Agriculture in Africa
Face the Challenges of Climate Change

Synthesis

Reinforced Climate Negotiation for Africa (NECTAR)
Agriculture in Africa
Face the Challenges of Climate Change

Synthesis

Reinforced Climate Negotiation for Africa (NECTAR)
This summary document has been prepared by the Group baastel and Iram on behalf of the Institut de l’énergie et de l’environnement de la Francophonie (IEPF). It does not necessarily represent the viewpoint of one or other of these organisations.

TEAM OF INSTITUT L’ÉNERGIE ET DE L’ENVIRONNEMENT DE LA FRANCOPHONIE (IEPF)

Director of publication
Fatimata Dia Touré, Director

Coordination
Rajae Chafil, Programme Specialist, International Négotiations on Environment
Prosper Biabo, Deputy Director, Programmes
Louis-Noël Jail, Communication Manager, Information and documentation Department
Jacinthe Potvin, Assistant, Information and documentation Department

With the support of Ministry of Foreign Affairs of France


© Institut de l’énergie et de l’environnement de la Francophonie (IEPF)
56, rue Saint-Pierre, 3e étage
Québec (Québec) G1K 4A1 - Canada
Tél. : 1-418-692-5727
iepf@francophonie.org
www.iepf.org

PRINTED IN QUEBEC CITY

November 2012
Table of Contents

Table of Contents ......................................................................................................................................... i
Glossary .......................................................................................................................................................... vii
Introduction.................................................................................................................................................... 1

PART 1 .......................................................................................................................................................... 3
I. African Agriculture: Strengths, Weaknesses and Main Challenges ......................................................... 3
   I.1. Economic and Demographic Transitions in Africa .............................................................................. 4
       I.1.1 Mainly agricultural countries ........................................................................................................... 4
       I.1.2 Macro-historic context: Government support to agriculture historically directed toward export crops ................................................................. 4
           I.1.2.1 1960-85: The interventionist State ................................................................................................. 4
           Liberalization of agricultural markets .................................................................................................. 5
           Drop in government investment in agriculture and government assistance ........................................ 5
           Limited agricultural financing policies ............................................................................................... 5
       I.1.3 Present situation in the agriculture sector ..................................................................................... 5
           I.1.3.1 Recently renewed interest in the agriculture sector ....................................................................... 5
           I.1.3.2 The new face of relations between the State and agriculture .......................................................... 6
           Decentralization ..................................................................................................................................... 6
           Producer organizations .......................................................................................................................... 6
           Emergence of regional institutions ........................................................................................................ 6
       I.1.4 Demographics in Africa ................................................................................................................ 7
           I.1.4.1 A formidable demographic vitality ............................................................................................... 7
           I.1.4.2 Demographic transitions vary by country and region ................................................................. 7
           I.1.4.3 Mainly intra-regional migrations ................................................................................................ 7
           I.1.4.4 Urban and rural populations will continue to grow .................................................................... 7
           I.1.4.5 The “demographic bonus” ......................................................................................................... 8
   I.1.2. African Agricultures’ Diversity ........................................................................................................ 9
       I.2.1 The physical environment of the African continent: Distinctive climatological and ecological features ............................................................................................................................ 9
       I.2.2 Distinctive features, strengths and weaknesses of the various agricultural systems ......... 11
           I.2.2.1 Mediterranean Zone .................................................................................................................... 13
           Mixed dry land farming systems in Northern Africa ........................................................................... 13
           Mixed rain-fed system farming operations ............................................................................................ 14
           Mixed cereal grain-livestock production farming systems – southern Africa .................................. 14
           I.2.2.2 Oasis systems ................................................................................................................................ 14
           I.2.2.3 Semi-desert, Sahel ......................................................................................................................... 15
           Large, irrigated areas .............................................................................................................................. 15
           Pastoral and nomadic livestock production systems ............................................................................ 15
           I.2.2.4 Dry savannah ............................................................................................................................... 15
           Agropastoral systems with land growing millet and sorghum, and that is uncultivated for short periods ......................................................................................................................................................... 15
           Mixed corn-based systems ...................................................................................................................... 16
           I.2.2.5 Moist savannah ........................................................................................................................... 16
           Grain and root crop mixed systems ......................................................................................................... 16
           System based specifically on root crops ............................................................................................... 17
           I.2.2.6 Tropical forest ............................................................................................................................... 17
           Dense forest slash-and-burn system ....................................................................................................... 17
           Pioneering front arboriculture agriculture ............................................................................................ 17


