scenario), to identify main CC policy and institutional issues, barriers and opportunities for possible project support. Also identify existing and planned projects/programmes addressing CC issues, including arrangements on how to coordinate with the proposed programme.	• Moser, S. C. and Julia Ekstrom. (2010). A framework to diagnose barriers to climate change adaptation. http://www.susannemoser.com/publications.adaptation.php • Annex 3 (under section 3 on "Tools and information systems for adaptation and mitigation")presents links to other methods that can also be used to identify issues, barriers and opportunities
		A.3. Adaptation	
Impacts of climate change and climate variability on agricultural sectors	1. What are the expected impacts of CC on the country's agriculture sectors? 2. How can existing data and related assessments on the impacts of climatic variability on agriculture in the project area be identified? Should a rapid assessment be conducted?)	• Documents available through national institutions mentioned in this table (see row above under "National and local priorities") should provide a general overview of impacts. • A rapid assessment of future potential impacts of CC should be considered as a first step in project formulation. It is important to at least understand the past and current local climate and then find the characteristics of historical impacts by examining observedpast impacts of climate variability and change on agriculture. This sets the basis for assessing future potential impacts. • See Annex 2 on how to identify relevant data and conduct a rapid assessment of impacts of climatic variability on agriculture in the project area so as to direct the identification of possible effective CC adaptation activities/options. Annex 2 also provides guidance on institutions to talk to at the country level.	• Annex 2 • For an overview of regionalized impacts of CC in agricultural sectors, see Chapter 2 • Annex 3 (under section 3 on "Tools and information systems for adaptation and mitigation") presents links to other methods to design assessment studies of CC impacts and related adaptation strategies • TheWorld Bank CC Portal and ADAPT: http://go.worldbank.org/AWJKT60300
Impacts of CC and climate variability on people	1. How are these impacts affecting the project beneficiaries and other potential stakeholders?	• In coordination with the technical information gathering suggested in Annex 2, this information can be obtained by holding discussions with government partners and key informants such as farmers' organizations, NGOs working on CC and research and environmental institutions. These could be undertaken through a discrete event (such as a rapid rural appraisal) with an allocated budget, or through meetings and workshops during the project identification and preparation stages.	• For methods available in the literature on how to plan and conduct stakeholders' consultations, see links on section A.2 of this table, under "Stakeholder identification and engagement"

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
Adaptive capacity of the project-supported activities	1. How can the project become more climate-resilient (i.e. how can it be improved to increase the resilience of the agricultural systems and livelihoods to CC impacts)?	• A proper way to direct the identification of possible effective CC adaptation options (i.e. climate resilient interventions) is to gather information on the impacts of climatic variability on agriculture in the project area (see **Annex 2**). With that information in hand, various recommendations on adaptation options are available in the literature. • For a general overview of possible adaptation options, see those promoted by the FAO Framework Programme on Climate Change Adaptation (FAO-Adapt – see **Annex 3**), which includes options for: - building capacities for improved data and knowledge; - establishing an enabling environment (e.g. institutions, policies and financing); - supporting climate-smart management of land, water and biodiversity; - implementing DRM actions; and - developing and disseminating technologies, practices and processes for adaptation in agriculture, forestry, fisheries and rural energy. • Considering that women have limited access to appropriate technologies, which curbs their productivity potential, pay special attention to ensuring that they have adequate access to technologies.	• See **Annex 3** (under its **section 2.1** on "General and agricultural sector documents") for description and links to relevant publications • See **Annex 4** for possible options and good practices for CC adaptation, and **Annex 5** for DRM options • See also **Section 5** of **Annex 3**
Options for disaster risk reduction (DRR)	1. Is there a DRR framework in place to protect beneficiaries' livelihoods from shocks and to strengthen their capacity to absorb the impact of, and recover from, disruptive climatic events? If not, how can the project help with that?	• The PT should identify whether there is a general agriculture risk reduction and management framework in place to support small-scale producers (e.g. farmers, fisher folk, forest dwellers) in the project area. For some risks, early warning and prevention can work efficiently, but for other risks, ex-post response, insurance and contingency planning can work better, depending on the frequency and exposure of their assets. • For a general overview of possible priority DRR themes and actions, see those promoted by the FAO's Framework Programme on Disaster Risk Reduction for Food and Nutrition Security and the FAO-Adapt.	• See **Annex 5** on framework and possible DRR options, as well as a brief description of various publications with practical guidance for disaster response and risk management in fisheries, crop production, nutrition and livelihoods • See **Annex 3** (under its **section 2.1** on "General and agriculture sector documents") for descriptions and links to relevant publications.

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
		A.4. Mitigation	
Impacts	1. What are the possible impacts of the project on CC in terms of increasing, reducing or avoiding GHG emissions? 2. Which anticipated impacts on CC could come from improved agricultural systems or from changes in land use? 3. Which other types of project activities have a potential impact on the project's carbon balance?	• NAMAs and other key national CC documents (see row above on national and local priorities) and specialized literature can assist the PT in developing a preliminary idea on the potential impacts of the project's proposed interventions on CC. Information provided in national documents made available by national institutions mentioned in this table (under "national priorities") may or may not be fully relevant to your project, but they should assist in identifying the possible impacts of the project. • Agricultural production activities generating GHG emissions (which therefore could be targeted to reduce emissions) may come both from changes in production systems (e.g. changes within the same land or water use) or from changes in land or water use (e.g. from degraded pasture to agroforestry). A project/programme may involve both; for details, see guidance provided below regarding how to estimate climate change mitigation potential of the project and, in particular, information provided on models available to estimate the mitigation potential of changes in agricultural production systems and land use. • Other project interventions may have a negative impact on CC, if not mitigated. They can be related with project management and policies. For example, if project implementation is expected to intensify technical assistance of project executers currently operating in the area (and/or new field staff to be recruited by the project), it can result in a substantial increase in the annual car fuel consumption and, hence, an expected increase in GHG emissions. Buildings (including office, agro- industries or other post-harvesting units) and other installations constructed or rehabilitated by the project can also be expected to generate emissions if low carbon-intense solutions are not implemented.	See **Annex 2** sections on "mitigation" and "list of resources" In addition, for an overview of possible impacts: • of agricultural projects in general: FAO Mitigation of Climate Change in Agriculture (MICCA) Programme http://www.fao.org/climatechange/micca/en/ • of crop production: FAO Publication on Food security and agricultural mitigation, http://www.fao.org/docrep/012/i1318e/i1318e00.pdf • of livestock, FAO publications on greenhouse gas (GHG) emissions from the dairy sector-a life cycle assessment, http://www.fao.org/docrep/012/k7930e/k7930e00.pdf • of forestry projects, FAO publication on Strategic framework for forests and climate change, http://www.fao.org/forestry/16639-064a7166b1dd027504bbfbb763878af99.pdf • of irrigation, FAO publication on Climate change, water and food security, http://www.fao.org/docrep/014/i2096e/i2096e00.htm • of fisheries projects, FAO publication on Climate change implications for fisheries and aquaculture, ftp://ftp.fao.org/docrep/fao/012/i0994e/i0994e.pdf See also **Annex 3** (mainly section 3)
Mitigation potential of the project	1. Which activities, practices or technologies proposed by the project have mitigation potential? 2. What is the climate change mitigation potential of the project?	• Based on government willingness, the PT should identify opportunities to adjust the proposed interventions to reduce GHG emissions and increase carbon sinks in order to pursue productivity and adaptation objectives. • There are models available (and others being developed) that estimate the mitigation potential of changes in agricultural production systems and land use and to support project managers in climate change decision-making. The EX-Ante Carbon-balance Tool (EX-ACT) is one such model developed by FAO to provide an *ex ante* evaluation of the impact of rural development projects on GHG emissions and C sequestration, thus estimating the potential contribution of the agriculture sector to climate change mitigation (Bernoux *et al.*, 2010, Cerri *et al.*, 2010). The model can be used to refine project components and activities to increase, whenever possible, the project's mitigation benefits.	• See more information on EX-ACT and other models in **section 2** of **Annex 2,** under the subsection on "emissions, mitigation options and potential"). • DNDC Biogeochemistry Model- http://www.dndc.sr.unh.edu/ • ENCOFOR Carbon Accounting and Project Design Tool, http://www.joanneum.at/encofor/tools/tool_demonstration/download_tools.htm

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
Win-win opportunities that include mitigation	1. Based on the project's CC mitigation potential, are there agricultural technologies and practices which would reduce GHGs (mitigation) and, at the same time, sustainably increase productivity and resilience (adaptation) and enhance achievement of national food security and development goals, or at least two of these?	• Once it has been determined in what areas the project has higher mitigation potential (e.g. pasture management, annual or perennial crop management, measures to address deforestation or forest degradation issues and management), the PT should consult local producers (beneficiaries) to discuss the adoption of double- or triple-win options, such as those identified as CSA in **Chapter 2**. Examples of many types of climate-smart production systems are provided in the literature (see adjacent column).In these guidelines, some examples are given in **Annex 4**. • For crop, forestry, grasslands and livestock projects, this question can also be phrased as this: if the project intends to increase land productivity of smallholdings, how could it also enhance the ability to sequester carbon dioxide equivalent (CO_2e)? • If there is interest in adding project activities involving "forest carbon projects", the Forest Carbon Portal (from Ecosystem Marketplace) includes a comprehensive series of guidance documents on forest carbon project development. For funding project activities on reducing emissions from deforestation and forest degradation, the Reducing Emissions from Deforestation and Forest Degradation (REDD+) Partnership Web site provides useful guidance. For more information, an extensive list of finance options for climate change activities (including climate mitigation) is presented in **Annex 7**.	• See **Annex 4** and **Annex 3** (under its **section 2.1**) for descriptions and links to relevant publications such as FAO "Save and Grow, section on mitigation of FAO Profile for Climate Change, etc. • FAO page on CSA: http://www.fao.org/climatechange/70746/en/ http://www.fao.org/docrep/013/i1881e/i1881e00.pdf • REDD+ Partnership Web site: (http://reddpluspartnership.org/en/) • Ecosystem Marketplace – a project of Forest Trends http://www.forest-trends.org/ – is a leading source of news, data, and analytics on markets and payments for ecosystem services, including carbon sequestration: http://www.ecosystemmarketplace.com/ • Forest carbon portal: http://www.forestcarbonportal.com/content/building-forest-carbon-projects
Mitigation options	1. What specific mitigation interventions could be proposed in view of local natural, social and economic conditions in the project areas? 2. How would you prioritize these possible interventions in the order of CSA, win-win options and mitigation interventions, based on the government's willingness?	• In assessing possible options, project developers and investment formulation practitioners should consider the availability of local knowledge and support systems for proposed innovations – i.e. agricultural research institutions, advisory services/extension and input suppliers (e.g. seeds, tools, agrochemicals). • For assessing the efficiency of possible CC mitigation measures being considered under the project/programme, cross-reference could be made, for example, between the relevant measures taken from **Annex 4** (or other sources) and the results of application of a model such as FAO EX-ACT Tool (see row above n mitigation potential), which can provide clear guidance on more effective mitigation options. Tools presented in **Annex 3** can also be useful to answer this question • A number of agricultural practices combining CSA, CC mitigation and other benefits (such as food security and adaptation) are already being used by rural producers. However, knowledge gaps still exist regarding the suitability and use of the production systems and practices across a wide variety of agro-ecological and socio-economic contexts and scales. Many practices also have local and temporal benefits or impacts, thus being very case-specific. Several practices are listed in Table 4.1 of Annex 4.	• For an illustrative list of investment options/practices for CSA, CC adaptation, mitigation and DRR, see **Annexes 4** and **5.** • For a list of possible CC mitigation measures, see **Annex 4** (under its **sections 2, 3** and **4**). Sector documents are referred to in **Annex 3** (under its **section 2.1**), including the MICCA Series produced under the FAO Mitigation of Climate Change in Agriculture (MICCA) Programme. For tools, see **Annex 3** (under its **section 3**). • IPPC guidelines (available in six languages) on "Good Practice Guidance for Land Use, Land-Use Change and Forestry": http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html • For an illustrative list of finance options for CC adaptation and mitigation measures, see **Annex 7** (and also **Chapter 4**).
Funding source	1. Are there any financing sources, in addition to the project fund, that can be used for the identified mitigation opportunities?	• Finance options for climate change activities can include either: - finance sources for agricultural and rural development investment projects or programmes which caninclude (as an option, not mandatory) climate change interventions; or - stand-alone climate projects or programmes or projects to support mitigation and/or adaptation benefits.	• See **Chapter 4** and **Annex 7**.

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
B.Questions and sources of information valid for the preparation stage (i.e. after concept note development)			
Project technical strategy and approaches	1. Has a strategy been defined to respond to CC issues? 2. Which integrated planning approach is being proposed at the landscape or ecosystem level to ensure the future sustainable development of rural communities in the project area? 3. Is the project seeking to capture synergies and manage trade-offs among food security, climate adaptation, mitigation and sustainable development?	• The objectives and strategy should be defined during preparation to address relevant CC issues identified during the conceptualization phase. If CC issues have not been properly identified, go back to the questions posed to assess in more detail: a) the impacts of climate change and climate variability on agriculture in the project area (*adaptation*); and b) the possible impacts of the project on climate change (*mitigation*). • It is recommended to adopt landscape-level approaches, such as Integrated Ecosystem Management (IEM), for the technical planning and implementation strategy. IEM was developed to ensure that the provision of environmental "goods and services" is sustainable and that the integrity of the ecosystem on which they depend remains intact.The strategy should also seek to capture synergies in terms of technologies and practices by adopting win-win options such as CSA practices listed in **Chapter 2** and **Annex 4**, **Table 4.1**.	• FAO page on CSA: http://www.fao.org/climatechange/70746/en/ • FAO publication "Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production: http://www.fao.org/ag/save-and-grow/ • For approaches, see also **Chapter 2** and **Annex 3**.
Climate change-related activities	1. Have the CC-related activities been identified? 2. Should these activities be bundled under a stand-alone CC component or subcomponent or integrated into other project components?	• See Chapter 3 (under its section "Project/programme preparation stage", sub-section "Moving from concept note to project/programme proposal") for guidance on the definition of CC-related activities • Depending on the relevance of adaptation and/or mitigation to the project and associated strategy, the PT may refer to the options and good practices introduced in **Annex 4** and **Annex 5** • The discussions on the project's results framework can be useful to decide whether to bundle (or not) CC-related activities under a stand-alone CC component. In a technical cooperation project, activities are usually aggregated in components by technical thematic areas such as "improved forest management", "agricultural land management", "addressing climate change adaptation" and "conservation of agro-biodiversity". However, in investment projects, component aggregates consist of (usually) key areas to address barriers/constraints which are impeding the generation of benefits (such as rural poverty alleviation or increased productivity) associated with the project objective. Barrier-related themes in these investment projects are (usually) not technical but cross-cutting themes, such as "capacity development", "planning, policy & institutional strengthening", "advisory services" or "investments to improve production systems". CC activities are usually mainstreamed into these various barrier-related themes; however, depending on the project proponent and donor strategy, they can also be bundled under a stand-alone CC component, provided that this component will also address the identified barriers related to CC.	• **Annexes 4** and **5** • FAO page on Climate-Smart Agriculture: http://www.fao.org/climatechange/70746/en/ • FAO publication "Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production: http://www.fao.org/ag/save-and-grow/ • FAO publication "Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production: http://www.fao.org/ag/save-and-grow/

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
Project results framework and M&E arrangements	1. Have CC considerations been incorporated in the project's results framework (RF)? 2. Have CC-related indicators been identified?	• See **Chapter 3** for general guidance on incorporating CC aspects in the RF and M&E plan; see **Annex 6** for an illustrative list of CC-related indicators for each agricultural sector or theme and a list of indicators collected from FAO's and other development partners' project documents. Once activities have been identified (see row below), ensure that they are properly clustered into the various project components/outcomes foreseen by the project, following the logic of the project's RF. • Determine tools and arrangements to monitor climate change-related indicators included in the project's results framework. Based the final project's RF, incorporate CC considerations in the project's M&E plan. The PT must ensure that the targets and indicators for monitoring the CC outcomes and outputs are clearly defined in the project monitoring plan.	• Annex 6
Institutional aspects	1. What are the implementation arrangements to ensure that CC activities will be properly executed?	• Review the capacity of the collaborating institutions and identify actions required to set up the institutional framework for CC mainstreaming, including discussions and agreement on implementation arrangements. The PT will identify the specific institutions (within the organizational structure of the project executing agency and implementing partners) which will be responsible for executing, monitoring and evaluating the project activities related to CC. This should include assessing the capacity development needs. Where appropriate, delineate reporting links to key national CC institutions and specify potential advisory or quality control support they can provide.	n.a.
Governance	1. Is there any governance risk which could jeopardize the implementation of project activities, including those related to CC?	• Assess whether there are any governance risks (e.g. corruption) that may affect the level of participation and the degree to which target groups may benefit in the proposed project activities (including those related to CC mitigation and adaptation). Determine whether any measures are required to mitigate against the envisaged governance risk, and if so, identify the measures.	• For considerations on monitoring governance of CC finance, see **Chapter 4**.
Intersectoral coordination	1. Have intersectoral linkages been properly addressed?	• Interventions in one sector or system may have implications for others. If intersectoral issues have been identified as relevant (i.e. if they can affect the project objective or the execution of CC activities), the project should consider including interventions on: - integrated landscape planning (e.g. at ecosystem, microcatchment or river basin level), including discussions on CC issues, to ensure that different interventions in individual sectors or areas are consistent with one another; - establishment of institutional mechanisms to facilitate integrated and cross-sectoral management practices such as instances of transferring resources from communities that benefit from ecosystem services to those that help to maintain them; - development of mechanisms for conflict resolution among resource users and other stakeholders in transitions from conventional to integrated ecosystem management approaches; and - development of public/community/private-sector partnerships for integrated ecosystem management planning and implementation.	n.a.

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
		C. Questions, sources and guidance for the supervision stage	
Supervision at project start-up	1. Is consultation with project beneficiaries and partner institutions planned for this stage? 2. Which subjects and documents should be reviewed by the supervision team?	• This dialogue includes supervision mission discussions (preferably workshops) with beneficiaries and partner institutions on their awareness of climate-related activities and outcomes foreseen by the project. • Check the inclusion of CC-related activities and arrangements for implementation (responsibilities) in the following project documents: (i) the operational manual (when required by the donor); (ii) the annual implementation (operational) plan for the first year; (iii) budget and procurement plans; and (iv) the project's monitoring plan. Also ensure that self/internal monitoring will be implemented on an ongoing basis in project management; this, however, should certify that the tools to be employed include ways to measure climate-related indicators included in the project's results framework and also in any additional lower-level indicators (at the output and activity level) included in the project's operational manual and/or annual implementation plan. If possible, a CC expert should be part of this first mission.	n.a.
Project supervision	1. Were all the CC considerations incorporated in project design? If yes, see questions below; if not, are there any CC issues being raised by stakeholders which could affect the achievement of the project's objective?What should be done to reduce this risk? 2. Have field visits and discussions with relevant institutions been planned? 3. Which CC-related subjects and documents should be reviewed by the supervision team? What adjustments are needed?	• If possible, a CC expert should be part of the project supervision and monitoring teams. A project is a process; hence, adjustments are required when well-justified. This expert would also be able to assist in identifying new activities to be proposed in such adjustments, particularly in cases where relevant CC considerations were not incorporated in project design and are ? If yes, see questions below; if not, are there any CC issues being raised by stakeholders which could affect the achievement of the project's objective. • For guidance on field visits and documents to be reviewed, see **Chapter 3** (under its section "Project/programme supervision and evaluation", subsection "Supervision"). • The list of institutions to be visited should be referred to in the project document. For national institutions coordinating and/or implementing CC activities (not necessarily under the project being supervised), see section A.2 of this Annex (institutional aspects).	• See **Chapter 3** on project/programme supervision

Subject	Question	Guidance (e.g. actions, who to talk to)	Sources of information
		D. Questions specific to project evaluation	
Base line information and baseline survey	1. What should be assessed prior to the development intervention in terms of CC?	• Based on CC-related indicators identified during project preparation (and included in the project document), baseline data have to be collected at the beginning of the implementation phase, although some donors and international financing organizations (IFIs) require baseline data collection during project preparation. It serves as a starting point for successful monitoring and evaluation (M&E), providing a basis for measuring progress in achieving project objectives, outcome and outputs. Without knowing what conditions are like prior to the start of a project (including the situation relevant to the execution and monitoring of CC activities), it would be impossible to measure progress. Not too much time or effort should be spent on this process. If specific numbers are not available or if it is too costly to collect data, rough approximations can be used. During a baseline assessment, team members should survey existing data to see if they fit their needs. • A detailed baseline survey/study may also be necessary (see paragraph on this subject in **Chapter 3** under "Project/programme evaluation").	There seem to be no major sources of information on methodologies for baseline collection and survey specific to investment projects incorporating CC considerations. There are, however, various baseline and monitoring methodologies available for stand-alone CC projects, such as the Clean Development Mechanism (CDM) (http://cdm.unfccc.int/methodologies/index.html). Also, for investment projects, each IFI usually has its own guidelines on project evaluation, including guidance on baseline data collection and survey, which can also be useful for CC-related indicators. These are usually available on the IFI homepage/link to evaluation. For example, the Web site of the International Fund for Agriculture Development (IFAD) has a special link to evaluation, to help project managers and M&E staff improve the quality of M&E in IFAD-supported projects:http://www.ifad.org/evaluation/index.htm
Mid-term review (MTR)	1. What should be assessed during MTR in terms of CC?	• See guidance on MTR in **Chapter 3** under "Project/programme evaluation".	See information above on baseline methodologies; it includes information on project evaluation, which is also relevant to MTR.
Project completion andevaluation	1. What could be included in the evaluation to generate lessons learned on achievements related to incorporating CC considerations in the project?	• The ten tasks suggested in **Chapter 3** (under Project Completion Evaluation) should be taken into consideration by the PT while conducting missions and analysis that will support the preparation of the final evaluation report:	See information above on baseline methodologies, which includes info on project evaluation which is also relevant to project completion.

ANNEX 2
Approaches to rapid assessments of impacts of climate variability and climate change on agriculture in the project area

Table of Contents

Introduction

Either at the project formulation stage or during the initial phase of the project, it is recommended to conduct a rapid assessment of the impacts of climate variability and climate change on agriculture in the project area. Such an assessment will be helpful in properly identifying possible effective climate change adaptation activities. It is also advisable to gather basic information on the project site's mitigation potential to guide mitigation activities and seek synergies between adaptation and mitigation.

A set of questions

It is necessary to understand the historical impacts of climate change in order to assess its possible future impacts. A rapid assessment should address the set of questions presented below in order to better characterize the climate interface of the project. This annex will help you answer these questions by discussing where to find basic sets of data from public archives and how to analyse them.

The focus of this annex is on crop agriculture; other agriculture sectors, such as livestock, fisheries and forestry, are not addressed here. However, the same principles should apply to impact assessments on non-crop agriculture, while data requirements and methodologies may differ. Examples of impact assessments in these sectors will be given in a later section to help you design such studies as necessary.

Figure 2.1 illustrates the flow of assessment steps, supporting data and major products, using yield (and/or area harvested) as a proxy for local crop agriculture productivity. The numbers and letters in Figure 2.1 correspond with those that appear in the list of questions below and in the list of minimum assessments (discussed later):

Seasonal climate and crop calendar (1)

- How large is the project area? What are different agro-ecological zones within the area?
- What is the average climate of the project site? What is the seasonal cycle of the local climate? (A)
- What kind of extreme events are common in the project site? At what time of year do extreme events typically occur? (B)
- What are the types of local agriculture? What kind of agriculture does the project address?
- What are local crop calendars? (C)

Historical climate trends (2)

- Do you find a trend in the recent climate records for the project site? (D)
- What is the recent history of local extreme events? (E)

Historical climate impacts on local agriculture (3)

- What is the state of local agriculture under the normal climate?
- How has the productivity of local agriculture changed in the past? Do you find a trend in the state of local agriculture? (F)
- Is there a relationship between climate trends and agriculture in the local area? How has climate been affecting agriculture in the local area? (G)
- What climatic factors affect agriculture more: temperature, rainfall or extreme events? During what time of the year is agriculture more sensitive to climatic factors? (H)
- What can be done to cope with current and historical impacts? (I)

Projected future climate impacts on yields (4)

- What is the projected change in the local climate in the future? What are possible ranges of change? (J)
- What is the projected impact on local agriculture in the future? (K)
- What can be done to cope with projected future impacts (L)?

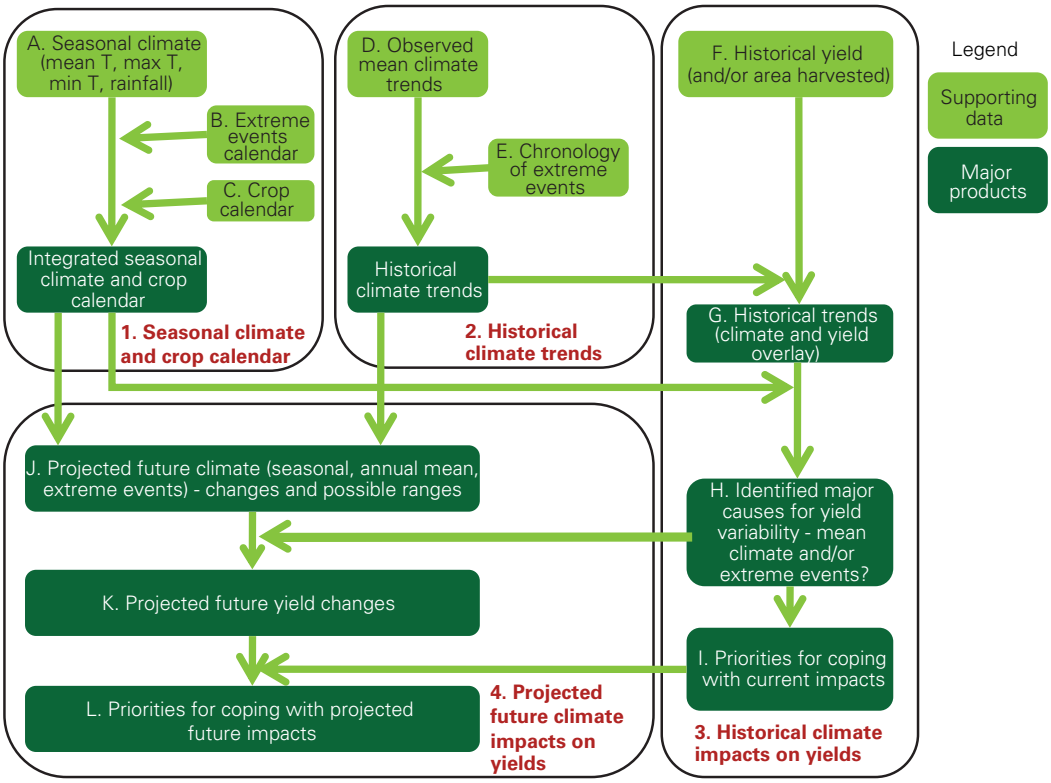
Vulnerability

- What is the nature of local vulnerability to climate change?
- What is the expected direction of changes in vulnerability with interventions?
- What can be the measures for reducing vulnerability?

Mitigation

- What is the emission of an activity?
- What are possible mitigation measures in the local area?
- What are their mitigation potentials?
- How much GHG does the food production chain emit?
- What can be done to increase carbon efficiency?

Figure 2.1
Steps, supporting data and major products from a rapid assessment of climate impacts on crop agriculture



This annex presents practical steps for answering some of these questions regarding seasonal climate and crop calendar, historical climate trends, historical climate impacts on local agriculture, projected future climate impacts on yields and mitigation in the local area. Assessments of vulnerability are beyond the scope of this annex as they usually require much more time and resources.

Minimum assessments

Not all assessments and products are possible because of limited data availability and resources. At the minimum, you should gain an understanding of the following from a rapid assessment:

Seasonal climate and crop calendar (1)

- Normal mean temperature, maximum temperature, minimum temperature and precipitation (monthly scale) for the local area (A)

- Types of extreme events and the seasons (months) they typically occur (B)
- Crop calendars for major crops (C)

Historical climate trends (2)

- No minimum requirements because obtaining long-term data may be difficult

Historical climate impacts on yields (3)

- Qualitative characteristics of climate impacts on yields for the local area (H)

Projected future climate impacts on yields (4)

- Future projected changes in climate for the region and possible range of changes (J)
- Implications for impacts on local agriculture given the projected future climate (K)

Mitigation

- Mitigation potential of possible local mitigation measures

Adaptation

- Possible adaptation measures, which preferably do not conflict with climate change mitigation (I and L)

Rapid literature review of impacts and vulnerability studies

Impact assessment is the practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems. Impact in the context of climate change is defined as the effect of climate change on those systems. Vulnerability is the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change, including climate variability and extremes. It is a function of exposure (i.e. impacts), sensitivity and adaptive capacity (IPCC, 2007).

In order to rapidly draw useful information for adaptation actions, a review of literature is highly recommended to gather already available information for the country and local areas. A literature review would identify knowledge gaps, and a rapid assessment would complement the literature review by collecting additional data and analysing them.

Abundant information on climate change and its impact on agriculture are available at global and regional scales. Information at national and subnational scales are scarcer but can be found from the following sources. These sources of information may or may not be relevant to your project depending on the extent of the project area, but they should give an overview of the state of climate change and agriculture within the country:

- Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Reports. The IPCC fourth assessment reports (AR4) consist of Synthesis Report, Working Group (WG) 1 (science), WG 2 (impacts, adaptation and vulnerability) and WG 3 (mitigation). The most relevant chapters are WG1 Chapter 3 (observations: atmospheric surface and climate change), Chapter 10 (global climate projections) and Chapter 11 (regional climate projections); WG2 Chapter 5 (food, fibre and forest products) and other sector-oriented chapters of your interest as well as Chapters 9 to 16 (by region). http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml
- National Communications to the UNFCCC. They typically report national circumstances, such as geography and climate as well as assessments of impact and vulnerability and adaptation options. http://unfccc.int/national_reports/non-annex_i_natcom/submitted_natcom/items/653.php
- UNFCCC National Adaptation Programmes of Action (NAPAs). They summarize climatic/environmental conditions and identify key adaptation needs of the country. Their focus is on urgent

and immediate needs rather than a long-term perspective. http://unfccc.int/cooperation_support/least_developed_countries_portal/submitted_napas/items/4585.php

- National climate change strategy and action plans. Many countries have designed their own climate change strategies and action plans. These documents should contain an overview of climate change issues in the country.
- Academic papers. Institutions like FAO have subscriptions to literature databases such as Scopus (http://www.scopus.com) and Web of Science (http://www.isiknowledge.com). Peer-reviewed journal articles can be located by searching on these databases with relevant keywords.
- Grey literature (non peer-reviewed reports and other documents). A large amount of information produced for developing countries tends to be published in non peer-reviewed reports. The academic databases mentioned above cover grey literature to some extent. Google Scholar (http://scholar.google.com) can also point you to both peer-reviewed and grey literature.
- National ministries, climate change bodies, research institutions and universities. It is highly recommended to inquire with relevant ministries, institutions and universities in the country for other useful information that is not published on the Internet.

When there are no good existing assessments and associated tools available from relevant institutions at the national/local level, it is highly recommended to conduct a rapid assessment of the impacts of climate variability and climate change on agriculture in the project area, as detailed in the rest of this annex. Impact assessments consist of four broad types of analysis. They are: (1) seasonal climate and crop calendar; (2) historical climate trends; (3) historical climate impacts on yields; and (4) projected future climate impacts on yields.

Seasonal climate and crop calendar

You can start a rapid assessment by assessing the characteristics of the project site and by understanding its local climate (past and current) and local agriculture. Then, examine observed (past and current) impacts of climate variability and climate change on agriculture. This sets the basis for assessing future potential impacts.

Basic characteristics of the project site

In this section, you will answer these questions: How large is the project area? What are different agro-ecological zones within the area?

Agricultural investment projects vary a lot in terms of spatial extent. You should find out the size and basic geography of the project area. If it encompasses different geographic features (e.g. proximity to ocean/lake/river, elevation, terrain), determine whether different agro-ecological zones exist within the area. The Agro-Ecological Zones (AEZ) approach, developed by FAO in collaboration with the International Institute for Applied Systems Analysis (IIASA), enables rational land-use planning on the basis of an inventory of land resources and an evaluation of their biophysical limitations and potential for crop production. At this stage of rapid assessment, it is sufficient to consult several global maps (Plate A-L) from the 2002 report (Fischer *et al.*, 2002). If distinctly different agro-ecological characteristics are found within the area, the same set of rapid assessments needs to be done for each agro-ecological zone.

Climate normals

In this section, you will answer these questions: What is the average climate of the project site? What is the seasonal cycle of the local climate? (A)

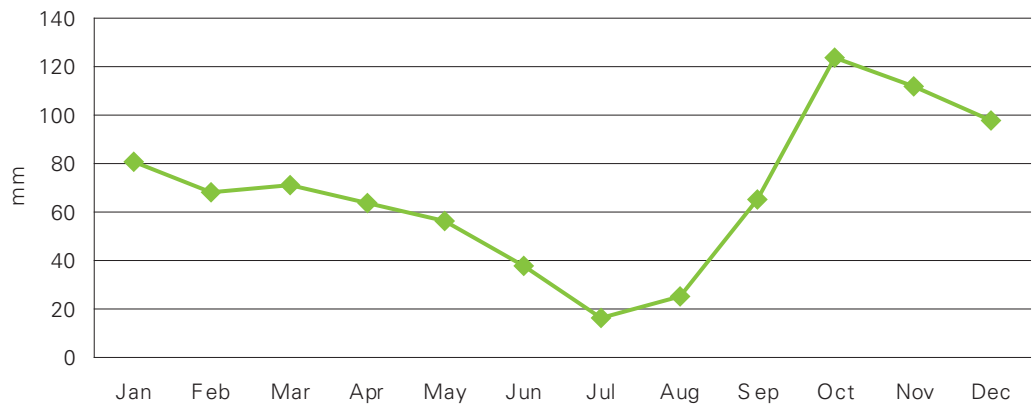
Basic climatic variables of interest to the agricultural sector include precipitation (i.e. rainfall), temperature (i.e. daily maximum, daily minimum, daily mean), wind speed and direction, solar radiation,

humidity, evaporation and runoff. They are measured at tens of thousands of land-based weather stations across the world at least once a day and often more frequently. They are complemented by observation by ships, radiosondes, aircraft and satellites. The data collected at each weather station are archived by different frequencies (e.g. hourly, daily, monthly and yearly), usually by national weather services. Some of the data are shared through the World Meteorological Organization with the international community, and others are withheld by the country. Therefore, it is advisable to inquire with the national weather service about data availability in the first place. This annex presents an alternative way to draw information mainly from public Web sites and services. Please note that data availability varies significantly by location, country, climatic variables and temporal frequencies, and data quality also varies. Whenever possible, choose quality-controlled data.

The data are usually available at points (e.g. weather stations) or on grids (spatial resolution may vary). If you are dealing with a large area and want to visualize climate and impacts in a map, gridded data may be easier to use than station data. In this annex, we focus on climate information at a particular location, mainly from land-based weather station data, because they are the primary data source for any local area. Even though this annex gives general pointers to useful online resources, proper processing and interpretation of climate data often require expert knowledge. It is strongly recommended to read the background document that accompanies data sets to understand the nature of the data before using them for your work. In case you cannot find data at your project location, use data from neighbouring locations or at different scales (e.g. provinces or even national data), but interpret the data carefully considering spatial heterogeneity in climate, agricultural practices and ecosystems. It is recommended to obtain the longest-possible datasets in order to establish observed trends (discussed later), but be aware of changes in observation locations and measurement methods which may cause discontinuity in time series (irrespective of climate change).

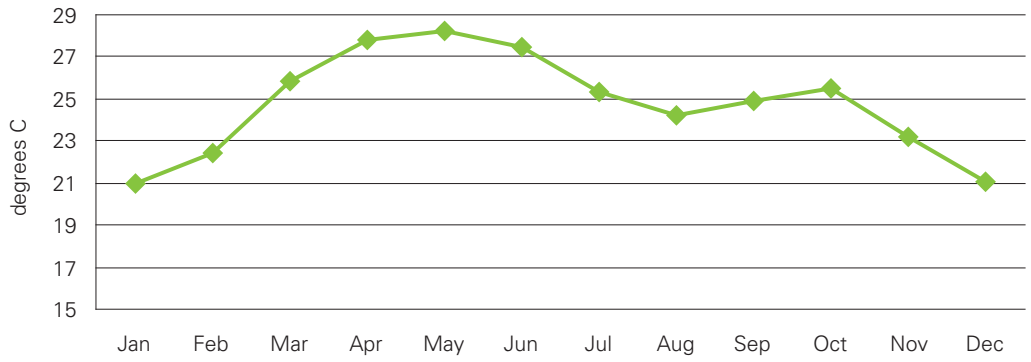
Climate change manifests itself in mean changes in climate and also in shifts in seasonal cycles. Therefore, it is always important to understand long-term mean climate (both annual mean and seasonal cycle) at a location. Climate normals are usually an average of a 30-year period (e.g. 1961 to 1990). There are a number of Web sites where you can get such data. In addition, FAOClim-NET provides weather station data (i.e. monthly climate normals, 1961–1990) from all over the world. There is no need for special software for simple analyses. See Figure 2.2 for a sample plot of precipitation drawn in Excel. You will understand the seasonal cycle of rainfall (i.e. dry season and rainy season).

Figure 2.2
Long-term average precipitation in Rome (1961-1990)



For locations where no weather station is available, it may be possible to derive information by spatially interpolating data from neighbouring stations. FAO's New_LocClim and Web LocClim provide interpolation tools with monthly, dekadal (10-daily) and daily data. The desktop application New_LocClim has more functions than its Web counterpart, Web LocClim. Figure 2.3 is a sample plot of temperature drawn in Excel with output from Web LocClim.

Figure 2.3
Long-term average temperature in Nyala, Sudan (1961-1990)

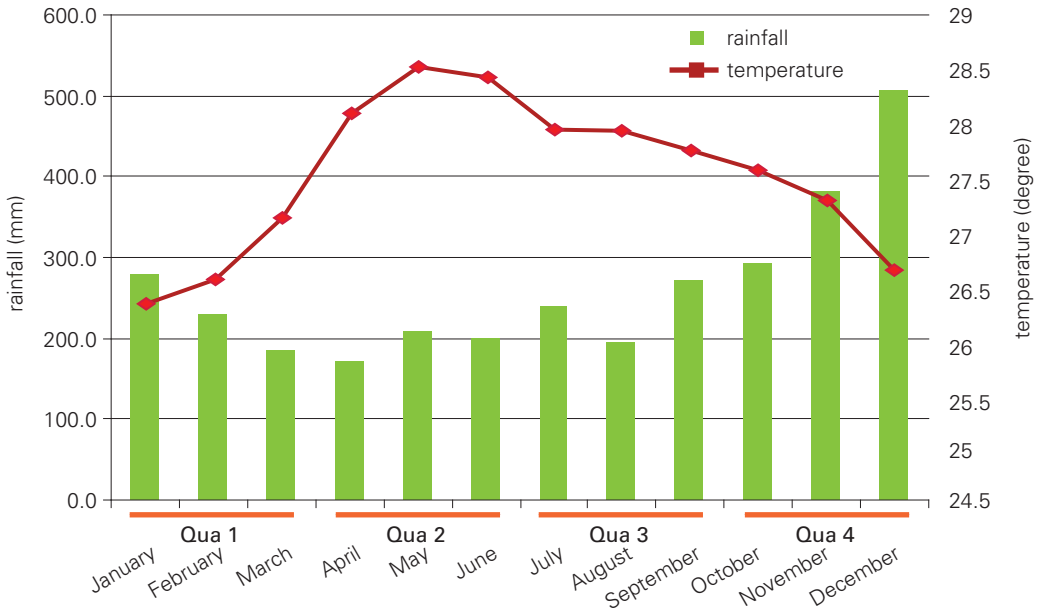


Extreme events

In this section, you will answer these questions: What kind of extreme events are common in the project site? At what time of year do extreme events typically occur? (B)

Intensity and frequency of extreme weather events are expected to change because of climate change. There are many types of extreme weather events: heat wave, wind storm, cold spell, drought, flooding, heavy rain, etc. You should learn which types of extreme events are common in the local area – and in which months/seasons they tend to occur – by talking with farmers and other local people. You can combine the extreme events information with temperature and precipitation plots to produce a climate calendar. Figure 2.4 is an example of a seasonal climate calendar from a project in the Philippines.

Figure 2.4
Seasonal climate calendar for Bicol, the Philippines (1994-2009)



Annual rainfall: 3,200 mm
Wetter season: Qua 4: Typhoons
Mean annual air temperature: 27.3°C
Drier season: Qua 2: Drought

Local agriculture

In this section, you will answer these questions: What are the types of local agriculture? What kind of agriculture does the project address?

At this point you should review the types of local agriculture, e.g. crops, livestock, forestry, aquaculture or fisheries:

- Climate change has direct effects on livestock productivity because of heat stress, changes in water availability, livestock diseases and disease vectors. Climate change will also affect the quality and quantity of available feed supply and the carrying capacity of pastures.
- Fisheries and aquaculture production systems are likely to suffer from increased water temperatures, rise in sea levels and decreased pH, changes in sea productivity patterns, flooding, droughts and increases in frequency and intensity of storms and other extreme weather events.
- Forests and rangelands will be sensitive to climate variation, weather extremes and long-term changes, such as changes in day, night and seasonal temperatures; storm patterns; duration and intensity of heat waves; droughts and floods; presence of invasive species; incidence of pests and diseases; frost, snow and ice cover; biodiversity; and increases in wildfires.

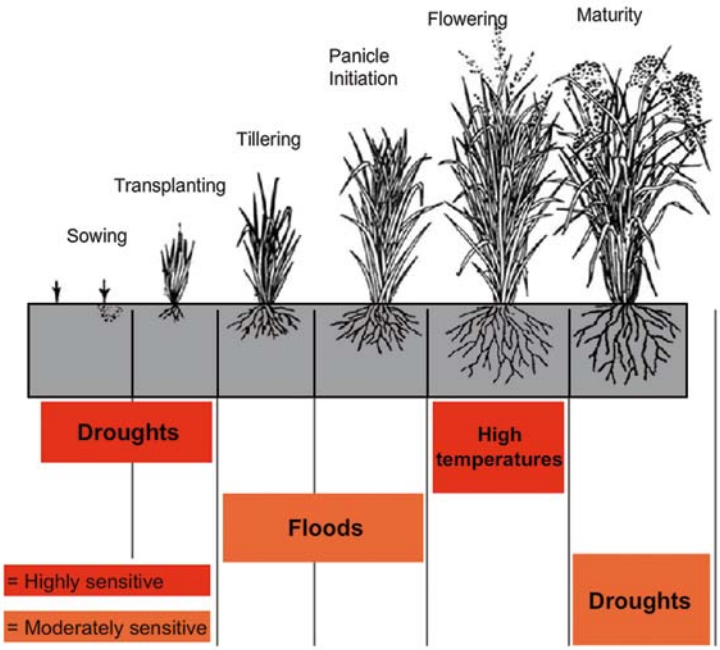
The rest of this annex focuses on crop agriculture; non-crop agriculture is beyond the scope of this document, except for references to some sample studies which are discussed later.

Crop calendar

In this section, you will answer this question: What are local crop calendars?(C)

Crops are affected by climate differently through their life cycle. Figure 2.5 illustrates the sensitivity of rice to different types of extreme events; it helps to understand the stages of crop growth that are most commonly affected by seasonal extreme climate events.

Figure 2.5
Sensitivity of rice crop to climate-related extremes



Source: FAO E-learning tool

Talk with farmers and extension workers about the major crops that are cultivated in the local area. In order to understand local agricultural practices, compile a crop calendar from sowing to harvesting for each major crop. You can start with the FAO crop calendar and revise it after becoming familiar with the local situation (http://www.fao.org/agriculture/seed/cropcalendar/welcome.do). For example, the database tells you that the sowing/planting period for sweet potato in Uganda's southwestern highlands is from 15 April to 30 September and the harvest period is between 25 July and 28 February. Note there is also a possibility of the double cropping farming system and changes in the system over time. Also you should make sure to verify the information from databases with local people.

To create an integrated seasonal climate and crop calendar, combine crop calendars with climate calendar results. Figure 2.6 is an example of crop calendar and extreme events calendar. You can also easily plot temperature and the seasonal rainfall cycle along with these calendars.

Figure 2.6
Crop and extreme events calendar for Shandong, China

Source: FAO E-learning tool

Historical climate trends

Historical mean climate trend

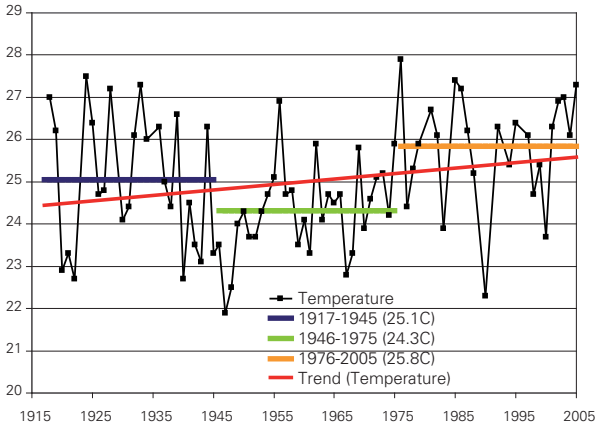
In this section, you will answer this question: Do you find a trend in the recent climate records for the project site? (D)

To determine if there has indeed been a significant trend in the historical climate record, you need to obtain long time series of weather station observations. FAOClim-NET provides long time series from around the world, and from there you can obtain monthly averages. Daily averages are much more useful as crops are usually affected by weather at much smaller temporal scales (10 days or shorter) than monthly scales. Extreme weather events, such as heavy rainfall (i.e. over a few days), may not be apparent in climate records at monthly time scales and may require analysis at daily scales.

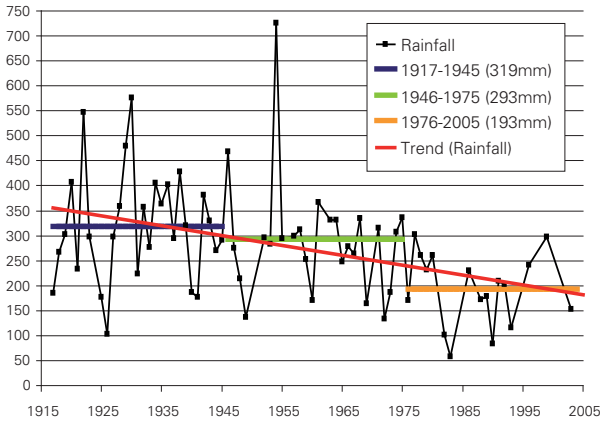
There are a number of public data archives that provide daily averages or information from stations that FAOClim-NET does not cover. The United States National Climatic Data Center (NCDC) offers a wide range of data (e.g. Global Historical Climatology Network (GHCN), Global Summary of the Day (GSOD)). Figures 2.7(a) and 2.7(b) are plots drawn in Excel using NCDC Global Climate Observing System (GCOS) Surface Network Monthly (GSNMON) data for El Fahser, Sudan.

Figure 2.7
Time series of temperature and rainfall in El Fasher, Sudan

(a) March mean temperature (degrees C)



(b) Annual rainfall (mm)



While you can find a long-term increasing trend (linear regression) of March temperature over the 89-year period plotted, the middle 30-year block (1946-1975) was actually cooler than the preceding 29 years (1917-1945), according to this local record. Therefore, it is important to obtain the longest record possible when you examine trends. If the data were not quality controlled, we could not rule out the possibility that the trend might not be true, but be due, for example, to changes in the location of the weather station or its surrounding environment. Please also note large year-to-year variability, particularly with rainfall, which is often larger than the observed long-term rate of change in mean climate. For investigating long-term trends of climatic variables, you can analyse either annual averages or only selected months for the growing season, rainy season, dry season, etc.

The next best data to weather stations, when station data cannot be found from public archives, is high-resolution gridded observations (such as those from the University of East Anglia's Climatic Research Unit (UEA CRU)) which offer data on 0.5-degree grids. However, be mindful that weather stations are still the original source of the data that went into the gridded products. So, in places where stations do not exist, they are interpolated from neighbouring stations that may be quite far away. Thus, only limited confidence can be placed on climate information in those places, even if sophisticated methods are used to fill the gap.

Historical trend of extreme events

In this section, you will answer this question: What is the recent history of local extreme events? (E)

It is a good idea to produce a chronological list of historical extreme weather events for the location, however qualitative and subjective it may be. EM-DAT[1] is a database of historical disasters at the country level. UNEP PREVIEW[2] also provides an overview of natural disaster risks in a given country. You may also be able to identify historical extreme weather events from weather data (preferably at a daily scale).

When analysing extreme events, pay particular attention to intensity and frequency – both of which are expected to change in the future. Heavy precipitation events can be found in monthly rainfall

1 The WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) maintains an Emergency Events Database EM-DAT.

2 PREVIEW stands for Project for Risk Evaluation, Information and Early Warning. It is supported by UNEP, UNDP/Bureau for Crisis Prevention and Recovery (BCPR)'s Global Risk Identification Program (GRIP), UNISDR and World Bank.

data (compared with climate normals) or daily rainfall data (i.e. a sum of daily values for a series of consecutive rainy days). Heat waves can be recognized in monthly temperature averages (i.e. either daily maximums, daily minimums or daily means, compared with the normal climate for the same month) or the number of consecutive hot days (above a certain threshold which can be defined for a given location) in daily temperature data. Droughts can be characterized by total monthly precipitation (compared with a normal climate) or by the number of consecutive no-rain days. Frequency can be expressed, for example, in the number of extreme events per year.

In order to analyse the nature of disasters that are not purely meteorological (e.g. flooding, landslides, agricultural/hydrological droughts), most probably you would need to get data from relevant institutions.

Historical climate impacts on local agriculture

Agriculture under a normal climate

In this section, you will answer this question: What is the state of local agriculture under a normal climate?

You have compiled crop calendars for major crops. Now, to understand local agricultural productivity, you should consult with local farmers and extension workers to find out the expected production, yield and/or harvested area under a normal climate (i.e. without particularly good or bad weather) through a cropping season at the subnational (or smaller) administrative unit of the project area. You can also obtain data about the size of the planted area, in addition to the harvested area. Whenever possible, look for data on all these variables because crop yield and harvested area are affected by climate in different ways. When collecting data, distinctions should be made between different types of agricultural practices (e.g. irrigated and rainfed croplands) because they have different responses to climate conditions.

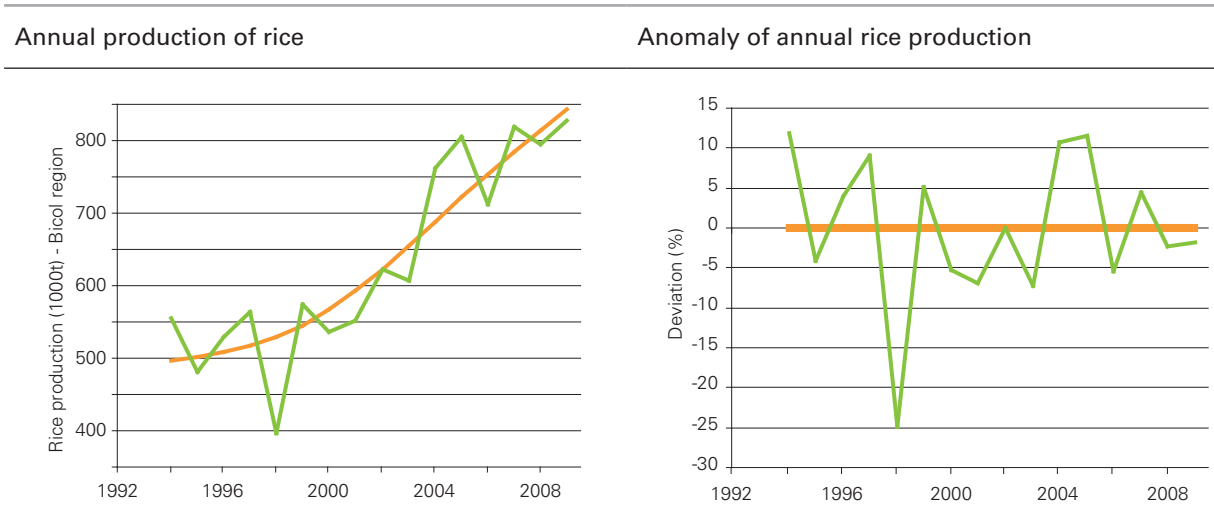
Past trend in local agriculture

In this section, you will answer this question: How has the productivity of local agriculture changed in the past? Do you find a trend in the state of local agriculture? (F)

To learn more about how climate has been affecting agriculture, you should try to obtain long time series data on crop yields, production and harvested/planted area by contacting national and local institutions that handle agricultural statistics. Depending on data availability, you can either study the project site, the province where it is located or the entire country if data at smaller spatial scales are not available. For national data, FAOSTAT, which provides time-series and cross sectional data relating to food and agriculture for about 200 countries, may be useful.

You can plot a time series of annual (or seasonal) crop yield, production or harvested/planted area to see how much variability exists from year to year or to see if there is an increasing/decreasing trend in the series. A steady increasing trend may be due to progress in technology (e.g. better varieties, infrastructure, fertilizer use) and may have nothing to do with climate. In such a case, the time series may be "detrended" by subtracting increasing technology effects from it.If you see any jumps in the data series, contact someone knowledgeable about local agriculture to find out why. It could be errors in the data set, significant policy changes, changes in the way statistics are logged, etc. Figure 2.8 is an example of detrending rice yields.

Figure 2.8
Annual yield of irrigated rice for each quarter of the year in Bicol, the Philippines and its long-term trend found by fitting a smooth curve (left), and % deviation from the trend (detrended year-to-year anomaly)

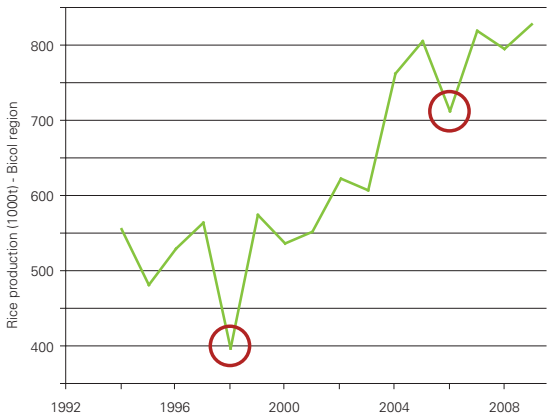


Relationship between past climate and agriculture

In this section, you will answer this question: Is there a relationship between climate trends and agriculture in the local area? How has climate been affecting agriculture in the local area? (G)

After obtaining long-term data of climate and agriculture, you may plot a time series of crop yield with climatic variables (e.g. temperature, rainfall and extreme events) side-by-side. For example, do you see a drop/gain in yield in years with smaller/larger rainfall? Do you find a loss in yield when an extreme event was reported? Please note that different types of extreme events affect different combinations of crops and practices (e.g. irrigation vs. rainfed).In Figure 2.9, the decline in annual rice production of Bicol (in the Philippines) appears to be related to recorded large typhoons (1998 and 2006).

Figure 2.9
Annual rice production of Bicol, the Philippines



If there is no apparent relationship between the two time series (i.e. agriculture vs. climate) with annual average climate data, consider looking at monthly/seasonal data. You can try to establish a statistical relationship between the series, but it is beyond the scope of a rapid assessment.

Identifying dominating climatic factors

In this section, you will answer these questions: What climatic factors affect agriculture more: temperature, rainfall or extreme events? What time of the year is agriculture more sensitive to climatic factors? (H)

There are many pairs of climate and agriculture variables which may have a meaningful causal relationship. Examine different pairs carefully. There are usually only one or two dominating climatic factors (e.g. average climatic variables or extreme events) that affect a particular crop under a particular agricultural practice. You can also pay attention to critical stages of crop growth (refer to crop calendars) that are especially susceptible to changes in climate or extreme events.

Figure 2.10 shows an example of dominating extreme events that impacted major crops in Bicol, the Philippines, which were found by multiple regressions. The same study went further (Figure 2.11) to derive common types of extreme events that affect a crop by quarter and by production system (i.e. irrigation or rainfed).