Rice and arboriculture in Madagascar .................................................................................. 18
I.2.2.7 Highlands, mountains .................................................................................................. 18
Highland farming systems based on perennial crops .............................................................. 18
Mixed farming operations in the temperate highlands ............................................................ 18
I.2.2.8 Dispersed systems ........................................................................................................ 19
Horticultural areas that are outside the city or out-of-season .................................................... 19
Integrated agricultural-traditional fisheries systems ............................................................... 19
Flooded rice-production systems ........................................................................................... 19
I.3. Challenges for African Farmers .......................................................................................... 20
I.3.1 Growing needs for food around the world ...................................................................... 20
I.3.2 Creation of productive employment in the rural sector ..................................................... 20
I.3.3 Competitiveness of African agriculture ............................................................................. 21
I.4. Conclusion ......................................................................................................................... 22

PART 2 ........................................................................................................................................... 23

II. Climate Change and International Negotiations .................................................................. 23

II.1. Greenhouse Gas Emissions in Africa and Distinctive Features of Emissions from
Agriculture and Soil Degradation .............................................................................................. 24
II.1.1 Greenhouse gas (GHG) emissions .................................................................................. 24
II.1.1.1 General information and methodology for calculating GHG inventories.................... 24
II.1.1.2 World trends .............................................................................................................. 24
II.1.1.3 Africa’s contribution to the world’s GHG emissions ................................................... 24
II.1.2 GHG emissions in Africa ............................................................................................... 25
II.1.2.1 Main sources of GHG in Africa .................................................................................. 25
II.1.2.2 Sub-regional trends ..................................................................................................... 25
II.1.3 GHG emissions from the agriculture sector ................................................................... 26
II.1.3.1 Agriculture’s place in climate change in the world......................................................... 26
II.1.3.2 Emissions sources in agriculture and mitigation potentials ........................................... 26
II.1.3.3 Africa’s position in world agricultural emissions ......................................................... 27

II.2. State of the Art of Climate Change in Africa .................................................................... 29
II.2.1 Climate change forecasts .............................................................................................. 29
II.2.1.1 Approach .................................................................................................................... 29
II.2.1.2 Limitations .................................................................................................................. 29
II.2.2 The expected changes in Africa ..................................................................................... 29
II.2.2.1 Temperature change .................................................................................................. 29
II.2.2.2 Rise in the sea level ..................................................................................................... 30
II.2.2.3 Changes in rainfall ...................................................................................................... 30
II.2.2.4 Greater frequency of extreme events ......................................................................... 31
II.2.3 Climate projections for the various regions ................................................................. 31
II.2.3.1 Expected climate changes in the Mediterranean region .............................................. 31
II.2.3.2 Expected climate changes in the desert regions .......................................................... 31
II.2.3.3 Expected climate changes in the Sahelian region ....................................................... 31
II.2.3.4 Expected climate changes in the dry tropical and moist tropical regions ................. 32
II.2.3.5 Expected climate changes in the equatorial region .................................................... 32
II.2.3.6 Climate of the African islands (excluding Madagascar) ............................................. 32

II.3. International Negotiations on Climate Change and the Issues for Agriculture .......... 34
II.3.1 The international framework ......................................................................................... 34
II.3.1.1 Introduction of the UNFCCC .................................................................................... 34
II.3.1.2 The Kyoto Protocol ................................................................................................... 34
II.3.1.3 The Bali Action Plan (COP13, December 2007) ......................................................... 35
II.3.1.4 Poznán: One step on the Copenhagen road (COP14 - December 2008) .................... 35
II.3.2 The negotiation process since Copenhagen .................................................................... 35
II.3.2.1 The major issues ....................................................................................................... 35
Environmental issues .............................................................................................................. 35
Political issues .......................................................................................................................... 35
Social issues .............................................................................................................................. 35
Development issues .................................................................................................................. 35
II.3.2.2 Main focuses of current negotiations ....................................................................... 36
Shared vision ........................................................................................................................................... 36
Mitigation ................................................................................................................................................ 36
Adaptation ............................................................................................................................................... 36
Transfer of technology ........................................................................................................................... 37