Figure 2.10
Chronology of dominating extreme events that impacted rice production in Bicol, the Philippines. (Quarter 1=green, 2=blue, 3=yellow and 4=red)

	Rice			
Year	Qua 1	Qua 2	Qua 3	Qua 4
1994				
1995				Rainfall
1996	Rainfall			
1997				
1998		Drought		Rainfall Wind
1999				
2000	Rainfall			
2001				
2002				
2003		Drought		
2004				
2005				
2006				Wind
2007				
2008	Rainfall			
2009				

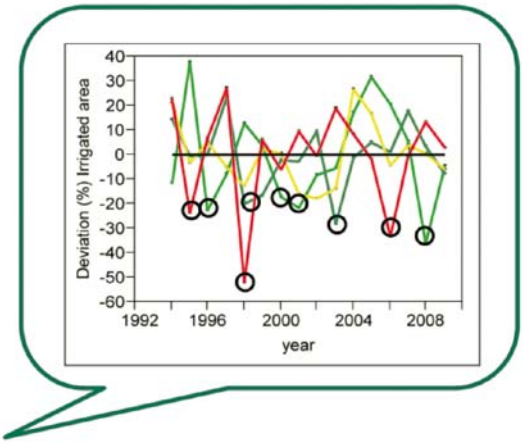


Figure 2.11
Generalized dominating extreme events that impact rice yield and area harvested by quarter and by production system (i.e. irrigation and rainfed), in Bicol, the Philippines.
(+) means positive and (-) means negative impact for yield or area harvested.

	Yield		Area Harvested	
Type	Irrigated	Rainfed	Irrigated	Rainfed
Qua 1	Total rainfall (-)		Total rainfall (-)	
Qua 2	Total rainfall (-)	dry spell (-)	dry spell (-)	Total rainfall (+)
Qua 3	dry spell (+)	dry spell (+)	dry spell (+)	
Qua 4	max wind (-) dry spell (+)	max wind (-)	max wind (-)	

Adaptation options
In this section, you will answer this question: What can be done to cope with current and historical impacts? (I)

It is suggested that you discuss your findings on climatic factors critical to local agricultural productivity with local extension workers and other knowledgeable professionals. The type of impact assessment we have been discussing so far is a top-down approach. This is a point where you can check whether the data-driven assessment agrees with the local perception of current and past climate risks. If there are discrepancies between these, you need to investigate why: Are the data not appropriate in terms of spatial scale and temporal scale? Are there critical errors in the data? Are you making assumptions in the analysis that may not hold? Are local farmers' perceptions biased by misconceptions and prejudice?

Once you agree on which critical climate risks for local farming need to be tackled, you can consult with subject experts and relevant institutions (e.g. an agronomist and water resources manager) to come up with viable adaptation options. You can start by asking how farmers have been coping with weather extremes in the past. Are they diversifying sources of income by growing more than one type of crop, or working in non-crop agriculture or a non-agriculture sector? Do they count on aids from the government in a bad crop year? Ideally, the actions for adapting to climate risks should boost productivity without degrading environmental conditions and without increasing greenhouse gas emissions.

To give you an example, the Bicol study found that excessive water from typhoons is a larger problem than drought is for rice. Therefore, improving the drainage system and introducing water-tolerant varieties would be effective in reducing rice yield loss. On the other hand, corn was found to be more sensitive to droughts than rice, so better irrigation systems would be a good option for corn fields.

Projected future climate impacts on yields

Projected future climate
In this section, you will answer these questions: What is the projected change in the local climate in the future? What are possible ranges of change? (J)

Future projections of climate are outputs from global climate models which typically operate at a coarse resolution of about 200km x 200km. IPCC Data Distribution Center, CMIP3 and CMIP5 (Coupled Model Intercomparison Project Phase 3 and 5) archives provide global climate model outputs, but expert

knowledge is usually needed to analyse those data. Data on such a coarse resolution is usually not relevant or useful for local applications. There are, however, Web sites that offer data on global climate change projections in an accessible format for non-experts, including the University of Cape Town's Climate Information Portal (CIP) and the World Bank Climate Change Knowledge Portal.

Global data are often translated into finer spatial scales by downscaling methods for use by applications (e.g. impact and vulnerability assessment studies, adaptation projects). FAO's Modelling System for Agricultural Impacts of Climate Change (MOSAICC) has a module for statistical downscaling. Performing climate downscaling requires expert knowledge, so it is beyond the reach of rapid assessments.

Downscaled climate data are often produced for specific applications by experts, but there are a few sites that provide ready-made downscaled products. University of Cape Town's Data Dissemination System is an example. Under a new programme, Coordinated Regional Climate Downscaling Experiment (CORDEX), institutions worldwide are currently running models to compare downscaled climate data, which will be made available to the public soon.

There are a couple of cautionary notes about the use of future climate projections:

Uncertainties. Future climate projections carry inherently deep, multi-layered uncertainties, and we only discuss a few of them here. We do not know how human activities will evolve in the coming decades, which will determine GHG emissions and further affect future climate change. All projections are based on emission scenarios that represent possible socio-economic development pathways. Even for the same emission scenario, different climate models project different future climates, although all of them are known to reasonably reproduce the past climate. Therefore, it is highly recommended to not base your assessment on one global climate model and one emission scenario. Always choose at least a couple of climate models and a couple of emission scenarios to understand the range of possible future climates.

Use of climate model outputs. Usually you cannot subtract current local climate values (observation) from future projected climate values (model output) to derive the size of future climate change because model outputs have biases and do not exactly match observation. Instead, take the difference between the future and current climate from the same model in order to quantify future changes in local climate.

Projected impact on agriculture

In this section, you will answer this question: What is the projected impact on local agriculture in the future? (K)

An assessment of future changes in crop yield requires technical expertise beyond a rapid assessment. One way to do this is to establish a statistical relationship between the local climate and yield and then apply the same relationship to the future climate to derive the future yield. Note that in the immediate future (e.g. the next 10 years), the interannual variability may be much larger than long-term changes in mean climate. Therefore, it is even more important to understand the local nature of extreme weather impacts and assume the possibility for the same or even worse impacts in the future.

Another, more elaborate, way to project future changes is to calibrate a crop model with historical climate, yield and other data, and use the same model to estimate future yields. See, for example, a study on future climate change impacts on Moroccan crop yields (FAO, 2009a). FAO's tool called MOSAICC facilitates such studies by national institutions.

Adaptation options

In this section, you will answer this question: What can be done to cope with projected future impacts (L)?

Once you understand the future potential impacts of climate change on agriculture, you should see if there are any significant changes in the characteristics of climate risks between the present (as identified in previous sections) and the future. It is a good idea to revisit the integrated seasonal climate and crop calendar and examine potential shifts in the seasonal cycles. The exercise will highlight adaptation measures for future climate change. Modifications to the set of current adaptation options (as identified by assessing current risks), taking into account future impacts, should be made in consultation with experts and relevant institutions. Additional consideration may be given to the mitigation potential of selected actions (presented in a separate section) whenever appropriate.

Detailed assessments

When a project is identified as relevant to climate change by rapid climate change assessments or climate change screening, and when specific climate change components/interventions are included in the project concept note, it is necessary during project preparation to assess the availability of relevant data and information and identify gaps in order to propose complementary studies that can enable quantitative analysis. More elaborate assessments usually require good data, i.e. long time-series of relevant variables at appropriate locations.

As an extension to assessing projected future yield changes (K in Figure 2.1), you can assess future impacts of climate change by employing FAO's MOSAICC, for example. MOSAICC consists of climate downscaling, crop models, hydrology models and economic models. It is necessary to form a national team of technical experts and provide training so they can run models after calibrating them for local conditions. With MOSAICC, the team can downscale historical climate and future projections to a local scale and simulate future surface water resources, evaluate crop yield changes and derive economic implications for the country. There are also a number of other crop models (often for specific crops), water models and economic models.

As an extension to assessing projected future climate (J in Figure 2.1), you can suggest downscaling historical and future climate data, rather than using ready-made products. In addition to MOSAICC's downscaling component, there are a number of tools such as Providing REgional Climates for Impacts Studies (PRECIS) of the UK Met Office and the Statistical Downscaling Model (SDSM). These tools can be run only by trained experts. Please note that downscaling is not a magic operation that can provide all the information you need at local scales. If global climate models perform poorly at a location (e.g. large uncertainties in future rainfall projection), a downscaling method (which uses global climate model data as inputs) cannot reduce such uncertainties. You may want to think backwards from the end product (e.g.the impact and vulnerability information you need) and decide if downscaling is really necessary to produce the information.

As an extension to assessing adaptation options (I and L in Figure 2.1) and mitigation options, you can summarize and compare possible adaptation and mitigation practices in terms of their cost-benefit, technical complexity and effectiveness. Before implementing any interventions, it is suggested to investigate and summarize local-friendly practices for measuring and assessing the effectiveness of adaptation and mitigation actions. This will contribute to formulating and implementing the project monitoring and evaluation (M&E) framework.

Impact assessments for livestock, forestry and fisheries

This annex focuses on rapid assessments for crop agriculture, but a few notable studies for livestock, forestry and fisheries are mentioned below as a reference when designing impact assessments for non-crop agriculture sectors:

- For an overview of how climate change affects livestock see Thornton *et al*. (2007) and Thornton *et al*. (2009). Batima (2006) assessed impacts of climate change on Mongolia's livestock sector from climate projections, including water resources, snow cover, permafrost, pasture and finally livestock. The report concludes with suggested adaptation measures.
- For the forestry sector, Forner (2006) provides their project's approach to assessments ("Tropical Forests and Climate Change Adaptation, TroFCCA"), which could be adapted for your use. Zhao *et al*. (2005) discuss climate impacts on forestry with case studies from the Philippines and Malaysia. Kirilenko and Sedjo (2007) provide more forest industry-oriented views of the impacts of climate change on forestry.
- Allison *et al*. (2005) is a good overview document about climate change impacts and the vulnerability of fisheries from poverty-reduction perspectives. Brander (2010) discusses the impacts of climate change on fisheries in general, including methodologies. Brander (2007) discusses a multitude of climate-related threats to future fish production. For freshwater fisheries, see also Ficke *et al*. (2007). For marine wild capture fisheries, Perry (2010) summarizes potential impacts from recent studies.

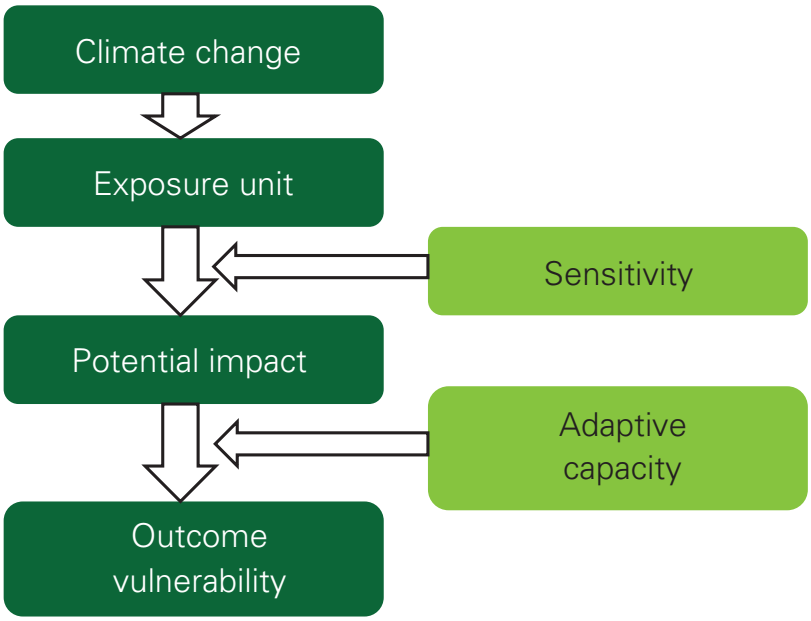
Vulnerability

In this section, you will answer these questions: What is the nature of local vulnerability to climate change? What is the expected direction of changes in vulnerability with interventions? What measures can reduce vulnerability?

While decision-makers must know the impacts of climate change on agriculture sectors, they also need to understand the current and future vulnerabilities of their food systems, ecosystems, societies and national economies to the impacts of climate change and variability.

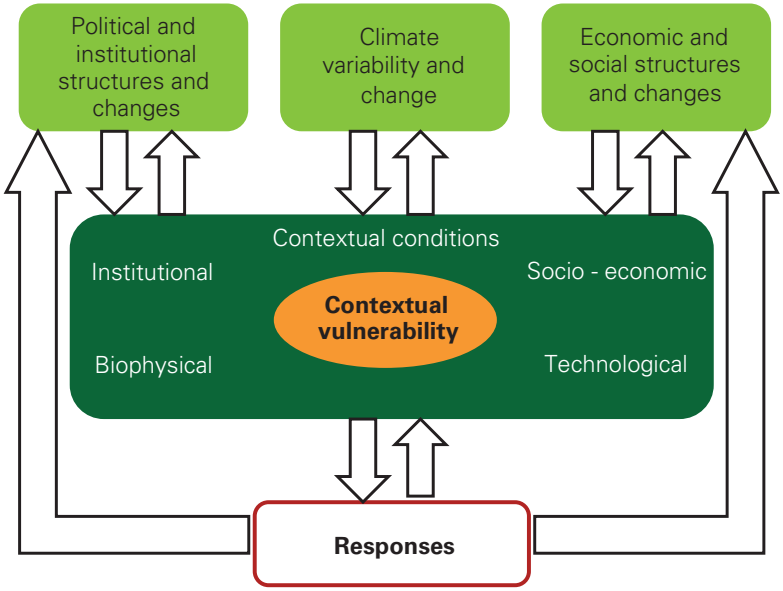
There are a number of definitions of vulnerability. The IPCC defines vulnerability as "the degree to which a system or society is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes" (Figure 2.12). In addition to biophysical impacts assessed in previous sections, an analysis of vulnerability would require an evaluation of local adaptive capacities to cope with the expected impacts.

Figure 2.12
Outcome vulnerability is a function of exposure, sensitivity and adaptive capacity



This definition of vulnerability is referred to as "outcome vulnerability" as opposed to "contextual vulnerability" which takes a more holistic view of the issue. In the contextual vulnerability assessment framework, climate projections are only one part of the assessment of threats to social and environmental resources (other parts include political and institutional changes and economic and social changes, as shown in Figure 2.13); however, this kind of assessment makes it possible to identify the most vulnerable area/sector/practice that requires immediate attention.

Figure 2.13
Contextual vulnerability



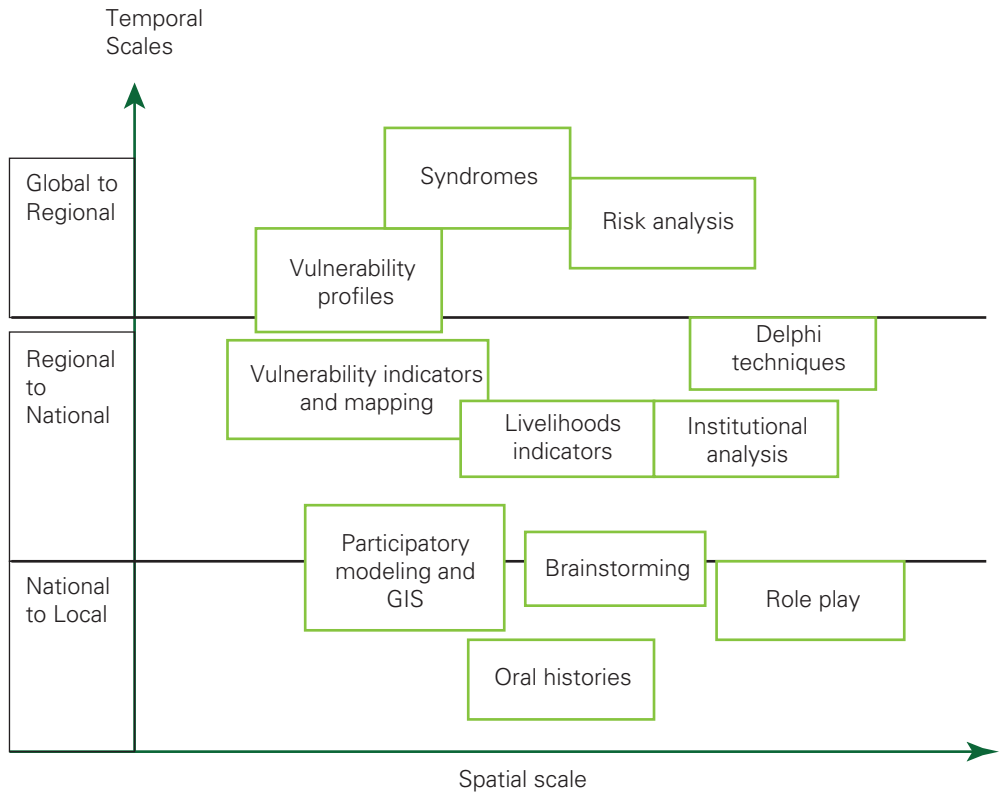
Source: Adapted from O'Brien et al., 2007

Vulnerability assessments usually require much more data than impact assessments and elaboration, and they cannot be conducted in a rapid way. Any vulnerability assessment should carefully consider the context (i.e. physical, socio-economic and institutional), temporal and spatial scales and inherent uncertainties to offer a framework for policy measures for adaptation. An assessment should be designed to answer these questions from the adaptation community:

- Which main population sectors, household groups, etc. are at risk in a given area?
- What are the dominant factors contributing to their vulnerability?
- What actions should we take, given that we cannot exactly predict the future, to reduce the possibility of an undesirable outcome to an acceptable level?
- What is the best strategy given a variety of possible outcomes?

Vulnerability assessments are not conducted using just one set of tools which could be applied to any situation. There are a variety of tools that can be used for different vulnerability assessments (see Figure 2.14). It is very important for you to know how to choose a methodology for the appropriate temporal and spatial scales of your study.

Figure 2.14
Vulnerability assessment tools on different temporal and spatial scales



Source: Environment Development Action in the Third World (ENDA), 2004

There are several questions to ask when selecting relevant tools for vulnerability assessments:

- What is the context and who are the users/clients of the assessment?
- What is the time scale of the problem?
- What are the expected results of the policies?
- What is the targeted scale/spatial level?
- Which stakeholders are involved in the assessment?
- What resources (e.g. time, finance) are available for the assessment?

You can also focus on specific aspects of vulnerability – food security, rural livelihoods, agro-ecosystems, etc. Once you understand the characteristics of local vulnerability (whether of the outcome or contextual type), it is good to simulate the impact of proposed project interventions. An intervention may reduce a certain type of vulnerability, but may expose the same community to a new risk. A vulnerability model could be used to design a strategy that would minimize overall vulnerability to a range of possible risks.

Mitigation

In this section, you will answer these questions: What are possible mitigation measures in the local area? What is their mitigation potential? How much GHG does the food production chain emit? What can be done to increase carbon efficiency?

To the extent possible, it is recommended that you gain an understanding of current carbon stocks and emissions of GHGs from the agriculture, fisheries, forestry and other land-use sectors in the project area, as well as possible impacts of project interventions on GHG emissions and mitigation possibilities.

Rapid literature review

GHG emissions vary a lot (e.g. by location, ecosystems, soil, agricultural practices, source of emission, type of gas), so it may be difficult to make even a back-of-the-envelope estimate. Nevertheless, the following resources may at least help to understand possible ranges of a typical value:

- IPCC Fourth Assessment Reports (http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml)These reports consist of a Synthesis Report, Working Group 1 (science), Working Group 2 (impacts, adaptation and vulnerability) and Working Group 3 (mitigation). The most relevant chapters for mitigation are Chapter 8 (agriculture) and Chapter 9 (forestry) in Working Group 3.
- National communications, which typically report national GHG inventory and mitigation measures. These include: national communications by the countries to the UNFCCC (http://unfccc.int/national_reports/items/1408.php); national climate change strategy and action plans; academic papers; grey literature (i.e. non peer-reviewed reports and other documents); and publications of national ministries, climate change bodies, research institutions and universities (see also under "Rapid literature review of impacts and vulnerability studies" above).

Emissions, mitigation options and potential

In this section, you will answer these questions: What is the emission of an activity? What are possible mitigation measures in the local area? What is their mitigation potential?

There are a number of resources that provide relevant data which can help you answer these questions. They are briefly described below:

IPCC's Task Force on National Greenhouse Gas Inventories (TFI) publishes guidelines for national GHG inventories. Two of the most relevant publications are "2006 IPCC Guidelines for National Greenhouse Gas Inventories" and "Good Practice Guidance for Land Use, Land-Use Change and Forestry". TFI

also offers the Emission Factor Database (EFDB), which is a database on emission factors and other parameters with background documentation or technical references that can be used for calculating emissions by sources and removals by sinks of GHGs. The estimated emission of a given emission/removal activity is calculated as the intensity of the activity multiplied by an emission factor. Parameters reported from similar environmental conditions and emission estimates based on them could be used as a reference for a rapid assessment in the project development stage.

Seeberg-Elverfeldt and Tapio-Biström (2011) (not yet published; see their Tables 2.2 to 2.5 quoted below as Table 2.1) give an overview of the GHG mitigation potential of practices (i.e. agroforestry, grassland, crop farming, and rice management) in different regions.

More succinct information is available in a 2010 FAO publication – Global survey of agricultural mitigation projects, Mitigation of Climate Change in Agriculture Series 1 (FAO, 2010b) – in its Table 4 (quoted below as Table 2.2; compiled from IPCC AR4 WG3) and Annex I, where examples are provided from different case studies of the carbon sequestration and mitigation potential of different land-use systems. In the cases presented in FAO (2010b), all projects use different methodologies for estimating GHG emissions: the Voluntary Carbon Standard methodology for the adoption of sustainable agricultural land management (SALM) by farmers; the Clean Development Mechanism (CDM) methodologies; the Plan Vivo Standards; and other measurement methodologies with carbon accounting through forestry assessment, IPCC guidelines and carbon soil determination methodologies. Also, see Annex II of FAO (2010b) for more information on the range of methodologies for agriculture, forestry and other land uses from different institutions.

Written mainly for the United States, T-AGG Report (Eagle *et al.*, 2011) describes the mitigation potential for a variety of agricultural management practices (e.g. conservation tillage) and conversions of land use (e.g. from cropland to pasture). The numbers presented could be used as a rough indication of mitigation potential in different locations. See Table 31 of the report for a comparison of all practices (quoted below as Table 2.3), in which the authors present three categories of GHG impacts: (1) change in soil C; (2) change in land emissions (N_2O and CH_4); and (3) change in upstream and process emissions (e.g. fuel, fertilizer and other).

There are other references available for specific practices. For soil carbon sequestration, West and Post (2002) looked at the effects of changing from conventional tillage to no-till and enhancing crop rotation (see their Table 2 and 3). For agroforestry, Nair *et al.* (2009) reviewed the carbon sequestration potential of prominent agroforestry systems (see their Table 1).For grassland management, Conant and Paustian (2002) summarized potential carbon sequestration by continent, level of current overgrazing and climate (see their Tables 4 and 5). FAO (2009b) gives a good summary of potential in drylands pastoral systems. Tennigkeit and Wilkes (2008) review the carbon sequestration potential of rangeland management practices (see their Table 6). Thornton and Herreros (2010) reviewed mitigation options and their potential for livestock and pasture management. Wassmann *et al.* (2000) present mitigation opportunities and potential for reducing methane emissions from rice fields.

The Ex Ante Carbon-balance Tool (EX-ACT) of FAO (http://www.fao.org/tc/exact/en/) is a more elaborate tool for *ex ante* estimations of the impact of agriculture and forestry development projects on GHG emissions and carbon sequestration; however, it is not appropriate for rapid assessments because it requires some data collection. It is a set of Excel sheets to estimate changes in emissions from land-use and management practices using IPCC default values and ad hoc coefficients. Although the use of EX-ACT may be beyond rapid assessment in the project development stage, it is recommended to use EX-ACT for a project with more focus on mitigation activities in the initial stage of project implementation. The EX-ACT model can be used to refine project components and activities in order to

increase (whenever possible) the project's mitigation benefits. The following information is needed in EX-ACT:

- current land use, together with land-use changes, in the "without project" and"with project" scenarios, with a description of the possible relevant farming systems, livestock production, input use, and other project investments; and
- land management options which will be promoted within every subsector (e.g. forests, cropland, grasslands).

If the aforementioned data are not available, you may hold discussions with relevant stakeholders during the conceptualization stage to plan for obtaining data later during the preparation phase.

For farm-level assessments, there is also the Cool Farm Tool (http://www.unilever.com/aboutus/supplier/sustainablesourcing/tools/?WT.LHNAV=Tools) which allows farmers to calculate their carbon footprint and how to reduce it.

Life cycle assessment

In this section, you will answer these questions: How much GHG does the food production chain emit? What can be done to increase carbon efficiency?

A life cycle assessment (LCA) approach is necessary to estimate the GHG emissions on the entire food chain throughout the life cycle of a product, including production, transport of inputs (e.g. fertilizer, pesticide and feed), transport of the product, processing, packaging and distribution of the product to retailers.

The LCA approach is widely accepted in agriculture and other industries as a method to evaluate the environmental impacts of production and to identify the resource and emission-intensive processes within a product's life cycle (FAO, 2010c). The method is defined in the International Organization for Standardization (ISO) standards 14040 and 14044 (ISO, 2006).The methodology is useful for identifying effective approaches to reduce emissions or for studying the effect of a certain change in a production process on the overall lifecycle.

However, a comprehensive LCA requires a large set of data which may not be always available for the agriculture sector. There are also many subjective elements in an LCA model, such as system boundary delineation, functional units and allocation techniques. Sensitivity tests would clarify the relative importance of those elements in an LCA study.

A good starting point is FAO's LCA study of the dairy sector (FAO, 2010c), which presents an overview of typical LCA study specifications, including data and methodology. Another short introduction to LCA is a fact sheet by Australia Climate Change Research Strategy for Primary Industries (CCRSPI) (2009).

The International Dairy Federation (IDF) has also produced a useful LCA guideline for the dairy sector (IDF, 2010). For the livestock sector, a good example is the European Union's Joint Research Centre study (Leip *et al.*, 2010). For the agriculture and horticulture commodities, there is a UK Department for Environment, Food and Rural Affairs (DEFRA) report (Williams *et al.*, 2006), which covers production of bread wheat, oilseed rape, potatoes, animal feed crops, grasslands and tomatoes, crop by-products and feed processing, buildings and machinery and animal production.