II.3.3 The issues related to agriculture .................................................................................................. 37
II.3.3.1 Agriculture: Major potential for the reduction of GHG emissions ......................................................... 37
II.3.3.2 Can agriculture be better integrated under the CDM? .................................................................. 38
The Clean Development Mechanism in Africa ......................................................................................... 38
Agriculture in the CDM ............................................................................................................................ 38
Perspectives ............................................................................................................................................... 39
II.3.3.3 Integration of agriculture in NAMAs in developing countries ......................................................... 39
II.3.3.4 Developing REDD projects, supporting an REDD-plus process? ...................................................... 40
II.3.4 Funding adaptation and mitigation .................................................................................................. 40
II.3.5 Integration of agriculture in negotiations ....................................................................................... 41

II.4. Conclusion ....................................................................................................................................... 42

PART 3 .................................................................................................................................................. 43

III Effects of Climate Change on Agriculture and Recommendations for Adaptation and Development .......................................................................................................................... 43

III.1. Effects of Climate Change on African Agriculture ........................................................................... 44
III.1.1 Effects of climate change and the increase in CO₂ concentrations on plant production .................. 44
III.1.1.1 The effect of atmospheric CO₂ ........................................................................................................ 44
III.1.1.2 Effect of temperature and the availability of water ........................................................................ 44
III.1.2 Impacts on agriculture and farmers’ life systems ............................................................................. 44
III.1.3 Adaptation strategies ..................................................................................................................... 46
III.1.3.1 Spontaneous adaptation .................................................................................................................. 46
III.1.3.2 Planned adaptation .......................................................................................................................... 46

In countries in moist savannah and tropical forest zones, where “pioneering front
arboriculture agriculture,” “root crops” and “mixed grain-root crop” farming systems are
prevalent, the main priority urgent actions identified in NAPAs are: ........................................... 47
III.1.4 Findings on the effects of climate change and adaptation ............................................................. 47

III.2. Prospects for agricultural development in Africa in the context of climate change ....................... 48
III.2.1 Non-agricultural alternatives .......................................................................................................... 48
III.2.1.1 Migrations ..................................................................................................................................... 48
III.2.1.2 Development of non-agricultural rural activities ........................................................................... 48
III.2.1.3 Imported food products .................................................................................................................. 48
III.2.2 African agriculture production potentials ....................................................................................... 49
III.2.3 Available land resources for expanding farming areas ..................................................................... 49
III.2.4 Land and environmental limits to the expansion of agricultural areas ........................................... 50
III.2.5 Is intensification impossible? .......................................................................................................... 51
III.2.5.1 Yields and intensification ............................................................................................................... 51
III.2.5.2 The narrow path for intensifying Africa’s agriculture .................................................................... 52
Increasing yields ....................................................................................................................................... 52
Towards a new green revolution for Africa or towards complexification of production
systems? .................................................................................................................................................. 52
Hydro-agricultural developments ........................................................................................................... 53
Remunerative prices – the indispensable and essential condition .......................................................... 54