List of resources

Climate change science

- FAO E-learning Tool Community-based adaptation to climate change, Module 1, http://www.fao.org/climatechange/67624/en/
- IPCC, 2007a, Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html
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- CMIP3 (Coupled Model Intercomparison Project) Multi-Model Dataset Archive http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php
- CMIP5 http://cmip-pcmdi.llnl.gov/cmip5/
- CORDEX Coordinated Regional Climate Downscaling Experiment, http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEX.html
- EM-DAT http://www.emdat.be/database
- FAO Climpag, http://www.fao.org/nr/climpag
- FAOClim-NET, http://geonetwork3.fao.org/climpag/agroclimdb_en.php Data from over 20 000 weather stations worldwide. Monthly averages from 1950s to present and climatological mean (1961-1990).
- FAO E-learning Tool Community-based adaptation to climate change, Module 2 Climate Change and Food Security, http://www.fao.org/climatechange/67624/en/
- FAO New_LocClim http://www.fao.org/nr/climpag/pub/en3_051002_en.asp
  and FAO Web LocClim http://www.fao.org/nr/climpag/locclim/locclim_en.asp
  Both provide estimates of average climatic conditions at locations for which no observations are available. New_LocClim can: (a) create climatic maps; (b) extract data in various formats from the database for further processing; and (c) display graphs showing the annual cycle of monthly climate and the crop calendar.Web LocClim provides (b) only. The user can choose from several interpolation methods and apply standard corrections such as altitude corrections. Data from over 20 000 weather stations worldwide. 30-year climatological mean of monthly, dekadal (10-day) and daily record.
- FAO MOSAICC http://www.fao.org/climatechange/mosaicc
- FAO STAT http://faostat.fao.org/
- FAO, 2009a, Impact of climate change on agricultural yields in Morocco, http://www.fao.org/nr/climpag/pub/FAO_WorldBank_Study_CC_Morocco_2008.pdf
- FAO, 2010a, Climate change, water and food security, http://www.fao.org/docrep/014/i2096e/i2096e00.htm
- FAO, 2011a, A Technical Report for the Study on Impacts of Climatic Variability on Agriculture in the Bicol Region of the Philippines: Implications for climate change adaptation
- Fischer et al., 2002. Global Agro-ecological Assessment for Agriculture in the 21st Century: Methodology and Results http://www.fao.org/nr/land/databasesinformation-systems/aez-agro-ecological-zoning-system/en/

- Forner, C., 2006. An introduction to the impacts of climate change and vulnerability of forests. Background document for the Southeast Asian Kick-off meeting of the project Tropical Forests and Climate Change Adaptation ("TroFCCA"), Bogor, 29 – 30 May 2006.
- GTZ, 2009. Climate change information for effective adaptation. A practitioner's manual http://www2.gtz.de/dokumente/bib-2009/gtz2009-0175en-climate-change-information.pdf
- International Research Institute for Climate and Society (IRI) Climate database, http://iridl.ldeo.columbia.edu/docfind/databrief/cat-atmos.html
  Provides a large number of climate datasets
- IPCC Data Distribution Center http://www.ipcc-data.org/
- IPCC, 2007b, Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html
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- UNEP PREVIEW Global Risk Data Platform, http://www.grid.unep.ch/index.php?option=com_content&view=article&id=73&Itemid=400&lang=en&project_id=1765D705 Spatial data information on global risk from natural hazards.
- UNFCCC National Communications non-Annex I Parties, http://unfccc.int/national_reports/non-annex_i_natcom/submitted_natcom/items/653.php
- UNFCCC NAPA National Adaptation Programmes of Action, http://www.grid.unep.ch/index.php?option=com_content&view=article&id=73&Itemid=400&lang=en&project_id=1765D705
- University of Cape Town, Climate Systems Analysis Group, Data Dissemination System
  Downscaled regional climate change data (currently for Asia and Africa)
- University of Cape Town, Climate Information Portal, http://cip.csag.uct.ac.za/webclient/introduction
  Observational climate data as well as projections of future climate, globally (as of August 2011, CIP seems to be still under development).
- University of East Anglia (UEA), Climatic Research Unit (CRU), High-resolution gridded data and country climate data http://www.cru.uea.ac.uk/cru/data/hrg/
- US National Climatic Data Center (NCDC) http://www.ncdc.noaa.gov/oa/ncdc.html. Under NCDC there are a number of useful data products. Here are a few examples:
  - GCOS Surface Network (GSN), Monthly (GSNMON), http://cdo.ncdc.noaa.gov/pls/plclimprod/cdomain.abbrev2id?datasetabbv=GSNMON
  - Global Surface Summary of Day (GSOD), http://lwf.ncdc.noaa.gov/cgi-bin/res40.pl?page=gsod.html
  - GHCN (Global Historical Climatology Network), http://www.ncdc.noaa.gov/oa/climate/ghcn-daily
  - http://www.ncdc.noaa.gov/ghcnm/
- World Bank Climate Change Knowledge Portal, http://sdwebx.worldbank.org/climateportal/
  Key climate variables (historical and projections) from different data sources. Most data are at 2-degree grid, and some are weather station levels. Also crop yield projections from Global Agro-ecological Zones (G-AEZ)

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Table 2.1.
Mitigation potential of different management practices

Table 2.2 Carbon sequestration potential in different agroforestry systems

Farming practice	Region	t CO_2/ha/yr	Source
Fodder bank	Ségou, Mali, W. African Sahel	1.06	Takimoto *et al.* (2008)*
Coffee-based system	Central Kenya	1.80	Forest Trends (2010)
Live fence	Ségou, Mali, W. African Sahel	2.17	Takimoto *et al.* (2008)*
Tree-based intercropping	Canada	3.05	Peichl *et al.* (2006)*
Traditional agroforestry parklands	Ségou, Mali, W. African Sahel	4.00	Takimoto *et al.* (2008)*
Silvopasture	W. Oregon, USA	4.07	Sharrow and Ismail (2004)*
Agrisilviculture	Chattisgarh, Central India	4.62	Swamy and Puri (2005)*
Silvopastoralism	Kurukshetra, India	5.03	Kaur *et al.* (2002)*
Full-sun cocoa	Southern Cameroon	7.19	Gockowski and Sonwa (2011)
Shaded cocoa	Southern Cameroon	13.03	Gockowski and Sonwa (2011)
Home and outfield gardens	Panama	15.74	Kirby and Potvin (2007)*
Agroforestry woodlots	Kerala, India	23.97	Kumar *et al.* (1998)*
Indonesian homegardens	Sumatra	29.36	Roshetko *et al.* (2002)*
Cacao agroforests	Turrialba, Costa Rica	40.66	Beer *et al.* (1990)*
Agroforestry woodlots	Puerto Rico	44.19	Parrotta (1999)*
Mixed species stands	Puerto Rico	55.82	Parrotta (1999)*

Sources with * reviewed in Nair *et al.* (2009).

Table 2.3 Carbon sequestration potential of different grassland management practices

Farming practice	Region	t CO_2/ha/yr	Source
Transition from heavy to moderate grazing	Eurasia	0.18	Conant and Paustian (2002)
Transition from heavy to moderate grazing	Australia/Pacific	0.33	Conant and Paustian (2002)
Avoided land cover/land-use change	Global	0.40	Tennigkeit and Wilkes (2008)
Transition from heavy to moderate grazing	North America	0.59	Conant and Paustian (2002)
Transition from heavy to moderate grazing	Africa	0.77	Conant and Paustian (2002)
Improved grazing management, rangeland	USA	1.26	Eagle *et al.* (2010)
Fertilization on grasslands	Global	1.76	Tennigkeit and Wilkes (2008)
Improved grazing on rangelands	Global	1.98	Conant *et al.* (2001)
Grazing management	Global	2.16	Tennigkeit and Wilkes (2008)
New grasslands	USA	2.20	FAO (2010b)
Transition from heavy to moderate grazing	South America	2.53	Conant and Paustian (2002)
Fire control on grasslands	Global	2.68	Tennigkeit and Wilkes (2008)
Improved grazing management, pasture	USA	4.26	Eagle *et al.* (2010)
Vegetation cultivation	Global	9.39	Tennigkeit and Wilkes (2008)

Table 2.4 Carbon sequestration potential in crop farming management practices

Farming practice/system	Region	t CO_2/ha/yr	Source
Diversify annual crop rotations	USA	0.66	Eagle *et al.* (2010)
Organic agriculture	Global	0.73–1.46	Niggli *et al.* (2009)
Conventional to no-tillage	USA	1.12	Eagle *et al.* (2010)
Conventional to conservation tillage	USA	1.23	Eagle *et al.* (2010)
Conventional to no-tillage	Global	2.09	West an d Post (2002)
Maize-based farming system (increasing residue production, tree plantations)	Western Kenya	2.10	Forest T rends (2010)
Application of organic matter (manure)	USA	2.63	Eagle *et al.* (2010)

Table 2.5 Mitigation potential of rice management practices

Farming practice/system	Region	t CO_2e/ha/yr	Source
Rice variety development for CH_4	various sites	1.34	Eagle *et al.* (2010)
Rice water management for CH_4	various sites	1.94	Eagle *et al.* (2010)

Source: Tables 2.2 to 2.5 of Seeberg-Elverfeldt & Tapio-Biström (2011)

Table 2.2.
Annual mitigation potential for different climate regions for agricultural practices

Table 4. Annual mitigation potential for different climate regions for agricultural practices

Improved land management practice	all GHG (t CO_2eq/ha/yr)			
	Cool-dry	Cool-moist	Warm-dry	Warm-moist
Agronomic practices	0.39	0.98	0.39	0.98
Soil nutrient management	0.33	0.62	0.33	0.62
Tillage and residue management	0.17	0.53	0.35	0.72
Water management	1.14	1.14	1.14	1.14
Set-aside and land cover (use) change	3.93	5.36	3.93	5.36
Agroforestry	0.17	0.53	0.35	0.72
Grazing, fertilization, fire	0.13	0.80	0.11	0.81
Restoration of organic soils	33.51	33.51	70.18	70.18
Restoration of degraded soils	3.53	4.45	3.45	3.45
Application of manure/bio-solids	1.54	2.79	1.54	2.79
Bioenergy (soils only)	0.17	0.53	0.35	0.72

Source: IPCC, 2007

Source: Table 4 of FAO (2010)

Table 2.3.
Comparison of GHG mitigation potential for agricultural land management practices in the United States, summarized from scientific literature.

Activity	Soil Carbon (t/ha/yr)			Land Emissions (N_2O and CH_4, t/ha/yr)			Direct Impact (t/ha/yr) [sum of the two]
	Mean	Max	Min	Mean	Max	Min	Mean
Conventional to no-till	1.08	2.60	-0.26	-0.18	0.72	-0.91	0.90
Conventional to conservation till	0.91	1.82	0.00	0.07	0.38	0.00	0.98
Eliminate summer fallow	0.48	2.35	-0.88	-0.03	0.16	-0.30	0.45
Use winter cover crops	0.84	3.24	0.37	0.20	1.05	0.00	1.03
Diversify annual crop rotations	0.58	3.01	-2.50	0.07	0.33	-0.04	0.65
Include perennial crops in rotations	0.57	2.20	-1.75	0.03	0.55	-0.55	0.59
Change from annual to perennial crops	2.26	4.67	0.00	0.12	0.84	-0.55	2.38
Application of organic materials (esp. manure)	2.19	5.10	0.18	0.19	1.81	-1.35	2.38
Reduce fertilizer N application rates	0.00	0.00	0.00	0.38	1.32	0.14	0.38
Change fertilizer N source – slow-release	0.00	0.00	0.00	0.46	1.43	0.00	0.46
Use nitrification inhibitors	0.00	0.00	0.00	1.01	2.23	0.00	1.01
Improve manure management (N_2O)		No data		0.89	1.22	0.37	0.89
Rice water management for CH_4	0.00	0.00	0.00	1.56	5.22	-0.88	1.56
Rice variety development for CH_4	0.00	0.00	0.00	1.17	2.71	0.00	1.17
Reduced rice area*		No data		4.82	10.26	2.32	4.82
Improved grazing management, rangeland	0.93	4.99	-0.10	0.28	0.31	0.27	1.22
Improved grazing management, pasture	2.71	5.86	0.55	0.28	0.31	0.27	2.99

Source: Adapted from Table 31a of Eagle et al. (2011)

Note: All GHG units are in equivalents of carbon dioxide (CO2e) with 100-year time horizon global warming potential.
* Impact of reduced rice acreage depends on subsequent land use. These estimates account for elimination of current CH4 emissions

ANNEX 3
Tools and information systems for climate change adaptation and mitigation in agricultural sectors

ANNEX 3
Tools and information systems for climate change adaptation and mitigation in agricultural sectors

Tools and information systems	Description	Sources and links
1. General context and overall guidance		
The fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC): climate change 2007- synthesis report Core Writing Team, R.K. Pachauri & A. Reisinger (eds.) IPCC, Geneva, Switzerland. 104 pp.	Contributions of Working Groups I, II and III to IPCC AR4, which provides an integrated view of CC, including (i) observed changes and their effects;(ii) causes of the observed changes; (iii) projections of future change and related impacts; (iv) adaptation and mitigation options and their interactions with sustainable development; (v) relationship between adaptation and mitigation; and (vi) major findings and remaining key uncertainties in the assessment.	http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html
IPCC AR4: climate change 2007 - the physical science basis S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, H.L. Miller (eds.) Cambridge University Press, Cambridge, UK and New York, NY, USA, 996 pp.	Contribution of Working Group I to IPCC AR4, which provides: the most complete and quantitative assessment of human affects on the radiative energy balance in the atmosphere; a more extensive assessment of changes observed throughout the climate system; a detailed assessment of past CC and its causes; the first probabilistic assessment of climate model simulations and projections; and a detailed assessment of CC observations, modeling, and attribution for every continent.	http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html
IPCC AR4: climate change 2007- impacts, adaptation and vulnerability M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (eds.) Cambridge University Press, Cambridge, UK and New York, NY, USA.	Contribution of Working Group II to IPCC AR4, which provides a comprehensive assessment of the CC literature on observed changes; the methods available for impacts analysis and scenarios; current and future CC impacts on systems, sectors and regions; vulnerabilities to these impacts and strategies for adaptation; possible adaptation responses and the synergies with mitigation; and the inter-relationships between CC and sustainability.	http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html
IPCC AR4: climate change 2007- mitigation of climate change B. Metz, O.R. Davidson, P.R. Bosch, R. Dave & L.A. Meyer (eds.) Cambridge University Press, Cambridge, UK and New York, NY, USA.	Contribution of Working Group III to IPCC AR4, which provides authoritative, timely information on all aspects of technologies and socio-economic policies, including cost-effective measures, to control GHG emissions.	http://www.ipcc.ch/publications_and_data/ar4/wg3/en/contents.html
2. Strategies, policies and frameworks		
2.1. General and agricultural sector documents		
Climate Change and Food Security. E-learning course. FAO, 2011	A basic discussion ofCC and food security, including climate science, CC adaptation, mitigation and CSA.	http://www.fao.org/climatechange/learning@155440/en
FAO profile for climate change FAO Rome, 2009	An FAO policy paper, which briefs the context of CC adaptation, mitigation, food security and sustainable development in agricultural sectors; introduces general approaches and options for capturing the synergies and managing the trade-offs; and outlines FAO current and future priorities on CC.	ftp://ftp.fao.org/docrep/fao/012/i1323e/i1323e00.pdf
FAO Framework Programme on Climate Change Adaptation (FAO-Adapt) FAO Rome, 2011	Discusses CC impacts on the agriculture sectors and food security; defines adaptation in the context of the agriculture sectors; describes means and measures for adaptation; introduces FAO's work on CC adaptation with its core principles and priority adaptation themes and actions; and presents FAO-Adapt's implementation proposals.	http://www.fao.org/climatechange/27594-03ecd7bd225b93086e7dca3944de64307.pdf

Tools and information systems	Description	Sources and links
FAO Framework Programme on Disaster Risk Reduction (FP DRR)	Provides strategic direction to the implementation of DRR measures in member states across the agricultural-related sectors. Promotes an interdisciplinary and programmatic approach to DRR by integrating the agriculture, livestock, fisheries, forestry and natural resource management sectors to respond more effectively to the diverse livelihoods of small-scale farmers and to the complex set of factors which contribute to disaster risk.	http://www.fao.org/docrep/015/i2540e/i2540e00.pdf
Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities FAO Rome, 2007	Reviews the impacts of CC in agricultural sectors; outlines the framework and approaches for CC adaptation in agriculture, forestry and fisheries; and introduces FAO's work related to CC adaptation.	ftp://ftp.fao.org/docrep/fao/009/j9271e/j9271e.pdf
Climate change and food security: a framework document FAO Rome, 2008	Provides background information on the interrelationship between CC and food security and ways to deal with the new threat. Shows opportunities for the agriculture sector to adapt, and describes how it can contribute to mitigating the climate challenge.	ftp://ftp.fao.org/docrep/fao/010/a1508e/a1508e00.pdf
"Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production FAO Rome, 2011	Provides a new approach to face CC (a quote on this publication from the New York Times: "To feed a growing world population, we have no option but to intensify crop production; but farmers face unprecedented constraints; in order to grow, agriculture must learn to save.")	http://www.fao.org/ag/save-and-grow/
Climate change, water and food security - FAO water reports No. 36 Turral, H., Burke, J. & Faurès, J. FAO Rome, 2011	Summarizes current knowledge of the anticipated impacts of CC on water availability for agriculture; examines the implications for local and national food security; discusses the methods and approaches to assess CC impacts on water and agriculture; emphasizes the need for closer alignment between water and agricultural policies; and makes the case for immediate implementation of "no-regrets" strategies.	http://www.fao.org/docrep/014/i2096e/i2096e00.htm
Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies. Mann, W., Lipper, L., Tennigkeit, T., McCarthy N.& Branca, G.FAO. 2009.	Explores potential synergies among food security, adaptation and CC mitigation from land-based agricultural practices in developing countries, which could help to generate the benefits needed to address the many demands placed on agriculture. Presents promising mitigation options with synergies, options that involve trade-offs, possible options for required financing and possible elements in designing country implementation processes.	http://www.fao.org/docrep/012/i1318e/i1318e00.pdf
Climate Change Mitigation Finance for Smallholder Agriculture - A guide book to harvesting soil carbon sequestration benefits Lipper, L., Neves, B., Wilkes, A., Tennigkeit, T., Gerber, P., Henderson, B., Branca, G. & Mann, W. FAO, 2011	Focuses on CC mitigation financing for smallholders. FAO, however, fully recognizes that adaptation may be the imperative and the priority over the short- and medium-term for many smallholders in circumstances where CC may adversely impact their efforts to overcome poverty and food insecurity. In many cases, most countries will need to deal with both adaptation and mitigation. FAO supports national efforts on CSA which seek to enhance the capacity of the agricultural sector to sustainably support food security, livelihoods and growth under CC, incorporating the need for adaptation and the potential for mitigation into development strategies. CC mitigation financing can play a role, along with other sources of financing, in enabling CSA.	http://www.fao.org/docrep/015/i2485e/i2485e00.pdf
Identifying opportunities for climate-smart agriculture investments in Africa Branca, G., Tennigkeit, T., Mann, W. & Lipper, L. FAO, 2011	Proposes a methodology to examine the potential of existing National Agriculture and Food Security Investment Plans (NAFSIPs, prepared through the Comprehensive Africa Agriculture Development Programme – CAADP, under the New Partnership for Africa's Development - NEPAD) to generate CC benefits. A rapid screening methodology is presented and applied to 14 NAFSIPs, all of which include agricultural development programmes/ subprogrammes that benefit: (1) adaptation to slow-onset climatic change and extreme events; and (2) CC mitigation.	http://www.fao.org/docrep/015/an112e/an112e00.pdf

Tools and information systems	Description	Sources and links
Climate-Smart Agriculture: A Synthesis of Empirical Evidence of Food Security and Mitigation Benefits from Improved Cropland Management Branca, G., McCarthy, N., Lipper, L. & Jolejole, M.C. MICCA series n.3. FAO, 2011	Synthesizes the results of a literature review reporting the evidence base of different sustainable land management (SLM) practices aimed at increasing and stabilizing crop productivity in developing countries. It is shown that soil and climate characteristics are key to interpreting the impact on crop yields and mitigation of different agricultural practices and that technology options most promising for enhancing food security at the smallholder level are also effective for increasing system resilience in dry areas and mitigating CC in humid areas.	http://www.fao.org/docrep/015/i2574e/i2574e00.pdf
Climate-Smart Agriculture: Smallholder Adoption and Implications for Climate Change Adaptation and Mitigation McCarthy, N., Lipper, L. & Branca, G. MICCA series n.4. FAO, 2011	Reviews the adaptation and mitigation benefits from various practices, focusing in detail on empirical evidence concerning costs and barriers to adoption, both from household and project-level data. Findings indicate that up-front investment costs can be a significant barrier to adoption for certain investments and practices, and evidence also supports the hypotheses on opportunity and transaction costs across a wide range of investments and practices. Additionally, potential synergies among food security, adaptation and mitigation opportunities, as well as costs, can differ substantially across different agro-ecological zones, climate regimes and historical land-use patterns.	http://www.fao.org/docrep/015/i2575e/i2575e00.pdf
Strategic framework for forests and climate change Collaborative Partnership on Forests, FAO Rome, 2009	Lays the groundwork for a coordinated response from the forest sector to CC, notably through the adoption of sustainable forest management and its integration into broader development strategies.	http://www.fao.org/forestry/16639-064a7166b1dd027504bbfbb763878af99.pdf
Climate Change for Forest Policy-Makers -An approach for integrating climate change into national forest programmes in support of sustainable forest management FAO Rome, 2011	Provides a practical approach to the process of integrating CC into national forest programmes. Aims to assist senior government officials and the representatives of other stakeholders, including civil society organizations and the private sector, to prepare the forest sector for the challenges and opportunities posed by CC.	http://www.fao.org/forestry/29498-0c35173780c27b13d094d92ad8d599afa.pdf
Climate change implications for fisheries and aquaculture - FAO fishery and aquaculture technical paper 530 K. Cochrane, C. D. Young, D. Soto & T. Bahri (eds.) FAO Rome, 2009	Contains three comprehensive technical papers that formed the basis for the technical discussions during the Expert Workshop on CC Implications for Fisheries and Aquaculture in April 2008 at FAO headquarters, which reviews climate variability and change and the physical and ecological consequences on marine and freshwater environments; analyses the consequences of CC impacts on fishers and aquaculture; and discusses possible adaptation and mitigation measures.	ftp://ftp.fao.org/docrep/fao/012/i0994e/i0994e.pdf
Strategy for Fisheries, Aquaculture and Climate Change. Framework and Aims 2011–2016. FAO, 2011	Provides the medium-term (2011–2016) framework defining the perspectives and objectives of the Fisheries and Aquaculture Department with respect to CC issues and development responses, and its coherence and operational effectiveness with respect to more localized delivery through regional and subregional offices.	ftp://ftp.fao.org/fi/brochure/climate_change/stragegy_fi_aq_climate/2011/climate_change_2011.pdf
Climate change and food security in Pacific island countries FAO Rome, 2008	Reviews the impacts of CC on food sources and water in the Pacific island countries; provides national assessments in selected countries; proposes recommendations for national strategies to mitigate, adapt and respond to the challenges; and presents the report of a regional expert group.	ftp://ftp.fao.org/docrep/fao/011/i0530e/i0530e.pdf
Coping with a changing climate: considerations for adaptation and mitigation in agriculture Glantz, M. H., Gommes, R., & Ramasamy, S. FAO, 2009, Rome	Elaborates on issues of less-than-perfect information on climate impacts and vulnerabilities, and the need for better-informed decisions. Offers new perspectives for policy-makers, institutions, societies and individuals on improved ways of identifying most at-risk communities and "best practices".	http://www.fao.org/docrep/012/i1315e/i1315e.pdf

Tools and information systems	Description	Sources and links
Climate smart agriculture - policies, practices and financing for food security, adaptation and mitigation FAO, 2010, Rome	Provides examples of climate-smart production systems; highlights the knowledge and technical gaps; examines the role that institutionsandpolicy mustplayinthetransformat iontoclimate-smart production systems; and discusses the financial opportunities, the shortfalls and constraints to be resolved.	http://www.fao.org/docrep/013/i1881e/i1881e00.htm
Food security and agricultural mitigation in developing countries: options for capturing synergies FAO Rome, 2010	Explores potential synergies among food security, adaptation and CC mitigation from land-based agricultural practices in developing countries, which could help to generate the benefits needed to address the many demands placed on agriculture. Indicates promising mitigation options with synergies, options that involve trade-offs, possible options for required financing and possible elements in designing country implementation processes.	http://www.fao.org/docrep/012/i1318e/i1318e00.pdf
Harvesting agriculture's multiple benefits: mitigation, adaptation, development and food security FAO Rome, 2010	As an FAO policy brief, advocates the establishment of a work programme on agriculture, within the CC convention process, and an interlinked suite of country-owned and led pilot projects to develop readiness to implement agricultural mitigation options with adaptation, food security and development synergies.	ftp://ftp.fao.org/docrep/fao/012/ak914e/ak914e00.pdf
Climate change response strategies for agriculture: challenges and opportunities for the 21st century Tubiello, F., Schmidhuber, J., Howden, M., Neofotis, P.G., Park, S., Fernandes, E. & Thapa, D. The World Bank, Washington, DC, 2008	Reviews CC impacts on plant function and farm-level production systems; analyses the repercussions of these local impacts on regional and global food productions discusses adaptation strategies; identifies synergies between adaptation strategies and mitigation options; and recommends practical and operational options from the perspective of short- and long-term sustainable rural development and agricultural planning.	http://www.fao.org/fileadmin/templates/em2009/docs/World_Bank__2008c_.pdf
Building climate resilience in the agriculture sector of Asia and the Pacific International Food Policy Research Institute (IFPR), Asian Development Bank, 2009	Provides a critical synthesis of the evidence and future scenarios of CC in the region; analyses the impacts of agriculture on CC and the impacts of CC on agriculture; assesses the policy and investment options for development practitioners and policy-makers; and outlines a conceptual framework for building CC resilience in the agriculture sector in the region.	http://beta.adb.org/publications/building-climate-resilience-agriculture-sector-asia-and-pacific
	2.2. National policies and priorities	
National Communications to the UNFCCC (including those for non-Annex I Parties)	Reports national circumstances, such as geography and climate, as well as assessments of impact and vulnerability and adaptation options, GHG inventory and mitigation measures.	http://unfccc.int/national_reports/items/1408.php Non-Annex I Parties: http://unfccc.int/national_reports/non-annex_i_natcom/submitted_natcom/items/653.php
National Adaptation Programmes of Action (**NAPAs**) UNFCCC, 2010	Provides the latest list of NAPAs submitted by parties and reproduced and uploaded by the UNFCCC Secretariat. Provides the date of submission, which determines eligibility to apply for the LDC fund which is managed by GEF for implementation. The NAPAs summarize climatic/environmental conditions and identify key adaptation needs of a country. The focus is on urgent and immediate needs rather than a long-term perspective.	http://unfccc.int/national_reports/napa/items/2719.php
Compilation of information on Nationally Appropriate Mitigation Actions (**NAMAs**) to be implemented by Parties not included in Annex I to the Convention Ad Hoc Working Group on Long-term Cooperative Action under the Convention, UNFCCC, 2011	Presents the information communicated by these Parties on the NAMAs that they intend to implement, as well as the related context, conditions and considerations, including with regard to the support required for their preparation and implementation.	http://unfccc.int/resource/docs/2011/awglca14/eng/inf01.pdf

Tools and information systems	Description	Sources and links
GEF National Portfolio Formulation Exercise (NPFE)	Presents priorities for funding CC mitigation and adaptation projects and activities to be possibly supported by the GEF. Identified priorities should be available when an NPFE exists, although it is not a mandatory exercise. The country's GEF Operational Focal Point (FP) coordinates the formulation of the NPFE.	Search document on the Web site of the National GEF FP. To identify who is the GEF FP, go to: http://www.thegef.org/gef/National_Portfolio_Formulation_Exercises
3. Tools and information systems for adaptation and mitigation		
Handbook on methods for climate change impact assessment and adaptation strategies Feenstra, J. F., Burton, I., Smith, J. B. & Tol, R. vrije Universiteit Amsterdam, Institute for Environmental Studies, UNEP, 1998	Introduces a wide range of methods that can be used to design assessment studies of CC impacts and related adaptation strategies. It does not serve as a "stand-alone," step-by-step, or "how to do it" document. It is not prescriptive nor does it describe only a single method by sector. The intent of providing an overview of methods is to give readers enough information to select the method most appropriate to their situation.	http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/465/Global_Methods_for_CC_Assessment_Adaptation_-_UNEP_1998.pdf
A framework to diagnose barriers to climate change adaptation Moser, S. C. & Ekstrom, J. (2010). *PNAS*, 107 (51): 22026-22031, doi:10.1073/pnas.1007887107.	Describes a framework to diagnose barriers to CC adaptation. Includes a useful table with diagnostic questions by the stage in the adaptation process and the adaptation system components.	http://www.susannemoser.com/documents/Moser-Ekstrom_PNAS_2010_barriersframework.pdf
Organic agriculture and carbon sequestration Müller-Lindenlauf, M. FAO Rome, 2009	Describes the potential of organic agriculture to sequester carbon and to meet the requirements of carbon accounting systems; discusses the suitability of measurement and verification methodologies to agriculture systems, including an analysis of existing carbon accounting instruments.	ftp://ftp.fao.org/docrep/fao/012/ak998e/ak998e00.pdf
Livestock's long shadow: environmental issues and options Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosale, M. & de Haan, C. FAO Rome, 2006	Assesses the impact of the world's livestock sector on the environment, and the contribution of animal agriculture to CC and air pollution, to land, soil and water degradation and to the reduction of biodiversity, building on the work of the Livestock, Environment and Development (LEAD) Initiative.	http://www.fao.org/docrep/010/a0701e/a0701e00.HTM
Greenhouse gas emissions from the dairy sector - a life cycle assessment FAO Rome, 2010	Presents a methodology based on the life cycle assessment (LCA) approach; and provides estimates of GHG emissions associated with milk production and processing for main regions and farming systems of the world, which will help to inform the public debate on GHG emissions and will support research, development and extension efforts to improve the sustainability performance of dairy farming.	http://www.fao.org/docrep/012/k7930e/k7930e00.pdf
Livestock and climate change-tools for project design Calvosa, C., Chuluunbaatar, D. & Fara, K. IFAD Rome, 2008	Examines the effects of CC on livestock and fisheries; presents adaptation and mitigation strategies in the livestock sector; analyses livestock and soil carbon sequestration and related gender issues; and provides recommendations for promoting both adaptation and mitigation activities in development projects.	http://www.ifad.org/lrkm/factsheet/cc.pdf
Climate change implications for fisheries and aquaculture - FAO fishery and aquaculture technical paper 530 K. Cochrane, C. D. Young, D. Soto & T. Bahri (eds.) FAO Rome, 2009	Contains three comprehensive technical papers that formed the basis for the technical discussions during the Expert Workshop on CC Implications for Fisheries and Aquaculture in April 2008 at FAO headquarters. Reviews climate variability and change and their physical and ecological consequences on marine and freshwater environments; analyses the consequences of CC impacts on fishers and aquaculture; and discusses possible adaptation and mitigation measures.	ftp://ftp.fao.org/docrep/fao/012/i0994e/i0994e.pdf