III.3. Key actions for mitigation, adaptation and agricultural development ............................................ 55
III.3.1 Can mitigation and adaptation be reconciled? ............................................................................... 55
III.3.2 Reducing vulnerability to climate change: A multi-dimensional approach ......................... 57
III.3.2.1 Protecting the ecosystems ............................................................................................................ 57
III.3.2.2 Managing humanitarian crises and preventing disasters ............................................................. 57
III.3.2.3 Managing the food supply at the international level .................................................................... 57
III.3.3 Key adaptation actions for the agriculture sector ........................................................................... 58
III.3.3.1 Strengthening the research institutions ......................................................................................... 58
Climatic forecast ....................................................................................................................................... 58
Agronomic research .................................................................................................................................. 58
III.3.3.2 Integrating climate change at every level of programming ............................................................ 58
III.3.3 Securing and democratizing access to land and water .............................................................. 59
III.3.3.4 Modifying the choice of cropping and livestock production methods ........................................... 59
   Developing new “adapted” varieties and promoting biodiversity ............................................................. 59
   Restoring and protecting the soil ............................................................................................................ 59
   Optimizing the use of rainwater and developing “sustainable” irrigation ............................................... 59
III.3.3.5 Recommendations for a few major types of agrarian systems .................................................. 60
   Mediterranean zone .................................................................................................................................. 60
   Deserts and semi-deserts .......................................................................................................................... 60
   Dry savannah .......................................................................................................................................... 61
   Moist savannah ....................................................................................................................................... 62
   Tropical forest ........................................................................................................................................... 62
   Highlands and mountains ......................................................................................................................... 64
   Dispersed systems .................................................................................................................................. 64
III.3.3.6 Findings on the development of the agriculture sector in a context of climate change ............ 65

III.4. Conclusion .......................................................................................................................................... 66

IV Conclusion ............................................................................................................................................. 67

Bibliography .............................................................................................................................................. 69

List of Maps, Tables, Graphs, Figures and Boxes:

MAP 1: ARRIVALS ON THE JOB MARKET BETWEEN 2010 AND 2030 ................................................. 8
MAP 2: AFRICA’S BIOMES ......................................................................................................................... 11
MAP 3: THE AGRICULTURAL SYSTEMS ON THE AFRICAN CONTINENT ........................................... 13
MAP 4: EVOLUTION OF PLANT-BASED ENERGY REQUIREMENTS BY COUNTRY BETWEEN 1995 AND 2050 20
MAP 5: CO2 EMISSIONS OF REGIONS AROUND THE WORLD (CUMULATIVE 1960-2004) ............... 24
MAP 7: TEMPORAL TRENDS IN THE AVERAGE ANNUAL RAINFALL IN THE COUNTRIES OF THE WEST AFRICAN SAHEL REGION ........................................................................................................... 32
MAP 8: IRRIGATION INTENSITY IN AFRICA ............................................................................................... 53

TABLE 1: EVOLUTION OF ODA IN THE WORLD ...................................................................................... 5
TABLE 2: DESCRIPTIONS OF THE VARIOUS AGRICULTURAL SYSTEMS IN AFRICA ................................ 12
TABLE 3: ADAPTATION TO CC: ESTIMATE OF ANNUAL FUNDING NEEDS ............................................. 40
TABLE 4: EXAMPLES OF THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURE, FORESTS AND FISHING 44
TABLE 5: POTENTIALS AND LIMITS FOR EXPANSION OF THE VARIOUS FARMING SYSTEMS .......... 51
TABLE 6: ORIGIN OF INCREASES IN PRODUCTION BETWEEN 1961 AND 2005, BY REGIONS, IN % ....... 52
TABLE 7: TECHNIQUES AND ACTIONS ALLOWING THE RECONCILIATION OF MITIGATION AND ADAPTATION .... 55
GRAPH 1: EXAMPLES OF DEPENDENCY ON RECEIPTS FROM THE EXPORT OF AGRICULTURAL PRODUCTS BY COMPARISON WITH A SINGLE BASIC PRODUCT, 1997-1999 ........................................................................................................ 4

GRAPH 2: ESTIMATED HISTORIC AND PROJECTED N₂O AND CH₄ EMISSIONS FROM THE AGRICULTURE SECTOR FOR THE WORLD'S 10 REGIONS OVER THE PERIOD 1990-2020 ........................................................................................................ 27

GRAPH 3: COMPARISON OF ARABLE LAND IN RAIN-FED FARMING WITH THE PRESENT CLIMATE AND WITH THE CLIMATE PROJECTED FOR 2080 BASED ON THE HadCM3-A1FI MODEL WITH LAND USE IN 1994-96 (IN MILLIONS OF HECTARES) ..................................................................................................................... 50