Tools and information systems	Description	Sources and links
Strategic framework for forests and climate change Collaborative Partnership on Forests, FAO Rome, 2009	Lays the groundwork for a coordinated response from the forest sector to CC, notably through the adoption of sustainable forest management and its integration into broader development strategies.	http://www.fao.org/forestry/16639-064a7166b1dd027504bbfbb763878af99.pdf
Climate change, water and food security-FAO water reports No. 36 Turral, H., Burke, J. & Faurès, J. FAO Rome, 2011	Summarizes current knowledge of the anticipated impacts of CC on water availability for agriculture; examines the implications for local and national food security; discusses the methods and approaches to assess CC impacts on water and agriculture; emphasizes the need for a closer alignment between water and agricultural policies; and makes the case for immediate implementation of "no-regrets" strategies.	http://www.fao.org/docrep/014/i2096e/i2096e00.htm
Climate change adaptation strategies: water resources management options for smallholder farming systems in sub-Saharan Africa Ngigi, S.N. 2009. The MDG Centre for East and Southern Africa, The Earth Institute at Columbia University, New York. 189 pp.	Reviews the trends and experience of water resources management in Africa; summarizes CC adaptation strategies and practices for smallholder farming in sub-Saharan Africa in terms of pilot projects, research agenda and governance interventions; identifies constraints and gaps and proposes options for further interventions. This is a synthesis report of a regional study supported by the Rockefeller Foundation.	http://www.rockefellerfoundation.org/news/publications/climate-change-adaptation-strategies
Economic approaches to climate change adaptation and their role in project prioritisation and appraisal GTZ, 2007	Outlines the vulnerability of developing countries to the impacts of CC; discusses various adaptation options and constraints; analyses costs and benefits of adaptation; discusses potential ways to prioritize development activities with a view to adverse effects of CC; deals with the appraisal and ranking of proposed projects; and outlines some limits of existing methods.	http://www.adapcc.org/download/Economic-Approaches-to-Climate-Change-Adaptation.pdf
Gender: the missing component of the response to climate change Lambrou, Y. & Piana, G. FAO Rome, 2006	Analyses the gender dimension of CC and the policies enacted to mitigate and adapt to its impacts with the aim of developing gender-sensitive approaches to mitigation measures, adaptation projects and national regimes.	http://www.fao.org/sd/dim_pe1/docs/pe1_051001d1_en.pdf
Strengthening capacity for climate change adaptation in agriculture: experience and lessons from Lesotho Dejene, A., Midgley, S., Marake, M.V., & Ramasamy, S. FAO Rome, 2011	Provides an overview of CC impacts on subsistence and smallholder farmers in Lesotho, and how the adaptation capacity in agriculture can be strengthened,drawing onexperiences and lessons learned from a pilot project. Makes recommendations on how community-based responses could be scaled up to other parts of the country and other countries across southern Africa.	http://www.fao.org/docrep/014/i2228e/i2228e00.pdf
FAO CROPWAT tool	This FAO computer program calculates crop water requirements and irrigation requirements based on soil, climate and crop data. It allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns.It can be used to evaluate farmers' irrigation practices and crop performance under rainfed and irrigated conditions.	http://www.fao.org/nr/water/infores_databases_cropwat.html
FAO AQUASTAT online database	AQUASTAT is a global information system on water and agriculture, developed by the Land and Water Development Division of FAO. Collects, analyses and disseminates information on water resources, water uses and agricultural water management with an emphasis on countries in Africa, Asia, Latin America and the Caribbean. Provides comprehensive and regularly updated information at global, regional and national levels.	http://www.fao.org/nr/water/aquastat/main/index.stm

Tools and information systems	Description	Sources and links
Weather-based indices for crop insurance	Helps to derive an effective weather-based crop yield index for crop insurance. The approach proposes to compute a crop-specific water balance to derive value-added crop-weather variables that can be combined with other data (e.g. remote sensing inputs, farm inputs such as fertilizer use). The methodology uses gridded information that is not too sensitive to individual missing stations, provided sufficient data points are available.	www.fao.org/nr/climpag/aw_2_en.asp
Crop monitoring box (CM Box)	An automated software suite with a "visual menu" that offers easy access to a database that holds all the data needed to analyse the impact of weather on crops. Useful for risk analysis and monitoring and forecasting crop production, which is an essential input to food security planning.	www.fao.org/nr/climpag/aw_6_en.asp or http://www.fao.org/nr/climpag/pub/cm_box_4.pdf
Climate change impact assessment toolbox	Assesses CC impacts on agriculture, with four main software components: a downscaling method for processing global climate model output data, a hydrological model for estimating irrigation water resources, a crop growth model to estimate crop yields and a Computable General Equilibrium (CGE) Model to simulate the effect of changing agricultural yields on national economies.	http://www.foodsec.org/web/tools/climate-change/climate-change-impact-assessment-tool/en/
Local climate estimate tool	This FAO software program and database provides estimates of average climatic conditions at any location on Earth, based on the FAOCLIM database.Includes the current updated version of the FAOCLIM database of almost 30 000 stations worldwide, but users can also process their own data and prepare maps at any spatial resolution.	www.fao.org/nr/climpag/data_5_en.asp
Farm adaptive dynamic optimization (FADO)	This FAO methodology helps to identify, analyse and prioritize the climate-related vulnerabilities and risks and optimize the adaptation practices to effectively respond to climate variability and change, including components on exploring knowledge on the local situation of farmers' decision problems; analysing the vulnerability and climate risks to optimize the management options; deciding adaptation practices relevant to local situations; and facilitating local action by communicating climate information and suitable adaptation practices to farmers.	www.fao.org/nr/climpag/aw_5_en.asp
FAO rainfall estimate routine (FAO-RFE)	An independent method to estimate the rainfall amount, particularly, for regions where the weather station coverage is scarce. Offers 10-day and monthly rainfall totals for all of Africa and four regions; can be implemented at a national level to improve rainfall estimates provided by national meteorological services.	http://geonetwork3.fao.org/climpag/FAO-RFE.php
Planning for community-based adaptation (CBA) to climate change	An FAO e-learning tool, supporting training on community-based CC adaptation in agriculture. Links research-based knowledge on CC impacts with examples and experiences on CBA drawn from FAO field projects and a range of country-specific case studies. Aims at assisting all those who face the challenge of initiating and facilitating adaptation processes at the community level.	http://www.fao.org/climatechange/67624/en/
Visual Soil Assessment, A Field Guide (includes environmental score cards for GHG emissions/sequestration potential) FAO Rome, 2008	Based on the visual assessment of key soil "state" and plant performance indicators of soil quality, presented on a scorecard. Of particular interest for CC are the score cards for GHG emissions/sequestration potential for pasture and for maize crops.	http://www.fao.org/docrep/010/i0007e/i0007e00.htm score cards for pasture: ftp://ftp.fao.org/docrep/fao/010/i0007e/i0007e07.pdf score cards for maize crop: ftp://ftp.fao.org/docrep/fao/010/i0007e/i0007e09.pdf

Tools and information systems	Description	Sources and links
Carbon finance possibilities for agriculture, forestry and other land-use projects in a smallholder context FAO, 2010	A guide for extension services and institutions working with smallholders to support them in their advisory role on development of the carbon markets and financial mechanisms. Aims to enhance knowledge on carbon finance and facilitate the integration of small-scale farmers into agriculture, forestry and land-use change (AFOLU) mitigation activities.	http://www.fao.org/docrep/012/i1632e/i1632e.pdf
FAO *ex ante* carbon-balance tool (EX-ACT)	A land-based accounting system measuring carbon stocks and stock changes per unit of land. Can help project designers select project activities with higher benefits in economic and CC mitigation terms. Output could be used in financial and economic analysis of the projects. Works at the project level but can easily be scaled up at the programme/sector level.	www.fao.org/docs/up/easypol/768/ex-act_flyer-nov09.pdf
Mapping system and service for canal operation techniques (MASSCOTE) - FAO irrigation and drainage paper 63 Renault, D., Facon, T. & Wahaj, R. FAO Rome, 2007	A step-wise procedure for auditing performance of irrigation management, analysing and evaluating the different elements of an irrigation system in order to develop a modernization plan. A modernization plan consists of physical, institutional and managerial innovations to improve water delivery services to all users and cost effectiveness of operation and management.	www.fao.org/nr/water/topics_irrig_masscote.html
FAO AquaCrop model FAO Rome, 2011	A crop model to simulate yield response to water of several herbaceous crops. Designed to balance simplicity, accuracy and robustness, it is particularly suited to address conditions where water is a key limiting factor in crop production. It is mainly intended for practitioners in extension services, governmental agencies, NGOs and farmers associations. Also of interest to scientists and as a training and education tool.	www.fao.org/nr/water/aquacrop.html
Adapting to coastal climate change: a guidebook for development planners Coastal Resources Center, University of Rhode island and International Resources Group USAID, 2009	A tool and a link to other resources valuable for assessing vulnerability, developing and implementing adaptation options and integrating options into programmes, plans and projects at the national and local levels.	http://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf
World Bank Climate Change Portal and ADAPT	Provides quick and readily accessible climate data to policy-makers and development practitioners, including a mapping visualization tool displaying key climate variables data and a computer-based prototype screening tool for Assessment and Design for Adaptation to Climate Change (ADAPT). Designed to assess whether a project might be sensitive to the effects of CC, and then provide guidance to the best sources of information to help take these potential effects into account in the project design.	http://sdwebx.worldbank.org/climateportal/index.cfm
The resilience tool, described on the Web site "Food Security Information for Decision-making" EC-FAO Programme on "Linking Information and Decision Making to Improve Food Security"	Provides a framework for understanding the most effective combination of short- and long-term strategies for lifting families out of cycles of poverty and hunger. Looks at the root causes of household vulnerability instead of trying to predict how well households will cope with future crises or disasters. Also considers how household food security links to the entire food system.	http://www.foodsec.org/web/tools/resilience/resilience-tool/en/

Tools and information systems	Description	Sources and links
4. Tools and information systems for disaster risk management		
Providing Regional Climates for Impacts Studies (PRECIS)	Provides climate impact assessments in developing country contexts which are freely available to many users. Uses the global climate model to provide grid-scale averages of spatial-temporal hydroclimatic state variables, soil hydrology and thermodynamics and some vegetation dynamic variables. Applicable to multiple scales, sectors and levels of screening, but is limited fine/point scale information.	http://www.metoffice.gov.uk/services/climate-services/international/precis
Statistical downscaling model (SDSM)	A user-friendly software package designed to implement statistical downscaling methods to produce high-resolution monthly climate information from coarse-resolution climate model (global climate model) simulations. This open-source, computer-based information tool is aimed at donors, governments and impact assessors. Provides daily, transient, climate-risk information for impact assessment over the 1961–2100 time horizon and has been primarily used for water resource management, though it is applicable to multiple sectors.	http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5487.php
Disaster risk management systems analysis - a guide book Baas, S., Ramasamy, S., DePryck, J., & Battista, F. FAO, 2008, Rome	Provides a set of tools to assess existing structures and capacities of national, district and local institutions with responsibilities for DRM in order to improve the effectiveness of DRM systems and the integration of DRM concerns into development planning, with particular reference to disaster-prone areas and vulnerable sectors and population groups.	http://www.fao.org/docrep/011/i0304e/i0304e00.htm
Disaster response and risk management in the fisheries sector Westlund, L., Poulain, F., Båge, H. & Anrooy, R. FAO Rome, 2007	Reviews different types of disasters impacting on the fisheries sector; discusses fisheries sector characteristics and gives an overview of the vulnerability context common to many coastal communities; and presents recommendations for disaster response and DRM in the fisheries sector, focusing on small-scale fisheries in developing countries.	ftp://ftp.fao.org/docrep/fao/010/a1217e/a1217e00.pdf
Guidelines for crop and food supply assessment missions (CFSAM) WFP and FAO, 2009	Provides basic information and practical guidance for anyone who participates in an FAO/WFP CFSAM – whether as an FAO/WFP core team member, a government or other agency participant or a donor observer. Also useful to organizations and individuals who provide information for such a mission or need to use the findings of a CFSAM report.	http://home.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197289.pdf
Resource guide: protecting and promoting good nutrition in crisis and recovery FAO 2005	Outlines the relationships between nutrition and sustainable livelihoods; examines possible approaches to protecting and promoting good nutrition; discusses issues related to the planning and selection of actions in crisis situations. A source and reference for a range of existing technical handbooks that cover such topics as assessing malnutrition, managing general and selective feeding programmes and designing specific interventions.	http://www.unscn.org/layout/modules/resources/files/Refman_36_FAO_Protecting_and_promoting_Good_Nutrition_in_Cri.pdf
Fire management voluntary guidelines: principles and strategic actions Working Paper FP/17/E FAO Rome, 2006	Sets out a framework of legally non-binding principles and internationally accepted strategic actions. Addresses the cultural, social, environmental and economic dimensions of fire management at all levels.	http://www.fao.org/docrep/009/j9255e/j9255e00.htm

Tools and information systems	Description	Sources and links
Livestock Emergency Guidelines and Standards (LEGS) The Schumacher Centre for Technology and Development, UK, 2009	A set of guidelines and standards for the design, implementation and assessment of livestock interventions to assist people affected by humanitarian crisis. Provides guidance on identifying appropriate livestock responses as well as detailed information on a number of interventions, namely: destocking, veterinary services, the provision of feed, the provision of water, livestock shelter and settlement and restocking.	http://www.livestock-emergency.net/userfiles/file/legs.pdf
Socio-economic and gender analysis (SEGA) for emergency and rehabilitation FAO/WFP, 2004	A guide on socio-economic and gender analysis for emergency and rehabilitation,based on participatory identification and analysis of the socio-economic factors that determine women's and men's priorities and potentials. Its main objective is to close the gaps between what people need and what development delivers, to contribute to effective and sustainable development.	http://www.fao.org/sd/seaga/downloads/EN/EmergencyGuidelinesEn.pdf
Towards effective and sustainable seed relief activities L. Sperling, T. Osborn & D. Cooper (eds.) FAO Rome, 2004	Provides an overview of seed systems; discusses the parameters of seed security; describes acute and chronic emergency situations; summarizes lessons learned from experience in the field, particularly in Africa; discusses major challenges for moving ahead, possible interventions, available tools and guidance to assist decision-making and implementation of seed relief interventions.	http://www.fao.org/docrep/007/y5703e/y5703e00.htm
Rapid Agricultural Disaster Assessment Routine (RADAR) Borgia, A., Gommes, R., Bernardi, M. & Kanamaru, H. FAO Rome, 2008	Describes the methods for model analysis; introduces the procedure and steps of RADAR by combining model analysis based on physical simulation of the disaster, with empirical analysis, using people's records of the environmental disruption after the event; and discusses its application in disaster preparedness and minimization of potential risks through early warning strategies and preparation of development plans.	ftp://ftp.fao.org/docrep/fao/011/i0183e/i0183e.pdf
Emergency prevention system for transboundary animal and plant pests and diseases (EMPRES)	FAO food chain crisis management framework aiming at promoting the effective containment and control of the most serious epidemic pests, diseases and food safety threats through international cooperation involving early warning, early reaction, enabling research and coordination. Involves three major systems: EMPRES Animal Health for animal diseases, including aquatic animal diseases; EMPRES Plant Protection for plant pests and diseases, including desert locust and forest plant pests and diseases; and EMPRES Food Safety.	http://www.fao.org/ag/againfo/programmes/en/empres/home.asp
Community-based adaptation in action - a case study from Bangladesh Baas, S. & Ramasamy, S. FAO Rome, 2008	Provides a summary of an approach to promote community-based adaptation within agriculture, developed and tested through a field project in Bangladesh. Presents lessons learned from the implementation process as well as the details of good practice options for drought risk management in the context.	ftp://ftp.fao.org/docrep/fao/010/i0481e/i0481e.pdf
Monitoring and evaluation in disaster risk management East Asia and Pacific Disaster Risk Management Team (EAP DRMT), World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR), 2011	Addresses the importance of quality monitoring and evaluation (M&E) in the disaster context. Provides an overview of how each can be used differently in the *ex ante* and *ex post* disaster scenarios. Gives general guidance on how to construct a logical framework for evaluating DRM projects by presenting best practices from three recent projects.	http://www.worldbank.org/eap

Tools and information systems	Description	Sources and links
	5. Guidelines and tools for mainstreaming	
Mainstreaming adaptation to climate change in agriculture and natural resources management projects Climate Change Team, Environment Department, World Bank	Presents eight guidance notes that provide lessons learned, best practices, recommendations and useful resources for integrating climate risk management and adaptation to CC in development projects, with a focus on agriculture and natural resources management. They are organized around a typical project cycle, starting from project identification, followed by project preparation, implementation, and M&E. Each note focuses on specific technical, institutional, economic or social aspects of adaptation.	http://www.worldbank.org/adaptnotes
Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners UNDP and UNEP, 2011	The framework proposed consists of three components: (i) finding the entry points and making the case; (ii) mainstreaming adaptation into policy processes; and (iii) meeting the implementation challenge, each of which involves a set of activities or modules for which a range of tactics, methodologies and tools can be used.	http://www.cakex.org/sites/default/files/Guide%20Mainstreaming%20Climate%20Change%20Adaptation%202011.pdf
Integrating climate change considerations in the country analysis and the UNDAF- a guidance note for United Nations country teams United Nations Development Group (UNDG), 2010	Includes a quick guide to mainstreaming CC considerations in the country analysis (such as CCA) and the United Nations Development Assistance Framework (UNDAF), which is organized around the main steps for UN common country programming. Outlines the entry points and related actions and tools.	http://www.undg.org/docs/11473/UNDG-GuidanceNote_ClimateChange-July2011.pdf
Quality standards for the integration of adaptation to climate change into development programming (CCA QS) UNDP, 2009	Provides a comprehensive yet concise and structured framework for the integration of adaptation into development practices, based on a small number of clearly defined steps.	http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5467.php
Tools and Guidelines to Mainstream Climate Change Adaptation –A Stocktaking Report UNDP, 2010	Explores the rationale for mainstreaming; outlines the main components necessary to operationalize mainstreaming; indicates the relevant levels and associated entry points to consider in the mainstreaming process; discusses and illustrates how key CC adaptation and mainstreaming concepts are defined and used; and presents climate risk screening methods, tools and guidance.	http://www.adaptationlearning.net/sites/default/files/UNDP%20Stocktaking%20Report%20CC%20mainstreaming%20tools.pdf
Climate change for forest policy-makers. An approach for integrating climate change into national forest programmes in support of sustainable forest management FAO, Rome 2011	Provides a practical approach to integrating CC into national forest programmes or national forest policy processes.Aims to assist senior officials in government administrations and other stakeholders in assessing the suitability of and amendingforest policies, legislation and institutions, as appropriate, to create an enabling environment (through information, capacity strengthening and financing)for CC adaptation and mitigation in the forest sector.	http://www.fao.org/forestry/climatechange/64862/en/
Guidelines for Integrating Climate Change Adaptation and Mitigation Options for Fisheries and Aquaculture into Project Design International Collaborating Centre for Aquaculture and Fisheries Sustainability (ICAFIS) and IFAD, 2011	Provide key recommendations to integrate of climate change/ fisheries and aquaculture into new projects, and presents case studies.	http://www.icafis.org/index.php/projects/completedproj/92-intclimchange
Guidelines on the integration of environment and climate change in development cooperation EuropeAid, 2009	Defines a comprehensive reference framework for integrating the environment and CC into the different stages of the operations cycle for EC development cooperation covering the three aid delivery approaches. Intended for EC staff and their partners.	http://ec.europa.eu/europeaid/infopoint/publications/europeaid/172a_en.htm

Tools and information systems	Description	Sources and links
Mainstreaming climate change adaptation: a practitioner's handbook Huxtable, J. & Yen, N.T. CARE International in Viet Nam, 2009	Directs a process of analysis and dialogue on CC issues, examining factors at multiple levels and using a variety of tools to gather information and inform decision-making. Primarily designed for CARE in Viet Nam (programme managers, component managers, project staff and programme officers) and project partners working at the district and commune levels, but may prove useful to other development NGOs.	http://www.careclimatechange.org/files/adaptation/CARE_VN_Mainstreaming_Handbook.pdf
ADB Disaster and Climate Change Risks Screening tool	The Asian Development Bank (ADB) helps the region's economies enhance their resilience to adverse CC impacts through mainstreaming adaptation into national, sectoral and project level plans and actions. To mitigate CC, ADB addresses the main causes of emissions in the region. The Climate Screening Checklist is not publicly available.	http://www.adb.org/Documents/RRPs/NEP/44058/44058-01-nep-oth-03.pdf
Strategic environmental assessment and adaptation to climate change OECD, 2008	Illustrates how Strategic Environmental Assessment (SEA) may provide a framework for integrated considerations of CC risks and opportunities into strategic planning. Guides planners, policy-makers and sector specialists working to prepare policies, plans and programmes (PPPs) and those already familiar with SEA in the inclusion of CC considerations into PPPs.	http://digital.library.unt.edu/ark:/67531/metadc28513/
Guidelines and source book for preparation and implementation of a results-based country strategic opportunities programme (RB-COSOP) IFAD, 2011	Includes a checklist for promoting climate-resilient development, which is structured around key entry points for integrating CC into the RB-COSOP formulation, implementation and review process.	http://www.ifad.org/operations/policy/cosop/guidelines/sourcebook/cosop.pdf
BMZ/GTZ Climate Check Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in cooperation with Potsdam Institute for Climate Impact Research (PIK)	Tackles CC issues from two angles: (1) climate proofing systematically analyses the risks that CC poses to the sustainability of development projects and identifies adaptation strategies for adjusting projects; and (2) emission saving analyses how projects can contribute to mitigating CC and identifies alternative options and measures to maximize these contributions.	www.gtz.de/climate-check
Training Guide for Gender and Climate Change Research in Agriculture and Food Security for Rural Development FAO and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), 2012	Provides resources and participatory action research tools for collecting, analysing and sharing gender-sensitive information about agricultural communities, households and individuals who are facing climate changes.	http://www.fao.org/docrep/015/md280e/md280e.pdf

Tools and information systems	Description	Sources and links
	6. Web sites	
UNFCCC Web site	The official Web site of the UN Framework Convention on Climate Change (UNFCCC), an international treaty that acknowledges the possibility of harmful CC.	http://unfccc.int/2860.php
IPCC Web site	The official Web site of the IPCC, a scientific intergovernmental body tasked with reviewing and assessing the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of CC	http://www.ipcc.ch/index.htm
FAO climate change Web site	FAO official Web site on CC	http://www.fao.org/climatechange/en/
FAO-EPIC Web site (Economics and policy innovations for climate-smart agriculture)	Housed in FAO's Agricultural and Development Economics Division (ESA), EPIC works with national and local partners in developing countries, providing economic and policy analysis to support the transition to CSA	http://www.fao.org/climatechange/73769/en/
World Bank (WB) climate change Web site	WB official Web site on CC	http://climatechange.worldbank.org/
IFAD climate change Web site	IFAD official Web site on CC	http://www.ifad.org/climate/
ADB climate change Web site	ADB official Web site on CC	http://www.adb.org/climate-change/
United Nations Development Programme (UNDP) climate change Web site	UNDP official Web site on CC	http://www.undp.org/climatechange/
United Nations Environment Programme climate change Web site	UNEP official Web site on CC	http://www.unep.org/climatechange/
African Development Bank climate change Web site	AfDB official webpage on CC	http://www.afdb.org/en/topics-and-sectors/sectors/climate-change/
Inter-American Development Bank	IDB official webpage on CC	http://www.iadb.org/en/topics/climate-change/climate-change,1448.html
European Commission Climate Action	European Union (EU) official Web site on CC	http://ec.europa.eu/dgs/clima/mission/index_en.htm
Stocktaking of planned and existing adaptation activities country by country	Adaptation Partnership (established in 2010) that takes stock of planned and existing adaptation activities country by country. Includes information on projects (not comprehensive though) and key adaptation priorities; highlights regional activities; assesses funding; and identifies gaps and opportunities for scaling up.	http://www.adaptationpartnership.org/blog/activities
UNREDD Programme Web site	The official Web site of the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD) in Developing Countries, which was launched in September 2008 to assist developing countries prepare and implement national Reducing Emissions from Deforestation and Forest Degradation (REDD+) strategies. Builds on the convening power and expertise of FAO, UNDP and UNEP.	http://www.un-redd.org/
GEF climate change Web site	Provides information on the Least Developed Countries Fund for climate change (LDCF) and the Special Climate Change Fund (SCCF), which were established by the Global Environment Facility (GEF) in response to guidance from the Conference of the Parties (COP) to the UNFCCC.	http://www.thegef.org/gef/climate_change

Tools and information systems	Description	Sources and links
International Institute for Sustainable Development (IISD) Climate Change Policy & Practice Web site	A Web site built on a knowledge management project for international negotiations and related activities on CC, which was launched in 2008 and managed by the IISD.	http://climate-l.iisd.org/
FAO technologies and practices for small agriculture producers (TECA) platform	An FAO-initiated platform that aims to improve access to information and knowledge sharing about proven technologies in order to enhance adoption in agriculture, livestock, fisheries and forestry subsectors. Provides web-based communication tools to better document and share good practices and customize its use to each user's characteristics.	http://teca.fao.org/home
Climate-resilient and Environmentally Sound Agriculture or "Climate-smart" Agriculture: a Package for Government Authorities C-RESAP online information package FAO and Chinese Academy of Agriculture Science (CAAS)	The on-line information package produced by the project of Enhanced Strategies for Climate-Resilient and Environmentally Sound Agricultural Production (C-RESAP) in the Yellow River Basin of China includes six modules covering: (1) current and future challenges; (2) climate variability and CC; (3) impacts of CC on agro-ecosystems and food production; (4) agriculture, environment and health; (5) CSA: technical considerations and examples of production systems; and (6) CSA: supporting tools and policies.	http://www.cpesap.net/online-c-resap-information-package
Global Facility for Disaster Reduction and Recovery (GFDRR)	GFDRR's official Web site, which was established in 2006 as a partnership of 38 countries and seven international organizations committed to helping developing countries reduce their vulnerability to natural hazards and adapt to CC.	http://www.gfdrr.org/gfdrr/
Climate Impact on Agriculture (CLIMPAG)	An FAO web portal bringing together the various aspects and interactions between weather, climate and agriculture in the context of food security. Contains data, maps, methodologies and tools for better understanding and analysis of the effect of the variability of weather and climate on agriculture. Covers six thematic areas: advice and warnings, climate change, climate indicators, data and maps, hotspots and natural disasters.	www.fao.org/nr/climpag/
FAO Best Practices Portal	Provides a series of summaries that introduce best practices in FAO's areas of expertise. It also provides links to further resources with supporting technical information. The practices have been divided by theme. They have been adopted successfully in more than one region and are interdisciplinary, reflecting the complex nature of the problems addressed.	http://www.fao.org/bestpractices/index_en.htm
FAO Web site on climate-smart agriculture	This Web site is part of the broader FAO official Web site on CC.	http://www.fao.org/climatechange/climatesmart/en/
World Overview of Conservation Approaches and Technologies (WOCAT) Web site	The official Web site of WOCAT, which is an established global network of Soil and Water Conservation (SWC) specialists, contributing to sustainable land management (SLM).	http://www.wocat.net/

ANNEX 4
Options, good practices and concepts for climate change adaptation and mitigation in agricultural sectors

In order to meet the challenges of food security and climate change, the agriculture sector will need to implement a number of changes. Agricultural production systems must respond to climate change by adapting to those changes and reducing net emissions of GHGs. Climate-smart practices are already implemented at landscape levels which combine adaptation and mitigation activities and use an ecosystem approach.

This annex outlines options and practices in agriculture and rural development to mitigate and adapt to climate change. A transition to sustainable agriculture requires investment in three different, but complementary alternatives: (1) reducing the negative environmental impacts of farming systems; (2) enhancing existing agricultural systems that have been shown to be environmentally sustainable; and (3) developing new agricultural systems which focus on providing ecosystem services (IAAASTD).

1. Climate change adaptation

Adaptation efforts require making anticipatory adjustments to prepare for climate change. Two approaches can be identified: risk management and change management.

Risk management

Disaster risk management (DRM) focuses on preventing, mitigating, preparing for and responding to shocks in the short and medium term. It serves to handle threats such as increased frequency and intensity of extreme weather events and changing patterns of pests and diseases. DRM requires improving local processes and practices for risk reduction and enhancing emergency response and rehabilitation operations (FAO 2011). Important management systems include:

- Integrated Disaster Risk Management (IDRM), which is a process for comprehensively and credibly estimating and managing risks from multiple synergistic sources; as such, IDRM presents a challenge to science and policy communities (Amendola, 2007);
- early warning systems for natural disasters (e.g. tsunami, drought, flood and cyclone);
- community-based, national and transboundary actions for disaster risk reduction (DRR), including measures such as risk assessment, early warning and sustainable, gender-sensitive practices to enhance preparedness for climate-related hazards (e.g. floods and droughts) in agriculture, forestry and fisheries;
- expanded and improved transition and linkages among emergency response, rehabilitation planning and development;
- integration of "building back better" principles to foster risk mitigation, prevention, preparedness and adaptation; and
- DRR strategies in agriculture, forestry and fisheries to: prevent food insecurity and reduce impacts of climate-related hazards and shocks; and promote the integration of DRM into sectoral development plans and programmes, including into water and land management.

Change management

Change management adds a strategic, long-term objective within policy, legal and research frameworks. In the agricultural sectors, it consists of several elements, such as legislation, social and

institutional development; policies and planning through changing and diversifying agricultural practices; and developing agriculture technologies and linking climate change adaptation and mitigation processes (FAO 2008, 2011).

There are a variety of technologies, practices and processes related to agriculture, forestry, fisheries, rural energy demands and rural income diversification which aim to increase the resilience of production systems and livelihoods and adaptation to climate change. Some examples include improving seed security; including crop relocation; adopting varieties that are drought-resistant, earlier maturing and pest- and disease-resistant; diversifying crops; and strengthening seed systems. More practices are listed in Table 4.1, and some are explained in more detail below.

2. Climate change mitigation

Mitigation of climate change involves taking actions to reduce the concentrations of GHGs. Three mitigation categories can be distinguished:

- **GHG emissions can be reduced** at the source through adoption of better management practices and more efficient management of carbon and nitrogen flows. For example, CH_4 emissions from livestock can be reduced by making more efficient use of feeds, and CO_2 emissions can be reduced through decreasing deforestation (including that caused by agriculture expansion) and forest degradation.
- **GHG emissions can be avoided or displaced**, such as through improving the energy efficiency of the agriculture sector or substituting forest products for fossil fuels and other non-renewable, energy-intensive products.
- **GHGs can be removed through sinks**. For example, a variety of agricultural management practices exist to improve the soil and biomass carbon sequestration, such as: (1) improved cropland and grazing land management practices; (2) rehabilitation of degraded land; and (3) afforestation, reforestation, forest restoration and agroforestry.

These categories are not mutually exclusive; agricultural practices usually overlap among them.

A variety of management options exist in the agriculture sector to reduce, remove and avoid emissions. They are listed in Table 4.1 and some specific measures are explained in more detail below.

3. Climate-smart agriculture

Food security and climate change can be addressed together by transforming agriculture and adopting practices that are "climate-smart". Climate-smart agriculture (CSA) sustainably increases productivity and resilience (adaptation), reduces/removes GHGs (mitigation) and enhances achievement of national food security and development goals (FAO, 2010). A number of agricultural practices combine these approaches and are already being used by farmers and food producers to reduce GHG emissions, adapt to climate change and reduce vulnerability. However, knowledge gaps still exist regarding the suitability and use of the production systems and practices across a wide variety of agro-ecological and socio-economic contexts and scales. Many practices also have local and temporal benefits or impacts, thus being very case-specific. Several practices are listed in Table 4.1 and more concrete examples are given in section 4 below.

Table 4.1.
Matrix of good adaptation and mitigation practices in the agricultural sectors

Agricultural sector or subsector practices and concepts	Adaptation	Mitigation	Climate-smart agriculture
Crops			
Improving cropland management	x	x	x
- Integrated nutrient/soil fertility management	x	x	x
- Reduced/zero tillage	x	x	x
- Residue management	x	x	
- Adjusted planting dates and crop varieties	x		
- Crop relocations	x		
- Improved land management (erosion control & soil protection through tree planting)	x	x	x
- Improved rice cultivation	x	x	x
Using perennials and agroforestry	x	x	
Managing organic soils	x	x	x
Restoring degraded land	x	x	x
Improving varieties and strengthening seed systems	x	x	x
Breeding adaptive varieties/developing new varieties	x	x	x
Integrated pest management	x	x	x
Energy crops		x	
Livestock			
Improving pasture management	x	x	x
Improving grazing management	x	x	x
Practising manure management	x	x	x
Addressing land conversion (land management)	x	x	x
Improving feed use		x	
Controlling enteric fermentation		x	
Increasing productivity		x	
Breeding adaptive species	x		
Practising effective disease control	x		
Forestry			
Agroforestry	x	x	x
Afforestation, reforestation and forest restoration	x	x	x
Sustainable forest management and use practices	x	x	x
Integrated fire management		x	
Reduction of deforestation and forest degradation		x	
Managing forest biodiversity	x	x	
Enhancing forest health and vitality to reduce vulnerability	x	x	
Intensifying fire management systems	x		
Adaptive management practices	x		

Managing harvested wood product		x	
Improving tree species to increase biomass productivity and carbon sequestration		x	
Fisheries			
Improving energy efficiency		x	
Decreasing use of fish meal and fish oil feeds		x	
Lowering post-harvest losses		x	
Increasing waste recycling		x	
Reducing excessive fishing capacity		x	
Increasing feeding efficiency		x	
Practising carbon capture and storage (sea beds, phytoplankton and blue carbon)		x	
Assessing renewable energy potential		x	
Integrated coastal zone management (ICZM)	x		
Breeding adaptive species	x		
Diversifying species	x		
Better managing water quantity and quality	x		
Natural resource (i.e.land and water) management			
Practising sustainable land management	x	x	x
Rehabilitating degraded lands	x	x	x
Conserving peat lands and wetlands for reducing emissions and increasing soil carbon sequestration	x	x	x
Integrated water resources management	x	x	x
Improving water management for paddy fields for reducing CH_4 emission	x	x	x
Improving irrigation performance and water productivity	x	x	x
Improving drainage and flood control	x		
Harvesting rainwater	x		
Using water storage and conservation techniques	x		
Practising water reuse	x	x	x
Using desalination	x		
Cross subsector			
Integrated crop-livestock management	x	x	x
Fish-crop systems (e.g. fish and rice systems)		x	
Integrated food-energy systems	x	x	x
Using early warning and information systems for tsunami, drought and food risks	x		
Developing monitor and control systems for animal and human disease risks	x		
Conducting DRM	x		
Advisory services/extension			
Developing supporting technology	x	x	x
Improving access to climate information	x		
Improving communication for extension	x	x	
Developing participative research to respond to needs of producers in the context of climate change	x	x	

Post-harvest			
Building capacity of farmers, traders and other stakeholders in post-harvest handling practices	x	x	
Providing advice and training on the design and proper management of post-harvest-specific infrastructure	x	x	x
Developing effective waste/ by-product management strategies (e.g. composting, feed)	x	x	
Using sustainable biomass residue for bioenergy generation	x	x	
Using local and renewable raw material to build storage infrastructure	x	x	
Supporting farmers in developing commercial strategies (e.g. avoid selling stocks at a low price and buying later at high prices)	x		
Value chain development			
Efficiently using resources (e.g. water and nutrients) (i.e. reuse, reduce, recycle) with closed loop systems, especially for processing/transformation	x	x	
Improving storage facilities for harvest	x	x	x
Risk management through, for example, insurance	x	x	
Improving energy efficiency	x	x	
Valuing and using by-products originating during the processing (for energy/fertilizers use)	x	x	
Producing renewable packaging	x	x	

4. Examples of good practice options and concepts

This section presents more information about different management practices in agriculture. Depending on the specific circumstances, some can provide "win-win-win" solutions, i.e. increase productivity and resilience and lower emissions.

Conservation agriculture

(Sources: FAO, 2011 (Save and Grow); TerrAfrica, 2011; FAO, 2010 Integrated Crop Management Vol.12-2010 - Green manure/cover crops and crop rotation in conservation agriculture on small farms)

Definition: Conservation agriculture (CA) is a farming system that conserves, improves and makes more efficient use of natural resources through integrated management of soil, water and biological resources. It is a way to combine profitable agricultural production with environmental concerns and sustainability. The three fundamental principles behind the CA concept are: (1) minimum soil disturbance; (2) permanent soil cover; and (3) crop rotation. Each of the principles can serve as an entry point to the technology; however, only the simultaneous application of all three results in full benefits. CA covers a wide range of agricultural practices based on no-till (also known as zero tillage), including within well-defined limitations high disturbance such as strip-till. These require direct drilling of crop seeds into cover crops or mulch. Weeds are suppressed by mulch and / or cover crops and need to be further controlled either through herbicide application or manual or mechanical (e.g. with a knife roller) weeding.

Applicability: CA has been proven to work in a variety of agro-ecological zones and farming systems: high or low rainfall areas; degraded soils; multiple cropping systems; and systems with labour shortages or low external-input agriculture. CA has good potential for spread in dry environments because of its water-saving ability, though the major challenge here is to grow sufficient vegetation to provide soil cover.

Resilience to climate variability: CA increases tolerance to changes in temperature and rainfall including incidences of drought and flooding.
Main benefits: CA is considered a major component of a "new green revolution" in sub-Saharan Africa which will: help to make intensive farming sustainable through increased crop yields/yield reliability and reduced labour requirements; cut fossil fuel needs through reduced use of machines; decrease agrochemical contamination of the environment through reduced reliance on mineral fertilizers; and reduce GHG emissions, minimize runoff and soil erosion and improve fresh water supplies. CA can thus increase food security; reduce off-site damage; reduce foreign exchange required to purchase fuel and agrochemicals; and create employment by producing CA equipment locally. The potential to mitigate and to adapt to climate change is high.

For specific references on CA and climate change:

- Proceedings of the FAO/CTIC Conservation Agriculture Carbon Offset Consultation 28-30 October, 2008 http://www.fao.org/ag/ca/carbonconsult.html
- Soil organic carbon accumulation and greenhouse gas emission reductions from conservation agriculture: a literature review (Corsi, S., Friedrich, T., Kassam, A., Pisante, M. & Moraes Sà, J.); FAO Integrated Crop Management Series (AGP), 2012 (forthcoming)
- Carbon monitoring on-farm assessment in no-till fields and mapping scaling up, University of Ponta Grossa/FAO (forthcoming)
- Soil C-sequestration in no-till cropping systems in subtropical and tropical agro-ecosystems in Brazil, University Ponta Grossa/FAO, (forthcoming)

Agroforestry
(Sources: TerrAfrica, 2011; FAO, 2011 (Save and Grow), FAO, 2010 (Climate-Smart Agriculture))

Definition: Agroforestry systems deliberately integrate the cultivation of woody perennials with crop or livestock production. It is increasingly practised on degraded lands, often with perennial legumes. The integration can be either in a spatial mixture (e.g. crops with trees) or in a temporal sequence (e.g. improved fallows, rotation). There is a huge variety of different systems and they range from very simple to very complex, including: alley cropping, farming with trees on contours, boarder planting, live fences, multi-storey cropping, shifting cultivation cropping, intercropping, multiple cropping, bush and tree fallows, parkland systems and home gardens.Many of them are traditional land-use systems. CA is often combined with agroforestry and with tree cropping systems, which are practised around the world. Agroforestry is thus not a single technology but covers the broad concept of trees being integrated into cropping and livestock systems in order to achieve multifunctionality.
Applicability:Agroforestry is practised around the world in various forms, their wide variety allowing for use in different ecological zones and for different purposes.
Resilience to climate variability: An agroforestry system is as tolerant to climate variability as are the components – tree, crop and/or livestock – of the system. In general, however, agroforestry systems will be more resilient than simpler, non-integrated systems because the tree component can increase the resilience of the agricultural system to ecologic and economic changes.
Main benefits: Agroforestry systems have great potential to diversify food and income sources, to improve land productivity and to reduce, stop and reverse land degradation. Trees/forests in the farming system can increase a family's total income, reduce risk of crop/livestock failure and provide essential products for home consumption. Their ecological functions (e.g. providing a favourable microclimate, providing permanent cover, improving soil fertility and structure, increasing water infiltration, providing protection against winds and providing shade for livestock) may contribute significantly to agricultural production. Agroforestry systems offer mitigation benefits through sequestering and storing atmospheric carbon and, in some cases, through substitution effects (e.g. fuelwood substituting for fossil fuels). The adaptation and mitigation potential depends on the agroforestry system applied.

Integrated crop-livestock management and integrated food energy systems

(Sources: TerrAfrica, 2011, FAO, 2011 (Save and Grow); FAO, 2010 (An international consultation on integrated crop-livestock systems for development. The Way Forward for Sustainable Production Intensification); FAO, 2010 (Making Integrated Food-Energy Systems Work for People and Climate- An Overview)

Definition: In integrated crop-livestock management (ICLM), crops and livestock interact to create synergies, making optimal use of resources. The waste products of one component serve as a resource for the other: manure from livestock is used to enhance crop production (i.e. improve soil fertility), while crop residues and by-products (e.g. grass weeds and processing waste) are supplementary feed for the animals. Grass – and prunings from agroforestry trees – grown on contour conservation barriers, as well as nitrogen-fixing legumes grown under CA systems, are further potential sources of fodder. Livestock are integral to many cropping systems in Africa and Asia; they provide traction and transport, as well as meat, milk and hides. Improvements to the livestock component of integrated systems include upgraded intensive pastures through shifting night enclosures (kraals / bomas), fodder planting/hay making and stall feeding (e.g. "cut-and-carry"and "zero grazing") in the more humid areas. Various factors influence the type and effectiveness of crop-livestock interactions, including socio-economic parameters (e.g. access to land, labour and capital) and ecological conditions (e.g. temperature and rainfall).

Integrated food energy systems (IFES) combine the production of feedstock for food and for energy on the same land, through multiple-cropping patterns or agroforestry systems and can be combined with livestock and/or fish production. It can also adopt agro-industrial technology (such as gasification or anaerobic digestion) that allows maximum utilization of all by-products and encourages recycling and economic utilization of residues. Both ICLM and IFES can function at various scales and configurations, from small-scale systems that operate at the village or household level mainly for the purpose of self-sufficiency, to large-scale systems adjusted for industrial operations but involving and benefiting small-scale farmers (FAO, 2010 IFES).

Applicability: ICLM systems and IFES are common in semi-arid and subhumid (and humid) areas as well as in tropical/temperate highlands. Given the growing demand for livestock products, the subhumid areas are predicted to have the best potential to provide most of this increase. ICLM can be applied in many areas, but needs to be adapted and modified to prevailing conditions. IFES systems are very variable and can be found in all climatic zones.

Resilience to climate variability: ICLM systems and IFES tend to be relatively well-adapted to climatic variability because of their diversity and flexibility – especially when soil and water conservation/water harvesting and agroforestry are integrated into the overall system.

Main benefits: Well-managed ICLM and IFES: (a) increase crop yields; (b) improve soil biological activity and health; (c) build up fertility through nutrient recycling and planting leguminous crops and trees; (d) reduce erosion; (e) intensify land use, improving profits and financial resilience; (f) increase biodiversity; and (g) improve livestock productivity and health. Including animals in farm systems increases sustainability and reduces reliance on external inputs. The risks of climate variability can be minimized through the diversification of the farming systems. Carbon storage can be high: in one case from West Africa, soil receiving manure for five years had 1.18 t/ha more carbon present than soil treated with plant residues alone (Woodfine, 2009 and FAO, 2007). Nevertheless, the carbon budget of such systems depends on livestock management, because of methane emissions. Improved manure management can reduce methane emissions by capturing the gas in covered manure-storage facilities (biogas collectors) which can offset the methane partially emitted by livestock. Furthermore, IFES reduce pressure on land use through intercropping of food and energy feedstocks and/or use of residues such as food, feed or fuel. Integrated systems thus reduce poverty and malnutrition and strengthen environmental sustainability.

Rainwater harvesting

(Sources: TerrAfrica, 2011; FAO, 1991 (Water Harvesting); FAO 2002, Crops and Drops))

Definition: Rainwater harvesting (RWH) refers to all technologies where rainwater is collected to make it available for agricultural production or domestic purposes. RWH aims to minimize effects of seasonal variations in water availability because of droughts and dry periods and enhance the reliability of agricultural production. An RWH system usually consists of three components: (1) a catchment/collection area which produces runoff because the surface is impermeable or infiltration is low; (2) a conveyance system through which the runoff is directed (e.g. by bunds, ditches or channels, although this is not always necessary); and (3) a storage system (target area) where water is accumulated or held for use – in the soil, pits, ponds, tanks or dams. When water is stored in the soil – and used for plant production there – RWH often needs additional measures to increase infiltration in this zone and to reduce evaporation loss, for example by mulching. Furthermore, soil fertility needs to be improved by composting/manuring or micro-dosing with inorganic fertilizers. Commonly used RWH techniques can be divided into microcatchments collecting water within the field and macro-catchments collecting water from a larger catchment further away.

Applicability: RWH is applicable in semi-arid areas with common seasonal droughts. It is mainly used for supplementary watering of cereals, vegetables, fodder crops and trees but also to provide water for domestic and stock use, and sometimes for fish ponds. RWH can be applied on highly degraded soils.

Resilience to climate variability: RWH reduces risks of production failure because of water shortage associated with rainfall variability in semi-arid regions. It also helps cope with more extreme events, enhances aquifer recharge and enables crop growth (including trees) in areas where rainfall is normally insufficient or unreliable.

Main benefits: RWH is beneficial because of increased water availability, reduced risk of production failure, enhanced crop and livestock productivity, improved water-use efficiency, access to water (for drinking and irrigation), reduced off-site damage (including flooding), reduced erosion and improved surface and groundwater recharge. Improved rainwater management contributes to food security and health through households having access to sufficient, safe supplies of water for domestic use.

Pastoralism and rangeland management

(Sources: TerrAfrica, 2011; FAO, 2009 (Review of evidence on drylands pastoral systems and climate change)

Definition: Pastoralism and rangeland management refer to extensive production of livestock using pastures and browse, and is mainly found in arid and semi-arid areas. In sub-Saharan Africa, the term "pastoralism" is usually associated with the use of common property resources subject to some group agreements rather than "open access". "Ranching", on the other hand, implies individual, privatized land ownership. Pastoralism is based on open grazing lands (e.g. savannas, grasslands, prairies, steppes and shrublands) managed through herding. Pastoralists adopt opportunistic land-use strategies; that is, they follow resources of grazing/browsing and water and destock in times of drought (often de facto through livestock mortality rather than stock sales), but have rapid-response post-drought restocking strategies (commonly based first on the high reproduction rates among indigenous sheep and goats). There are many types and degrees of pastoral mobility, which vary according to environmental conditions or the given household situation. Mobility can be either seasonal, regular between two well-defined pasture areas or following erratic rain. It is rarely the same from one year to another. Movement is not necessarily undertaken only for resource-based reasons; it can be for trade or because of conflict. Pastoral activities have conventionally been considered uneconomic and ecologically destructive. Current thinking increasingly recognizes these strategies as economically viable, environmentally sustainable and compatible with development. The challenge is to adapt traditional pastoralism to today's changing environmental conditions. Opportunities include: establishment of feed banks;

improvement of herd composition and health; a more dense distribution of wells, collection and storage of surface water by, for example, "charco dams"; adaptive grazing; land-use plans; access to markets; and empowerment.

Applicability: Grasslands – as the basis for livestock production – cover some 70 percent of the global land area. It is a production system found in marginal, dry lands with relatively low inherent productivity because of aridity, altitude, temperature and/or a combination of all factors. Pastoralism is becoming increasingly constrained because of weakening of traditional governance over communal natural resources, restricted mobility, sedentarization, boundaries and advancing agriculture.

Resilience to climate variability: By definition, pastoralism is based on continuous adaptation to highly uncertain environments, especially climate. Traditional pastoralism has lost and continues to lose flexibility and options for coping with drought (e.g. loss in mobility because of encroachment of cropping and growing human populations), which leads to increased risk.

Main benefits: Mobile herding systems combine economic production in marginalized land and environmental protection (biodiversity) of vulnerable ecosystems, which have been modified over time by pastoralism itself, improved food security and livelihoods of marginalized and disadvantaged people. The vast areas of degraded rangeland play a vital role in sequestering carbon. Dry soils are better longer term sinks for C than soils in more humid environments.

Other examples

Livestock manure management:

The efficient treatment of manure can reduce emissions and raise the sector's productivity. For example, the anaerobic digestion of manure stored as a liquid or slurry can lower methane emissions and produce useful energy (e.g. biogas), while composting solid manures can lower emissions and produce useful organic amendments for soils. The substitution of manure for inorganic fertilizers can also lower emissions and improve soil condition and productivity. The reintegration of livestock with crop activities, the strategic location of intensive livestock production units and enhanced processing techniques to reduce production losses are also effective strategies for boosting productivity (FAO, 2010).

Rice production systems:

A number of methods and practices for rice production can be adopted to address climate change challenges. For example, production systems are adapted by altering cropping patterns, planting dates and farm management techniques. Embankments have been built to protect rice farms from floods and new drought- and submergence-tolerant varieties of rice are being produced and distributed by government institutions and the private sector. In addition, many farmers are diversifying their production systems, growing other cereals and vegetables and rearing fish and animals (such as pigs and chickens). The residues and waste from each system are being composted and used on the land, thereby reducing the need for external inputs. This diversification has increased incomes, improved nutrition, built resilience to shocks and minimized financial risks. The development of advanced modeling techniques, mapping the effect of climate change on rice-growing regions and providing crop insurance are other examples of managing risks and reducing vulnerability.

Research on rice cultivation has identified that emissions mainly occur in the few months of the year when the ground is fully waterlogged. A more integrated approach to rice paddy irrigation and fertilizer application has therefore been found to substantially reduce emissions. The use of ammonium sulphate supplements have also been used to promote soil microbial activity and reduce methanogens. In addition, urea deep placement (UDP) technology has been developed where urea, in the form of super granules or small briquettes, is placed under the soil near the plant roots and out of the floodwater where it is susceptible to loss (FAO, 2011). Furthermore, integrated fish-rice farming is environmentally and ecologically sound and can benefit farmers in terms of a higher income. Energy and nutrients are

recycled more efficiently through the food chain, creating a stable and highly productive system. Fish feeding and swimming activities generally improve the fertility of the soil. The integration of different systems can reduce the vulnerability to climate change, as mentioned under the ICLM and IFES systems.

Agro-industry:

Within the agro-industrial sector, the energy efficiency of the production chain can be targeted and contributions can be made to reducing GHG emissions. In many cases, this involves modernizing energy-efficient and centralized machinery and infrastructure. Furthermore, strengthening agro-industry through sustainable ethanol production, electricity and thermal heat (i.e. through biomass production) can provide potential sources of energy. An example is the Furatena Energy Efficiency World Bank project in Colombia, which aims to contribute to the reduction of GHG emissions from the panela (brown sugar) sector by developing a modern, energy-efficient and centralized manufacturing facility that will replace small, artisan manufacture.

ANNEX 5
Framework and options for disaster risk reduction in agricultural sectors

1. Climate change and disaster risks

The world has witnessed an alarming increase in the frequency and intensity of natural disasters. Each year from 2000 to 2005, natural disasters, on average, affected 240 million people, claiming 80,000 lives and US$80 billion in property[3] losses. About 98 percent of natural disasters were climate-related, predominantly floods and windstorms, followed by droughts.[4] The number of hydro-meteorological disasters, such as droughts, floods, tropical storms and wild fires, increased from 195 per year during 1987–1998 to 365 per year during 2000–2006.[5] A number of factors contributed to the increase in disaster frequency, intensity and losses, including increased climate variations and extreme weather events associated with climate change, population growth, unplanned urbanization, improper natural resource management and environmental degradation.[6]

The IPCC 4th assessment report summarized impacts of climate change in the past decades, including: increased number of drought-affected areas since the 1970s, particularly in the Sahel, the Mediterranean, Southern Africa and parts of Southern Asia; more frequent heat waves over most land areas; increased frequency of heavy precipitation events over most areas; increased incidence of extremely high sea levels; and increased intense tropical cyclone activity in the North Atlantic since about 1970. Future major hydrometeorological disaster risks are also projected, including:

- widespread droughts, which will decrease the areas suitable for agriculture, the length of growing seasons and yield potential (particularly along the margins of semi-arid and arid areas) and increase water stress for about 75 to 250 million people by 2020;
- more frequent and intensified floods, which may exceed historical parameters and affect areas that have not developed coping capacities;
- tropical cyclones, which will directly increase hazard exposure in existing cyclone hotspots and create new hotspots; and
- sea level rise, which will severely affect low-lying coastal areas and heavily populated mega-deltas in South, East and Southeast Asia.[7]

Agricultural sectors are vulnerable to natural disasters. About 40 percent of world food crises in 2007 were mainly due to natural causes.[8] The projected impacts of climate change will further alter the basic elements of agro-ecosystems, including temperature, rainfall, land and water availability and biodiversity, and add additional risks to agricultural development, food security and rural livelihoods. At the same time, maladaptation and inappropriate development interventions (e.g. over-exploitation of water resources, increased farming in high-risk areas, large area mono-cropping and deforestation) also may increase vulnerability to disaster risks. It is therefore necessary to integrate disaster risk reduction (DRR) with climate change adaptation in agricultural and rural development to be better prepared to manage more frequent and intense and less predictable disaster risks.

3 CRED, March 2007, the data source-EM-DAT.
4 CRED Crunch, Issue No 12, April 2008.
5 CRED, UCL, UNISDR, Annual Statistical Review: Numbers and Trends, 2006, Brussels 2007.
6 FAO, Climate change and disaster risk management, High-level conference on food security: the challenges of climate change and bioenergy, 3-5 June 2008, Rome.
7 The IPCC 4th assessment report, 2007.
8 FAO Approach to disaster risk management-preliminary baseline assessment, April 2009.

2. The concept and approach of disaster risk reduction

The United Nations International Strategy for Disaster Reduction (UNISDR) defines DRR as 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, and improved preparedness for adverse events.[9] It refers to the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society – to prevent or limit the adverse impacts of hazards – within the broad context of sustainable development.[10]

Disaster risk is determined by the nature, intensity and frequency of hazards and the vulnerability to hazard. Hazards can result from natural causes – geological (e.g. earthquake, tsunami, volcanic activity), hydrometeorological (e.g. floods, tropical storm, drought) or biological (e.g. epidemic diseases) – or from human causes, such as climate change, fires, mining of non-renewable resources, environmental degradation and bad technologies. Vulnerability refers to the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. The recognition of vulnerability as a key element in the risk notation is accompanied by a growing interest in understanding and enhancing the positive capacities of people to cope with the impact of hazards. These coping capacities are closely linked to the concept of resilience, which is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. Box 5.1 illustrates some basic terminologies defined by UNISDR.

Box 5.1: **Basic definitions**

Hazard: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its ownresources.

Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Risk: The combination of the probability of an event and its negative consequences.

Disaster risk: The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

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.

Relief/response: Provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

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 and improved preparedness for adverse events.

Resilience/resilient: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Source: UNISDR Terminology on Disaster Risk Reduction, 2009.

A comprehensive approach to reducing disaster risks is set out in the United Nations-endorsed Hyogo Framework for Action (HFA), adopted in 2005. The UNISDR system provides a vehicle for cooperation

9 UNISDR, Terminology on Disaster Risk Reduction, 2009

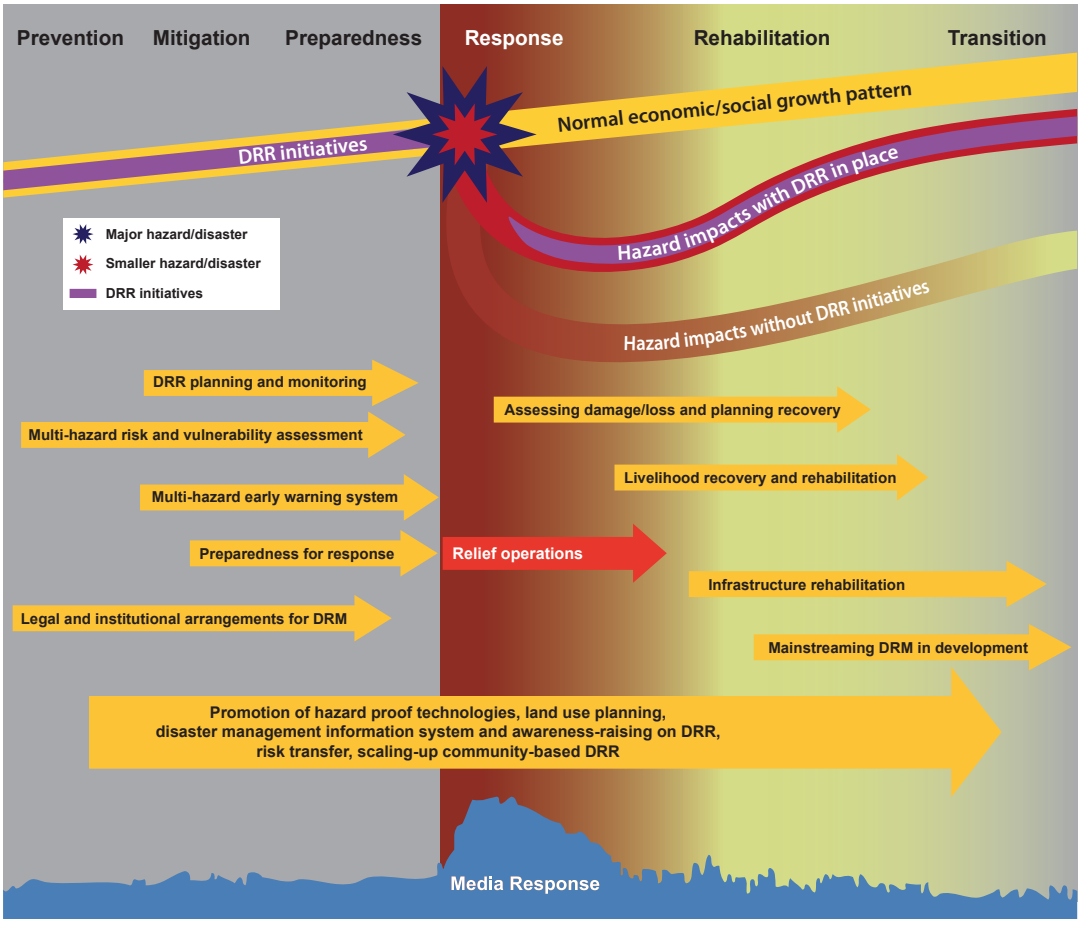
10 FAO, Disaster risk management systems analysis – a guide book, 2008

among governments, organizations and civil society actors to assist in the implementation of the HFA. The HFA identified the following five priority areas for action:

1. Ensure that DRR is a national and a local priority with a strong institutional basis for implementation;
2. Identify, assess and monitor disaster risks and enhance early warning;
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels;
4. Reduce the underlying risk factors; and
5. Strengthen disaster preparedness for effective response at all levels.

Figure 5.1 illustrates the overall framework of disaster risk management (DRM), which shows a continuum of an ongoing process of interrelated actions, including DRR before disasters, response during and immediately after disasters and post-disaster rehabilitation. The major focus of DRR is prevention, mitigation and preparedness. Elements of the framework are further elaborated in Box 5.2.

Figure 5.1:
Disaster risk management framework (DRMF)



Source: Disaster Risk Management Cycle (DRMC). Diagram (modified from TorqAid; http://www.torqaid.com/default.asp)

Box 5.2: **Elements of DRM framework**

Disaster risk reduction continuum:

- **Ongoing development activities** – Ongoing DRM aspects in development programmes
- **Risk assessment** – Diagnostic process to identify the risks that a community faces
- **Prevention** – Activities to avoid the adverse impact of hazards
- **Mitigation** – Structural/non-structural measures undertaken to limit the adverse impact
- **Preparedness** – Activities and measures taken in advance to ensure effective response
- **Early warning** – Provision of timely and effective information to avoid or reduce risk

Immediate disaster response:

- **Evacuation** – temporary mass departure of people and property from threatened locations
- **Saving people and livelihoods** – Protection of people and livelihoods during anemergency
- **Immediate assistance** – Provision of assistance during or immediately after a disaster
- **Assessing damage and loss** – Information about impact on assets and loss to production

Post-disaster continuum:

- **Ongoing assistance** – Continued assistance until a certain level of recovery
- **Recovery** – Actions taken after a disaster with a view to restoring infrastructure and services
- **Reconstruction** – Actions taken after a disaster to ensure resettlement/relocation
- **Economic & social recovery** – Measures taken to normalize the economy and societal living
- **Ongoing development activities** – Continued actions of development programmes
- **Risk assessment** – Diagnostic process to identify new risks that communities may face again

Source: FAO, Disaster risk management systems analysis – a guide book, 2008.

3. FAO Framework Programme for DRR

As illustrated in Figure 5.2, the FAO Framework Programme for Disaster Risk Reduction (FP DRR) includes four integrated thematic pillars, which together address core themes in DRR for the agricultural sectors. Each pillar makes a direct contribution to one of the priorities for action in the HFA:

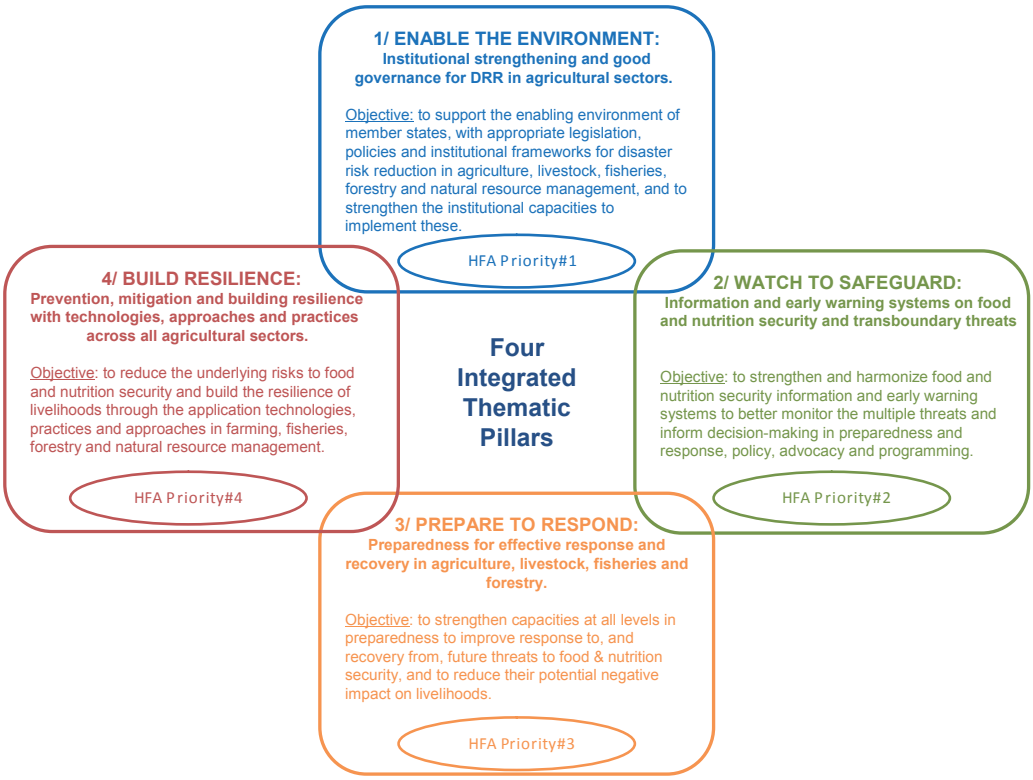
- **Pillar 1 – Enable the environment: Institutional strengthening and good governance for DRR in agricultural sectors.** This pillar supports the enabling environment of member states with appropriate legislation, policies and institutional frameworks for DRR in agriculture, livestock, fisheries/aquaculture, forestry and natural resource management, while strengthening the institutional capacities to implement these.
- **Pillar 2 – Watch to safeguard: Information and early warning systems on food and nutrition security and transboundary threats.** This pillar aims to strengthen and harmonize food and nutrition security information and early warning systems to better monitor the multiple threats and inform decision-making in preparedness, response, policy, advocacy and programming.
- **Pillar 3 – Prepare to respond: Preparedness for effective response and recovery in agriculture, livestock, fisheries and forestry.** The aim is to strengthen capacities at all levels in preparedness to improve response to, and recovery from, future threats to food and nutrition security, and to reduce their potential negative impact on livelihoods.
- **Pillar 4 – Build resilience: Prevention, mitigation and building resilience with technologies, approaches and practices across all agricultural sectors.** This pillar addresses the underlying risks to food and nutrition security and builds the resilience of livelihoods through the application of technologies, practices and approaches in farming, fisheries/aquaculture, forestry and natural resource management.[11]

11 Resilient livelihoods: disaster risk reduction for food and nutrition security – an FAO framework programme, 2011.

The FP DRR includes four cross-cutting priorities:

- capacity development, through assistance in technical expertise, technology transfer, services, practical tools, methodologies, extension, capacity-development training, policy advice, advocacy, education and awareness-raising;
- knowledge management and communication, through stimulating the generation, documentation, sharing and application of information and knowledge;
- strategic partnerships, through working through partnerships and alliances at local, national, regional and global levels; and
- gender equity (i.e. taking into account the differences in women's and men's vulnerability to disasters, as well as their differentiated roles in fostering a culture of resilience and in actively contributing to building disaster resilience) to ensure that gender concerns, needs and capacities in DRR are integrated.

Figure 5.2:
The four pillars of the FAO Framework Programme on Disaster Risk Reduction



4. Options and good practices for disaster risk reduction

Agricultural and rural development need to address relevant DRR requirements at different levels, especially at the local level. Some DRR options and good practices in agricultural sectors are summarized below. Investment programmes/projects can incorporate and implement these based on local needs and conditions.

Disaster risk profiling

Disaster risk profiling provides quality assessment and prioritization of hazards, risks and vulnerabilities, which is the prerequisite of DRM planning and implementation. Disaster risk profiling can be realized through the following practices:

- **hazard assessment:** identify the typology, frequency and potential severity of hazards;
- **hazard mapping:** describe the distribution of hazards across geographical areas and vulnerable groups;
- **vulnerability assessment:** identify the key factors of vulnerability and local coping and adaptive strategies and capacities;
- **institutional mapping:** assess the role of agricultural sectors and institutions in DRM and their linkages with other sectors and institutions;
- **needs assessment:** identify major gaps and requirements in DRM in agricultural sectors, including gaps in national and local policies, legislation and institutional capacity.

Promoting prevention and mitigation

Options for disaster prevention and mitigation focus on reducing underlying risk factors. This normally requires a medium- to long-term planning framework that can allow for the adjustment of institutional mechanisms and the integration of appropriate measures in sectoral development policies and planning. It includes structural and non-structural measures to avoid or limit the adverse impact of potential natural hazards, including:

- **Legislation and policies:** National legislation on DRR is a basic requirement. It would normally include a national act establishing and mandating a national authority for DRR and an interministerial commission/committee for policy-making and coordination on DRR. It would specify responsibilities and tasks of relevant public and private stakeholders in the DRR process, as well as a coordination mechanism and procedures. Some examples of legislation and policy issues for the agricultural sector are listed in Box 5.3.

Box 5.3: **Legislation and policy issues for DRR in agricultural sectors**

- Risk reduction standards for agricultural infrastructure and construction
- Clear definitions about declaring emergency situations and phasing of emergencies
- Sector development policies to define priorities and strategies for risk reduction
- Land-use planning and zoning
- Frameworks to control land degradation and combat desertification
- Strategies and policies for natural resources management
- Transboundary agreements for watershed management and control of animal and plant disease

FAO, Disaster Risk Management Systems Analysis, 2009

- **Institutional capacities and coordination:** This measure includes ensuring:
  - proper representation of agricultural sectors in national and local DRR coordination mechanisms and institutions;
  - clear definition of the technical contributions and capacities of agriculture departments, research institutes and extension services to DRR systems; and
  - close linkages with other relevant line departments, such as water affairs, meteorological services, environment and natural resources.

FAO published a guide book on DRM systems analysis in 2009, which provides a set of tools to assess existing structures and capacities of national, district and local institutions with responsibilities for DRM in order to improve the effectiveness of DRM systems and the integration of DRM concerns into development planning, with particular reference to disaster-prone areas and vulnerable sectors and population groups. A seven-step diagnostic study process is introduced in the publication (see Box 5.4).

Box 5.4: **Seven-step diagnostic process for disaster risk management systems analysis**

1. Conduct initial preparation and literature review
2. Hold inception meeting and field work planning meetings
3. Prepare national-level institutional profile
4. Prepare provincial/regional/district institutional profile
5. Prepare profile of the community and local institutions
6. Analyse data analysis and write draft report
7. Hold wrap-up meeting with in-country stakeholders and finalize report

Source: FAO, Disaster Risk Management Systems Analysis, 2009.

- Technical interventions: Technical options can be implemented through sectoral agencies in partnership with national and local-level DRR (see Box 5.5).

Box 5.5: **Technical interventions for DRR in the agricultural sectors**

Agricultural measures
- Appropriate crop selection and animal breeding
- Improved cropping systems and cultivation methods
- Post-harvest management
- Pest control
- Sustainable water management and water conservation techniques
- Afforestation/reforestation and agroforestry

Infrastructural measures
- Raised seeds beds, dams, wind breaks, fire breaks
- Proofing of storage facilities and livestock shelters
- Improved design, construction and maintenance of water infrastructure
- Safe rescue places/platforms and strategic animal fodder reserves
- Flood-safe seed and fodder stocking infrastructure

Early warning systems
- Informing farmers about what they are facing and what they can do
- Communicating in a way that is understandable by vulnerable people
- Transmitting through media accessible to rural communities
- Including medium- and long-range forecasts to allow for contingency cropping plans

Socio-economic measures
- Risk sharing and transfer instruments (e.g. crop/livestock/fishery insurance, compensation and calamity funds, microcredit and cash transfers)
- Livelihood diversification (e.g. new agriculture activities and non-farm activities)

Training and awareness-raising
- Awareness-raising and training for those who might be affected and those who will be providing support to the affected communities
- Dissemination and demonstration of good practices
- Mock exercises to simulate disasters and individual responsibilities and tasks

Source: FAO's Role in Disaster Risk Reduction, F. Battista, S. Bass and F. Rolle, 2009.

Preparedness

Preparedness measures are short-term, preparatory activities taken directly in advance of an announced or expected hazard to prepare for and reduce its effects and potential impacts. Key components of disaster preparedness are described below:

- Dissemination of hazard alerts and early warning messages at the local level: This involves defining national and local responsibilities and creating the capacities to ensure immediate outreach of the early warning messages to the most vulnerable households and people living in marginal or remote areas. In this effort, local DRR groups or farmers' cooperatives and associations have proven to be suitable mechanisms to assist.
- Contingency planning: Effective response during an emergency relies on the existence of ready-made and tested contingency plans, which should be available at national, provincial and local levels. Contingency plans at different levels should be complementary and ensure that appropriate linkages are established to coordinate and support action along lines of command. Contingency planning measures are normally associated with life-saving measures (e.g. identification of evacuation procedures and safety sites and search and rescue); however, they may also be a key instrument for saving equipment, livestock, seeds and other agricultural inputs. Contingency planning in agricultural sectors includes: contingency crop planning (e.g. changing cropping patterns to match late/early rains, using seed and crop varieties tolerant to drought, flood and salinity and having famine reserve crops); conservation of forage/fodder; moving of animals to safer grounds; plans for vaccinating livestock exposed to flooding; creation of emergency seed procurement networks; and development of safety-at-sea measures for fishermen.
- Household-level preparedness: Communities and households are the first line of response in any emergency. Many disasters occur on a small/regular basis, unnoticed by national authorities and the international community. Community-led initiatives play a major role in immediate response, such as saving lives and moving people to safer ground, providing emergency food and shelter; and engaging in recovery, such as mutual support in reconstruction work. Examples of community/household preparedness measures include: cleaning drainage channels, pruning trees exposed to hurricanes, bringing animals and seeds to secure places; preparing buffer capacities of food, fodder and water for humans and animals; providing basic medical/veterinary packages; establishing stand-by agreements for the use of equipment and machinery (e.g. water pumps and fishing boats) for rescue operations; and emergency harvesting, if the season and time allows.

5. Issues deserving special attention

In mainstreaming DRR and climate change adaptation into development planning and investment, some issues deserve special attention, such as:

- improving risk and vulnerability assessments by combining historical trends with climate change scenario modelling;
- setting realistic disaster prevention standards according to local economic and technical capacities and short-term and longer-term development needs;
- considering longer-term perspectives to address secondary impacts of disasters, such as wider scale migrations and their implications for conflicts and security issues;
- investing in furthering preparedness so all levels (i.e. local communities, governments, regional and international organizations) can respond more effectively to humanitarian consequences of climate change;
- revising land-use planning schemes to include evolving hazard profiles and subsidized relocation schemes in high-risk areas;

- strengthening sustainable natural resource management practices for water, land, fisheries and forestry which constitute the baseline for all risk reduction and adaptation options;
- investing in management and dissemination of climate information tailored to different social groups in different areas;
- ensuring that food security contingency plans consider global and local climate and market shocks and diversified responses (e.g. production, trade, stockpiling, food and cash transfers);
- increasing investment in social protection and risk transfer, since the increase in frequency of hazards may erode people's abilities to recover and the increase in magnitude of hazards will result in additional pressure on national social protection systems and humanitarian aid;
- formulating better communication and awareness-raising methodologies and strategies to ensure that climate information reaches end users and that communities and policy-makers are mobilized at all levels to initiate preventive action;
- building stronger coordination mechanisms to avoid overlap, increase efficiency and improve targeting and quality of interventions; and
- designing and implementing DRR as an integral part of the continuum cycle of DRM, rather than as a separate phase before disasters.

ANNEX 6
Identifying climate change-related indicators

Challenges in identifying indicators

The project preparation step of developing a results framework – or M&E framework – and related monitoring arrangements is an opportunity to review previous project design steps and verify whether the proposed project strategy is comprehensive. The project's results framework characterizes the fundamental logic to achieve the project development objective, and is used to monitor performance throughout the project. It defines the results chain – from activity to output, outcome and impact – as shown in Figure 6.1 (by OECD/GIZ). To measure project progress and achievement, it is necessary to identify suitable indicators and clarify related baselines, targets and means of verification for each of the results at different levels; this forms the core part of the project M&E framework. Indicators should, wherever possible, be SMART.[12] Incorporating climate change considerations in the project framework adds complexity to identifying, monitoring and evaluating project indicators because of the following reasons:

Challenges in distinguishing adaptation interventions from development activities: Many adaptive options are the same as those for normative development, but with longer-term perspectives under changed climate boundary conditions. It is not easy to clearly distinguish these two types of interventions, especially when adaptation is not designed and implemented as a stand-alone project or component, but incorporated into various development activities. This is part of the reason why developed countries are reluctant to fund adaptation activities in developing countries. The difference between normative development activities and climate change interventions will mainly be distinguished by indicators at outcome and impact levels. Therefore, indicators for adaptation interventions should reflect achievements in addressing additional impacts induced by climate change, such as the capacity to cope with increased scope, frequency and intensity of natural disasters in the longer term.

Uncertainty of climate change impacts: When there are no local climate change impact projections or when they are not certain, a project may adopt a general "non-regret" approach (providing that a sound cost-benefit analysis is done). Under such circumstances, quantitative analysis and evaluation of climate change-related interventions may be limited, and relevant qualitative indicators may be needed to complement the limited quantitative ones.

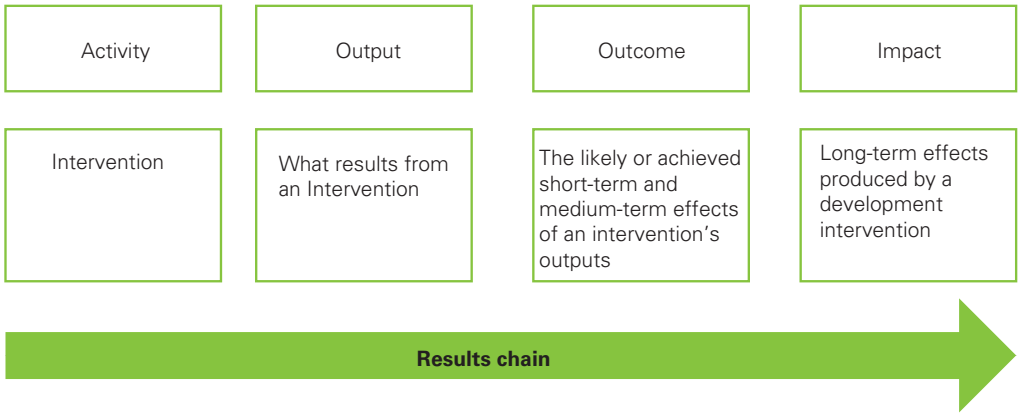
Unavailability to evaluate the long-term impacts: All investment projects/programmes have clearly defined durations, normally of several years. However, climate change-related interventions mainly aim at longer-term objectives that require decades – far beyond the project cycle. Thus, some expected outcomes and impacts may not be evaluable at the time of project M&E.

Complexity of climate change issues: Climate change objectives link together many issues (e.g.health, social turmoil, conflicts, migration and cross-sector issues), some of which are not usually considered in a typical agriculture development project. However, these can considerably affect the project's impact and need to be taken into account in M&E.

12 SMART indicators are one that are: **Specific**, i.e. they have a strong correlation with the results to be measured; **Measurable**, i.e. the needed data are accessible with sources of verification in the logframe; **Accurate**, i.e. they arecalculated on the basis of reasonably reliable data, obtained by means of adequate sampling approaches, avoiding excessive bias or statistical error; **Realistic**, i.e. it is possible to collect the data with available resources, based on the principle of "proportionate analysis"; and **Timely**, i.e. changes can be monitored according to the time-lag between the action and the expected change (European Commission, 2009).

Gaps in MRV of mitigation interventions: Technical gaps still exist in monitoring, reporting and verification (MRV) of climate change mitigation effects in the agriculture sector, especially in smallholder farming systems. This is why mitigation in agriculture, especially soil carbon sequestration, currently is left out by major climate change financing windows. Relevant M&E approaches and methods need to be identified and arranged if specific mitigation indicators are adopted.

Figure 6.1
Results chain



Source: GIZ, 2011[13]

Impact and intermediary outcome indicators

Impact indicators (or "higher-level outcome indicators", depending on the terminology adopted by the donor) should be able to measure the long-term effects of project outcomes, as well as capture the change in adaptive capacity and resilience to climate shocks of both natural systems and human communities, based on a proper baseline. Because of the complexity in M&E of climate change-related interventions, special methods and procedures for project impact evaluation may need to be proposed and included in the project M&E framework. According to the definition of CSA, the overall objectives of climate change adaptation and mitigation interventions in the agriculture sectors are increased productivity, increased resilience to climate risks, reduced GHG emissions, increased GHG uptake and enhanced achievement of national food security and development goals. Indicators for monitoring and evaluating project impact should try to reflect these, such as in the examples listed below:

- agricultural productivities in the project area over a multi-year period;
- resilience to flood/drought disasters over a multi-year period;
- total amount of annual GHG emissions reduced from the project areas over a multi-year period; and
- food security rate in the project areas over a multi-year period.

Outcome indicators (or "intermediary outcome indicators", depending on the terminology adopted by the donor) are mainly process indicators. They measure the extent to which activities financed by the project contribute to the mainstreaming of climate change considerations within national and local policies and institutions. In order to be meaningful and measurable, it is recommended that outcome indicators be limited to a minimum set of "aggregated" indicators, i.e. those based on a bigger set of indicators closely linked to concrete adaptation and mitigation activities specified in the logframe. For example, the outcome indicator "number of household or ha of farmland benefited from infrastructure

13 GIZ/OECD (2011). "Integrating Climate Change Adaptation into Development Cooperation: A Practice-oriented Training Based on the OECD Policy Guidance. A Training Manual".

systems" can be better assessed and interpreted by establishing strong links to the output indicators of each related activity (e.g. improvement of water infrastructure, agriculture infrastructure and rural infrastructure). In view of most climate change interventions, there is often a need to develop and establish outcome indicators to track, among other things:

- capacity development, including strategy and policy capacity, institutional capacity and technical capacity at different levels;
- infrastructure improvement, including water infrastructure, agriculture infrastructure and rural infrastructure; and
- technology dissemination, including technologies for climate change adaptation and mitigation in each of the agricultural sectors.

Table 6.1 below shows an illustrative list of climate change-related indicators in agricultural investment projects/programmes.Table 6.2 summarizes some indicators collected from project documents of FAO, GEF, IFAD, WB and ADB.

As Benson *et al.* (2007)[14] note, the implementation performance of CC-related measures in development projects can also be measured indirectly via proxy indicators:

> *"Use of proxies and alternative indicators may also assist measurement. For instance, in a project aimed at strengthening the drought-resilience of poor households, fluctuations in livestock sales or school enrolment will be easier and cheaper to monitor than movements in household income. Considerable care is required in thinking through the implications of the achievement of possible indicators and ensuring that appropriate, and collectively fully informative, indicators are selected. The consequences of reliance on particular indicators also require careful thought. For instance, a rise in flood-plain land prices may help capture the benefits of a flood control project. However, rising land prices could also imply that poorer households are forced into other marginal areas and thus a second indicator measuring population movements by income group or occupation in and out of the project area might also be required. In cases where it proves difficult to identify a relevant risk reduction indicator, it may be because the related intermediate objective or output has been defined too broadly or ambitiously and needs to be more closely defined. The magnitude of the hazard event itself may need careful definition to support identification of appropriate indicators, e.g. protection against a 1 in 25-year flood event rather than protection against flooding."*

Useful tools suggested by other agencies

There are other useful sources of information and guidance to identify indicators and incorporate climate change in the project's results framework, particularly for climate change adaptation. For example:

- Online guidance for M&E for community-based adaptation is available from the UNDP Web site at: http://www.undp-alm.org/projects/spa-community-based-adaptation-project/monitoring-and-evaluation
- A training manual on climate change adaptation published recently by GIZ (2011)[15] – under its section entitled "Develop a monitoring and evaluation framework" – provides a practical training exercise for developing an M&E framework, suggesting the use of a helpful matrix which can be adapted to incorporate both adaptation and mitigation to any type of agricultural investment project. For details, consult the full GIZ training manual at: http://www.oecd.org/document/40/0,3746,en_2649_34421_42580264_1_1_1_1,00.html

14 Benson, C., J. Twigg and T. Rossetto (2007), "Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations", International Federation of Red Cross and Red Crescent Societies and ProVention Consortium Secretariat, Geneva, Switzerland.

15 GIZ/OECD (2011). "Integrating Climate Change Adaptation into Development Cooperation: A Practice-oriented Training Based on the OECD Policy Guidance. A Training Manual".

Table 6.1
Illustrative list of climate change-related indicators

Project results chain		Climate change considerations/ interventions	Illustrative indicators
Impact		Contribute to CSA development in the project areas	Agricultural productivities in the project area over a multi-year period
			Resilience to flood/drought disasters over a multi-year period
			Total amount of annual GHG emissions reduced from the project activities (areas) over a multi-year period
			Food security rate in the project areas over a multi-year period
Outcome		Capacity development	Number of institutions or people benefited from capacity development on CC
		Infrastructure improvement	Number of households or area of farmland benefited from improved infrastructure systems
		Technology dissemination	Area of farmland that adopted CSA technologies
Outputs	1.Capacity development	Policy advice	1.1 Strategy, policy and regulation formulated for responding to CC in agricultural sectors
		Institutional support	1.2 Number of institutions established and empowered for mainstreaming CC response
		Technical training	1.3 Number of people trained in CC adaptation and mitigation
	2. Infrastructure improvement	Water infrastructure	2.1 Number of water infrastructure systems improved and area covered
		Agriculture infrastructure	2.2 Number of agriculture infrastructure systems improved and households benefited
		Rural infrastructure	2.3 Number of rural infrastructure systems improved and households benefited
	3. Technology dissemination	Crop production	3.1 Area of farmland that adopted CS cropping technologies
		Livestock production	3.2 Area of grazing land or number of herder households that adopted CS livestock technologies
		Forestry	3.3 Forest area or number of forestry dwellers in which CS forestry technologies were adopted
		Fishery and aquaculture	3.4 Number of fishery systems or fishermen that adopted CS fishery technologies
		Natural resources management	3.5 Number of ha and households that adopted CS natural resources management technologies
		Post-harvest and value chains	3.6 Number of households that adopted CS post-harvest and value chain technologies
Activities	1.1 Policy advice	Formulation of CC strategy in agriculture	1.1.1 Number of strategies on CC in agricultural sectors formulated/adopted
		Policy innovations on CC in agriculture	1.1.2 Number of policy innovations on CC in agriculture formulated and implemented
		Technical regulations and codes	1.1.3 Number of technical regulations and codes incorporating CC formulated/adopted
	1.2 Institutional support	Establishment of proper mechanisms	1.2.1 Number of procedure/mechanisms established for CC mainstreamingin agriculture
		Establishment of institutions	1.2.2 Number of institutions established for CC adaptation and mitigation in agriculture

Project results chain		Climate change considerations/ interventions	Illustrative indicators
		Empowerment of institutions	1.2.3 Number of institutions empowered and functioningin CC adaptation and mitigation
	1.3 Technical training	Training for government staff	1.3.1 Number of government staff trained on CC adaptation and mitigation
		Training for professionals	1.3.2 Number of professional staff trained on CC adaptation and mitigation
		Training for farmers	1.3.3 Number of farmers trained on CC adaptation and mitigation
	2.1 Water infrastructure	Irrigation systems	2.1.1 Number of systems that raised drought prevention standards and area of farmland area covered
		Drainage systems	2.1.2 Number of systems that raised water-logging control capacity and area of farmland area covered
		Flood control systems	2.1.3 Number of systems that raised flood prevention standardsand people benefited
	2.2 Agriculture infrastructure	Farm access roads	2.2.1 Km of access road developed
		Community storages	2.2.2 Number and capacity of community storages developed
		Agriculture machinery	2.2.3 Number of agriculture machines procured and distributed
	2.3 Rural infrastructure	Energy supply systems	2.3.1 Number of households that benefited from rural energy rehabilitation activity
		Water supply systems	2.3.2 Number of water supply systems developed and households benefited
		Bio-gas development	2.3.3 Number of bio-gas systems developed and households benefited
	3.1 Crop production	Dissemination of CA	3.1.1 Area of cropping land that adopted CA technology
		Dissemination of system of rice intensification (SRI)	3.1.2 Area of paddy rice areas that adopted SRI technologies
		Dissemination of integrated pest management (IPM)	3.1.3 Area of cropping land that adopted IPM technologies
	3.2 Livestock production	Grazing land management	3.2.1 Area of grazing land area improved
		Animal waste management	3.2.2 Number and capacity of animal waste management systems
		Adoption of adaptive varieties	3.2.3 Number of adaptive varieties adopted
	3.3 Forestry	Establishment of forest and tree cover for protective purposes	3.3.1 Increase in area of forest or number of trees planted/ re-established (e.g. in wind-breaks, riparian strips, mangroves and coastal forest, erosion-prone drylands or sloping lands)
		Afforestation and reforestation	3.3.2 Area of land afforested (i.e. non-forest land converted to forest) and reforested (i.e. forest restored on forest land that had been cleared)
		Forest restoration	3.3.3. Area of degraded forest land on which ecological functions of the land have been restored
		Agroforestry development	3.3.4 Area of land on which agroforestry practices were adopted and number of households benefited

Project results chain	Climate change considerations/ interventions	Illustrative indicators
3.3a. Forest management	Forest management (SFM)	3.3.5. Forest area in interventions consistent with sustainable management (including for production, protection and/or conservation purposes) were implemented successfully
	Forest harvesting	3.3.6. Area of timber production forest area in which reduced impact logging (RIL) techniques (especially felling and hauling) are practised.
	Forest use	3.3.6. Extraction of timber and non-timber forest products do not exceed sustainable levels and the access and benefits from these are equitably shared among stakeholders, recognizing traditional and statutory use rights
	Forest products transport /infrastructure	3.3.7. Timber industries and forest product consumers are close to the forest area minimizing/optimizing transport of logs and other forest products/services and maximizing value addition in the country.
	Reduction of excess fishing capacity	3.3.9 Tonnes of excess fishing capacity reduced
	Water quality and quantity management	3.4.0 Number and area of fish ponds with improved water management
3.5 Natural resources management	Integrated land planning	3.5.1 Number of plans conducted and land area covered
	Integrated soil and nutrition management	3.5.2 Number of ha that adopted integrated soil and nutrition management technology
	Biodiversity conservation zone	3.5.3 Number and area of biodiversity conservation zones established and functioning
3.6 Post-harvest and value chain	Post-harvest management	3.6.1 Number of households covered by post-harvest management extension activities
	Improving food processing	3.6.2. Number of food processing facilities procured and distributed
	Marketing	3.6.3 Number of marketing information systems established and farmers benefited
4.1 Project M&E	Establishment of M&E system	4.1.1 Number of monitoring points/stations established
	Establishment of baseline data	4.1.2 Number of project sites and beneficiaries covered by baseline survey
	Data collection, verification and reporting	4.1.3 Number of data monitored and reports formulated

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Table 6.2

Indicators collected from project documents of development partners

Agricultural sectors and themes	Interventions	Adaptation (A) and/or Mitigation (M)	Results chain	Illustrative example of indicators	Source of information
Water resources management and watershed management	Flood protection	A	Outcome (impact)	• Annualized flood damage and disaster-relief costs reduced in participating communities as a result of increased standards for flood protection works and improved flood emergency preparedness • Direct economic losses from floods and water logging reduced compared with current average losses • Number of the people with improved flood protection increased • Economic losses from flooding mitigated (RMB million) • Groundwater overdraft reduced in project irrigation areas and the basin • Water productivity in irrigated agriculture, measured in terms of evapotranspiration (ET), increased in project irrigation area	Asian Development Bank (ADB). China: Hunan Flood Management Sector Project World Bank (WB). China Xinjiang Turpan Water Conversation Project
	Non-structural flood management systems	A	Intermediate outcome	• Increased warning time against potential floods in project area • Forecasting and warning data more frequently accurate	ADB. China: Hunan Flood Management Sector Project
	Flood management sector planning	A	Intermediate outcome	• Basin-wide flood warning system development needs assessed; flood insurance appraised with support from advisory technical assistance; next actions for inclusion in future flood management plan agreed upon by key government authorities	ADB. China: Hunan Flood Management Sector Project
	Watershed protection[16]	A	Outcome	• Evidence of increased areas of watershed protection and recharge enhancement in the project areas	
	Irrigation and watershed development	A and M	Outcome	• Increase in land area under sustainable management in targeted project intervention areas, as a percentage of baseline, to be checked by satellite image. • Increase in vegetative cover (as a percentage of baseline) in targeted project intervention areas, to be checked by satellite image and field verification.	WB and GEF, Madagascar. Irrigation and Watershed Development Project
	Water mobilization	A	Intermediate outcome	• Number of people trained in: (i) water resource management, (ii) participatory planning and development, and (iii) income-generating activities	WB-Djibouti: Rural community development - Water Mobilization project
Crop production	Improving productivity	A	Outcome	• Amount of evapotranspiration reduction in project irrigation areas and the basin	WB. CHINA Xinjiang Turpan Water Conversation Project

Agricultural sectors and themes	Interventions	Adaptation (A) and/or Mitigation (M)	Results chain	Illustrative example of indicators	Source of information
	Mainstreaming CC adaptation in agriculture	A	Intermediate outcome	• Analysis of the baseline, projected scenarios, and possible long-term impacts of CC for the project area through analyses of relevant hydraulic and agricultural production models and of the results of economic research and surveys • Number of hectares where relevant adaptation measures have been implemented in selected demonstration areas and number of farmers trained to enhance CC adaptation in agricultural practices	GEF-China: Mainstreaming climate change adaptation in irrigated agriculture project
	Productivity	A	Intermediate outcome	• Number of climate-resilient production systems implemented with project support	BRAZIL Santa Catarina Rural CompetitivenessProject (WB loan)
	Productivity	A and M	Intermediate outcome	• Number of CA systems introduced, adapted and used by farmers	FAO Fact Sheet: Land Degradation Mitigation and Prevention including Local and Global Environment Benefits
	Resilience	A	Intermediate outcome	• Introduction of new drought-resistant crop varieties	WB-India.The World Bank project Andhra Pradesh Drought Adaptation Initiative (AP-DAI)[17]
	Productivity and vulnerability	A	Outcome	• Number of male and female small-scale producers who have adopted improved agricultural technologies that reduce vulnerability to climatic variations	IFAD and GEF. Zambia Smallholder Productivity Promotion Programme (under preparation)
	Agroprocessing	A and M	Intermediate outcome	• Number (or %) of new and existing agro-industries taking into consideration CC adaptation and mitigation	WB. BRAZIL Santa Catarina Rural CompetitivenessProject
Disaster risk management	Climate information generation	A	Outcome	• Generation of early warning systems of floods, droughts and storms • Increased capacity of national-level institutions to better assess and respond to current and future climate risks, and to promote institutional coordination among currently fragmented agencies managing disaster and climate risk	WB web-based tool on Mainstreaming adaptation to climate change in agriculture and natural resources management projects Web link: http://siteresources.worldbank.org/EXTTOOLKIT3/Resources/3646250-1250715327143/GN6.pdf
	Climate information generation	A	Intermediate outcome	• Increase of vulnerability assessments that integrate climate information with available natural resource and socioeconomic information • Downscaled climate projections, based on past and current climate observations and global and regional climate models • Climate risk screening of community-driven development (CDD) microprojects and in arid lands	WB- Kenya:Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL) from WB web-based tool on Mainstreaming adaptation to climate change in agriculture and natural resources management projects Web link: http://siteresources.worldbank.org/EXTTOOLKIT3/Resources/3646250-1250715327143/GN6.pdf

Agricultural sectors and themes	Interventions	Adaptation (A) and/or Mitigation (M)	Results chain	Illustrative example of indicators	Source of information
Land use, land degradation and forestry	Territorial planning	A and M	Intermediate outcome	• Decrease of resettlement of population as a consequence of good territorial planning • Decrease of investments with high irreversibility (e.g. large infrastructure projects such as large reservoirs)	WB web-based tool on Mainstreaming adaptation to climate change in agriculture and natural resources management projects Web link: http://siteresources.worldbank.org/EXTTOOLKIT3/Resources/3646250-1250715327143/GN6.pdf
	Participatory and locally-managed system for conservation, management, and sustainable use of forest resources and associated biodiversity	A and M	Outcome	• Project generates 13.3 million m^3 of timber and 2.73 billion kg of bamboo by 31 December 2025; RMB 1.1 billion net income from tree crop production by 31 December 2022 • Plantations to relieve pressure on natural forests established in selected areas and operated sustainably • Capacity of government implementing agencies and people increased, including vocational training of forestry workers: six county training plans approved by date XXX; 3 500 personnel trained by date XXX	GEF- Second Beijing Environment Project
	Foster improved conservation and sustainable management of remaining natural forest	M and A	Outcome	• Over 1 million hectares of natural forests and protected areas brought under active management • Reduction of community reliance on forest resources inside biodiversity important zones • Increase in local government's capacity to supervise, monitor and implement conservation and sustainable resource use activities	GEF- Second Beijing Environment Project
	Multi-functioning forests	A and M		• Areas of multifunction forests established: (a) wind breaks (x ha) • (b) soil & water conservation forests (x ha); (c) farmland shelter belt (x ha)	WB CHINA. Integrated Forestry Development Project
	Training	A and M	Outcome	• Households and forest staff trained and improved technologies introduced	WB CHINA. Integrated Forestry Development Project
	Forest tenure-ship and REDD+	M	Outcome	• Area for which forestland use right certificates are granted (increased commitment to avoid deforestation)	WB CHINA. Integrated Forestry Development Project

Agricultural sectors and themes	Interventions	Adaptation (A) and/or Mitigation (M)	Results chain	Illustrative example of indicators	Source of information
	Protected areas	M		• Creation of new protected areas, sometimes by converting suitable areas into national parks and reserves and encouraging their use for tourism and leisure. Some countries are cooperating in common structures or with interstate agreements for the conservation and management of transboundary resources (e.g. the Aral Sea agreements, the Alps-Adriatic and the Danube Region Community Programme, Nile and Mekong River Basin Agreements and programmes)	FAO Fact Sheet: Land Degradation Mitigation and Prevention including Local and Global Environment Benefits
Policy framework and institutional capacity to reduce GHG emissions from the agricultural sector	Institutions and policies	A and M	Intermediate outcome	• A unit within the Ministry of Agriculture is established to support and/or formulate, implement and monitor CC mitigation and adaptation policies and programmes in the agriculture sector • Number of workshops (including interministerial) promoting collaboration and knowledge sharing on CC activities related to the project carried out • Policy and regulatory framework for grid-connected renewables in place	WB/GEF MEXICO.Mexico Rural Development
Rural electrification & renewable energy	Policy, planning and on-the-ground investments	M	Outcome	• Policy and regulatory framework for grid-connected renewables in place • Targets/guidelines for off-grid rural electrification established • A 10-year action plan for renewable energy development completed • Wind mapping based on satellite data and ground-level monitoring stations completed • Market study on Solar Home System (SHS) potential completed • Number of consumers with SHS • Wind pilot projects completed • Completion of training activities • Tonnes of GHG emission reductions	GEF. Republic of Yemen:Rural Electrification and Renewable Energy Development Project
Sustainable agricultural technology and support services	GHG emission-reduction technologies	M	Outcome (impact)	• Tonnes of $C0_2$ equivalent avoided • Ministry of Agriculture is successfully formulating CC mitigation and adaptation policies and programmes in the agricultural sector and monitoring their implementation	WB/GEF MEXICO.Mexico Rural Development

Agricultural sectors and themes	Interventions	Adaptation (A) and/or Mitigation (M)	Results chain	Illustrative example of indicators	Source of information
		M	Intermediate outcome	• Number of KWh of energy saved from adoption of energy-efficient technologies (and corresponding tonnes of avoided CO_2e emissions) • Number of agribusinesses having adopted low carbon-intensity technologies • Number of energy efficient and/or renewable energy subprojects prepared and implemented • Number of energy efficiency and /or renewable energy subprojects that received technical assistance for the preparation of business plans on energy efficiency and/ or renewable energy technologies • Data gathering and inventory of GHG emissions from: – all energy sources – industrial processes – agricultural processes – land-use change and forestry	WB/GEF MEXICO.Mexico Rural Development

16 Watershed protection through increasing surface and groundwater availability through rehabilitation of small- to medium-spate irrigation schemes, terrace rehabilitation, bank protection works and other water and soil conservation activities.
17 Source: Annex 20 of WB web-based tool on Mainstreaming adaptation to climate change in agriculture and natural resources management projects..

ANNEX 7
Finance options for climate change activities

ANNEX 7
Finance options for climate change activities

Name	Description of fund	Project type	Target group	Geographical focus	Weblink
Adaptation Fund	The Adaptation Fund is a financial instrument under the UNFCCC and its Kyoto Protocol. It was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol in an effort to reduce the adverse effects of climate change facing communities, countries and sectors.	• Water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems • Monitoring of diseases and vectors affected by climate change, and related forecasting and early-warning systems • Supporting capacity building, including institutional capacity, for preventive measures, planning, preparedness and management of disasters relating to climate change • Strengthening existing and establishing national and regional centres and information networks for rapid response to extreme weather events	Developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change	Developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change	http://adaptation-fund.org/
Africa-European Union (EU) Energy Partnership (AEEP): Renewable Energy Cooperation Programme (RECP)	The RECP objectives are to bring benefits of economic growth, employment, energy security andimproved energy access and to pavethe way for a future low-carbon energy system in Africa. At the same time, the RECP will help build a significant new area for industrial trade and business cooperation between Africa and Europe. It is still in its start-up phase to identify priority activities.	Specific initiatives will focus on five priority areas: – energy access; – energy security; – renewable energy and energy efficiency; – institutional capacity building; and – scaling-up investment.	Open	Africa	http://www.aeep-conference.org/documents/aeep_recp.pdf

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Amazon Fund	The Amazon Fund was created to help foster the preservation of forests. The fund is aimed at raising donations for investments in efforts to prevent, monitor and combat deforestation, as well as to promote the preservation and sustainable use of forests in the Amazon Biome. It is managed by the BNDES, the Brazilian Development Bank.	• Management of public forests & protected areas • Environmental control, monitoring & inspection • Sustainable forest management • Economic activities created with sustainable use of forests • Ecological and economic zoning, territorial arrangement and agricultural regulation • Preservation and sustainable use of biodiversity • Recovery of deforested areas	Public institutions, state-owned companies and nongovernmental organizations	Amazon Forest	http://www.amazonfund.gov.br/
Asian Development Bank (ADB) - Clean Energy Financing Partnership Facility (CEFPF)	CEFPF resources are intended to finance policy, regulatory and institutional reforms that encourage clean energy development.	• Deployment of new clean energy technology • Projects that lower the barriers to adopting clean energy technologies • Projects that increase access to modern forms of clean and energy-efficient energy for the poor • Technical capacity programmes for clean energy	Open	ADB's developing member countries	http://www.adb.org/sectors/energy/contacts
Asian Development Bank (ADB) - Energy for All Partnership	ADB launched the Energy for All Partnership after extensive consultation with stakeholders on how to rapidly scale up access to energy. The Partnership aims to provide access to safe, clean, affordable modern energy to an additional 100 million people in the region by 2015.	• Scaling up access to energy through enterprise development and financing		ADB's developing member countries	http://beta.adb.org/sectors/energy/programs/energy-for-all-initiative
BioCarbon Fund (BioCF) of the World Bank	The BioCF is based on a public/private partnership model which aims to deliver cost-effective emission reduction and support biodiversity conservation and poverty alleviation.	• AFOLU projects: afforestation, reforestation, REDD, agriculture	Open	Open	http://wbcarbonfinance.org/Router.cfm?Page=BioCF&ItemID=9708&FID=9708

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Climate Investment Funds (CIF)	The CIF help developing countries pilot low-emissions and climate-resilient development.The CIF are channelled through the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank and World Bank Group. It includes two funds: The Strategic Climate Fund (SCF) and the Clean Technology Fund (CTF). The SCF comprises three targeted programmes: (1) Pilot Programme for Climate Resilience (PPCR) to mainstream climate resilience in sector plans and projects in nine countries and two regional pilots worldwide; (2) Forest Investment Programme (FIP) to promote sustainable forestry management in eight pilot countries worldwide; and (3)Scaling Up Renewable Energy Programme in Low-income Countries (SREP) to champion renewable energy where it can matter most. There are six pilot countries worldwide.	• With CIF support, 45 developing countries are piloting transformations in clean technology, sustainable management of forests, increased energy access through renewable energy and climate-resilient development.	Developing countries	Open	http://www.climateinvestmentfunds.org/cif/
Community Development Carbon Fund (CDCF) World Bank	The CDCF spreads benefits of carbon finance to the poorest countries and poor communities in all developing countries which would otherwise find it difficult to attract carbon finance because of country and financial risk. It is a multi-donor trust fund – a public/private partnership.	• All CDM projects, including AFOLU, are eligible	Least developing countries – community benefits are a requirement	Open	http://wbcarbonfinance.org/Router.cfm?Page=CDCF&ItemID=9709&FID=9709
Congo Basin Forest Fund (CBFF)	The overall goal of the CBFF is to alleviate poverty and address climate change through reducing the rate of deforestation. It is administered by the African Development Bank.	Provides grants to eligible entities for activities that: – slow and eventually reverse the rate of deforestation in the Congo Basin; – provide support mechanisms which conserve the forests; – maintain benefits to local communities; and – mobilize additional financial resources to support required actions.	Central African Forests Commission (COMIFAC) member countries (Burundi, Cameroon, Central African Republic, Chad Congo, Democratic Republic of Congo,Equatorial Guinea, Gabon, Rwanda and Sao Tome & Principe)	Congo basin	http://www.cbf-fund.org/

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Energy+ (NORAD)	The initiative will establish a partnership among developing and developed countries to serve as a platform for developing countries to scale up energy sector actions and finance, and to that end to take immediate action, including improving the effectiveness, efficiency, transparency and coordination of energy initiatives and financial instruments, to facilitate among other things knowledge transfer, capacity enhancement, mitigation actions and technology development and transfer. This is under development.		Open	Developing countries	
EU-Energy Facility Pooling Mechanism / ACP-EU Energy Facility	The Energy Facility is a co-financing instrument which was established in 2005 in order to support projects on increasing access to sustainable and affordable energy services for the poor living in rural and peri-urban areas in African, Caribbean and Pacific (ACP) countries. The Energy Facility Pooling Mechanism was created to blend grants from the 10th European Development Fund Energy Facility with loans from the EU multilateral and bilateral finance institutions	• Investment projects for access to energy services (including related capacity-building activities) • Advanced preparatory studies (technical assistance only)	Open	African, Caribbean and Pacific (ACP) countries having ratified the revised Cotonou Agreement, i.e. all ACP countries except Sudan, Equatorial Guinea and South Africa	http://ec.europa.eu/europeaid/where/acp/regional-cooperation/energy/index_en.htm
Forest Carbon Partnership Facility (FCPF) – World Bank	The FCPF assists developing countries in their efforts to reduce emissions from deforestation and land degradation (REDD)	• Build capacity for REDD in developing countries • Test a programme of performance-based incentive payments in some pilot countries	All borrowing member countries of the International Bank for Reconstruction and Development (IBRD) or the International Development Association (IDA) that are located in subtropical or tropical areas	Subtropical or tropical areas	http://www.forestcarbonpartnership.org/fcp/ (not yet operational)

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GEF Small Grants Programme: Climate Change	The main focal areas of the programme are climate change abatement and adaptation, conservation of biodiversity, protection of international waters, reduction of the impact of persistent organic pollutants and prevention of land degradation.	• Removal of barriers to energy efficiency and energy conservation • Promoting the adoption of renewable energy by removing barriers and reducing implementation costs • Conservation and restoration of arid and semi-arid areas • Efficient stoves and biogas to reduce forest loss • Integrated watershed management • Soil conservation • Afforestation • Prevention of forest fires • Organic farming	NGOs and community-based organizations (CBO)	Open	http://sgp.undp.org/index.php?option=com_content&view=article&id=275&Itemid=171#.UUssMxdOS5I
GEF Trust Fund - Climate Change focal area	The objective of this fund is to help developing countries and economies in transition to contribute to the overall objective of the United Nations Framework Convention on Climate Change (UNFCCC). The projects support measures that minimize climate change damage by reducing the risk or the adverse effects of climate change.	• Demonstration, deployment, and transfer of innovative, low-carbon technologies • Market transformation for energy efficiency in the industrial and buildings sectors • Investment in renewable energy technologies • Energy-efficient, low-carbon transport and urban systems • Conservation and enhancement of carbon stock through sustainable management of land use, land-use change and forestry • Support enabling activities and capacity building	Developing countries and countries with economies in transition	Open	http://www.thegef.org/gef/archived/country_support_program/166
German International Climate Initiative	The German International Climate Initiative has been working since 2008 with annual funds of 120 million Euros. All projects run from one to five years.	• Promoting a climate-friendly economy • Promoting measures for adaptation to the impacts of climate change • Promoting measures for preservation and sustainable use of carbon reservoirs/ REDD+	Federal implementing agencies, government organizations, NGOs, business enterprises, universities and research institutes, international and multinational organizations and institutes	Developing, newly industrializing and transition countries	http://www.bmu-klimaschutzinitiative.de/en/news

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Japan's Fast Start Finance	This initiative covers all of Japan's activities relating to climate change.	• Mitigation: Assisting developing countries in their efforts to reduce emissions in such areas as climate change policy formulation and promotion of renewable energy • Reducing Emissions from Deforestation and Forest Degradation (REDD+): Assisting developing countries to survey forest resources and formulate forest management plans to promote sustainable usage and preserve forests • Adaptation: Strengthening developing countries' capability to cope with natural disasters caused by climate change	Disbursement of funds is dependent on bilateral policy consultations with Japan	Open	http://www.faststartfinance.org/contributing_country/japan
Intelligent Energy - Europe II Programme	The Intelligent Energy – Europe (IEE) programme is giving a boost to clean and sustainable solutions. It supports their use and dissemination and the Europe-wide exchange of related knowledge and know-how.	• Foster energy efficiency and the rational use of energy resources • Promote new and renewable energy sources and support energy diversification • Promote energy efficiency and the use of new and renewable energy sources in transport		EU (please note that it might be possible to receive funding for projects that produce energy for the EU outside of the EU)	http://ec.europa.eu/energy/intelligent/
International Climate Fund (ICF)	The ICF is a UK initiative linked to the Department for International Development (DFID), the Department for Energy and Climate Change (DECC), the Department for Environment, Food and Rural Affairs (DEFRA), Her Majesty's Treasury (HMT), and in consultation with the Foreign and Commonwealth Office (FCO).	• Supports international poverty reduction by helping developing countries adapt to climate change, take up low carbon growth and tackle deforestation	Specific criteria for eligibility	Open	http://www.decc.gov.uk/en/content/cms/tackling/international/icf/icf.aspx
International Forest Carbon Initiative (IFCI)	This initiative supports international efforts on REDD through UNFCCC. It is jointly administered by the Australian Department of Climate Change and the Australian Agency for International Development (AusAID).	• Undertaking practical demonstration activities to show how REDD+ can be included in a post-2012 global climate change agreement • Increasing international forest carbon monitoring and accounting capacity • Supporting international efforts to develop market-based approaches to REDD+	No intention to set up a new fund or governance structure through IFCI, but will work through established channels of bilateral dialogue and cooperation at the international level	Funding will support projects in selected developing countries (particularly, but not exclusively, in Indonesia and Papua New Guinea)	http://www.climatechange.gov.au/government/initiatives/international-forest-carbon-initiative.aspx

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Least Developed Countries Fund (LDCF)	The LDCF supports the preparation and implementation of the NAPAs, country-driven strategies which identify urgent and immediate needs of least developed countries (LDCs) to adapt to climate change. Does not require the generation of global benefits. It is managed by the GEF Secretariat.	• Preparation and implementation of the National Adaptation Programmes of Action (NAPAs).	Open	All LDCs	http://www.thegef.org/gef/LDCF
Special Climate Change Fund (SCCF)	The SCCF supports the preparation and implementation of projects involving technology transfer and adaptation (adaptation as a top priority). Does not require the generation of global benefits. It is managed by the GEF Secretariat.	• Supports both long-term and short-term adaptation activities in water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems (including mountainous ecosystems) and integrated coastal zone management (ICZM)	All developing country parties to the UNFCCCall developing country parties to the UNFCCC		http://www.thegef.org/gef/SCCF
The Energy and Environment Partnership Programme with the Mekong Region (EEP Mekong)	A key objective will be to facilitate actions on the ground and demonstrating from the bottom up that an incentive-based NAMA approach in the energy sector is feasible. Furthermore, the partnership will be focused on incentivizing private-sector investments to significantly increase investments in energy efficiency and renewable energy in developing countries' energy supply.	• Renewable energy • Energy-efficient technology development and use • Modern energy and clean technology • Waste-to-energy • Electricity from renewable energy sources		Cambodia, Lao PDR, Viet Nam and Thailand	www.eepmekong.org/main_navigation/contact_us.php?reload www.eepmekong.org/index.php?reload
UNEP's Rural Energy Enterprise Development (REED) Programme	This initiative offers enterprise development services and start-up financing to clean energy enterprises. Since beginning in 2000, REED has financed 44 enterprises that are now returning capital each year to an investment fund that is then re-invested in new enterprises.	• Energy	Open	Five African countries (AREED), Brazil (B-REED) and China (C-REED)	http://www.unep.fr/energy/activities/reed/areed.htm

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The United Nations Collaborative Programme on REDD in Developing Countries (UN-REDD) Programme	This multi-donor trust fund allows donors to pool resources and provide funding with the aim of significantly reducing global emissions from deforestation and forest degradation in developing countries.	• Monitoring, reporting and verification • National REDD+ governance • Engagement of indigenous peoples, local communities and other relevant stakeholders • Ensuring multiple benefits of forests and REDD+ • Transparent, equitable and accountable management of REDD+ payments • REDD+ as a catalyst for transformations to a green economy	Open	Several selection criteria for countries exist	http://www.un-redd.org/
United States Agency for International Development (USAID) Development Grants Programme (DGP)	The DGP is closely aligned with agency initiatives addressing today's pressing problems of hunger and food security, health impacts of insufficient water resources, challenges that accompany global climate change, local capacity development, women and peace-building and post-conflict resolution.	• Climate change adaptation	The DGP offers USAID a unique opportunity to foster partnerships with organizations and communities that have not been direct US Government development partners and to collaborate with grant recipients to make contributions to country development objectives, and the U.S. Government priorities and initiatives.	Eligible countries will be specified in the FY 2012	http://idea.usaid.gov/ls/dgp

Climate Funds Update is an independent Web site that provides information on the growing number of international climate finance initiatives designed to help developing countries address the challenges of climate change. http://www.climatefundsupdate.org/

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