FIGURE 1: ILLUSTRATION OF THE THEORY MECHANICALLY TYING POPULATION GROWTH AND RISING POVERTY ... 49

BOX 1: EXTENSIVE GRAIN FARMING ........................................................................................................................................... 14
BOX 2: THE LARGE SUGAR CANE PLANTATIONS ....................................................................................................................... 17
BOX 3: THE IMPOVERISHMENT OF THIRD WORLD FARMERS ................................................................................................... 54
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>$US</td>
<td>U.S. Dollar</td>
</tr>
<tr>
<td>AFOLU - AFAT</td>
<td>Agriculture, Forestry and Other Land Uses - Agriculture, foresterie et autres affectations des terres</td>
</tr>
<tr>
<td>ODA</td>
<td>Official Development Assistance</td>
</tr>
<tr>
<td>LUCF</td>
<td>Land-use Change and Forestry</td>
</tr>
<tr>
<td>CC</td>
<td>Climate change</td>
</tr>
<tr>
<td>CH₄</td>
<td>Methane</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>COP</td>
<td>Conference of the Parties (at the UNFCCC)</td>
</tr>
<tr>
<td>E-CO₂</td>
<td>Equivalent CO₂ (conversion of all types of emissions into CO₂ based on global warming potential)</td>
</tr>
<tr>
<td>FAO</td>
<td>United Nations Food and Agriculture Organization</td>
</tr>
<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
</tr>
<tr>
<td>CIF</td>
<td>Climate Investment Funds</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>Gteq.CO₂</td>
<td>Giga tonne equivalent CO₂</td>
</tr>
<tr>
<td>IIASA</td>
<td>International Institute for Applied Systems Analysis</td>
</tr>
<tr>
<td>NAMA</td>
<td>Nationally Appropriate Mitigation Actions</td>
</tr>
<tr>
<td>GCM</td>
<td>General Circulation Models</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>RCM</td>
<td>Regional Climate Model</td>
</tr>
<tr>
<td>MTECO₂</td>
<td>Metric tonne equivalent CO₂</td>
</tr>
<tr>
<td>N₂O</td>
<td>Nitrous Oxide</td>
</tr>
<tr>
<td>GMO</td>
<td>Genetically Modified Organism</td>
</tr>
<tr>
<td>WFP</td>
<td>World Food Program</td>
</tr>
<tr>
<td>NAPA</td>
<td>National Adaptation Programmes of Action</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>LDC</td>
<td>Least Developed Countries</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>REDD</td>
<td>Reduce Emissions from Deforestation and Forest Degradation</td>
</tr>
<tr>
<td>EWS</td>
<td>Early Warning System</td>
</tr>
<tr>
<td>NARS</td>
<td>National Agriculture Research System</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>TE-CO₂</td>
<td>Tonne equivalent CO₂</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change (CCNUCC in French)</td>
</tr>
<tr>
<td>CER</td>
<td>Certified Emission Reduction</td>
</tr>
</tbody>
</table>
Introduction

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) concludes that the warming of the climate system is unequivocal and already a reality. The planet’s warming is expected to be more intense in Africa than in the rest of the world.

The report also confirms the human origin of this accelerated change, the main idea being that the rise in the globe’s average temperature observed since the mid-20th century is very likely attributable to the rise in concentrations of anthropomorphic greenhouse gases (GHG) (mainly CO₂, NH₄ and N₂O) since the beginning of the industrial age.

Faced with this phenomenon that will have considerable consequences on the populations, the international community must implement a strategy consisting of two complementary approaches:

- On the one hand, a preventive approach for the purpose of reducing GHG emissions to limit the rise in temperatures and mitigate the impacts of climate change;
- One the other, an approach that takes the changes into account for the purpose of adapting to the impacts.

Africa is a particularly vulnerable continent to these changes because there is a good chance that climate changes will be greater there than elsewhere, and because its population is already in an especially precarious social and economic situation.

This sectoral study is part of the IEPF NECTAR project for the purpose of placing the question of sustainable development at the core of climate negotiations post-2012 through six sectoral studies which:

- Create a picture of the impacts of climate change in sector in Africa;
- Propose concrete action priorities in sustainable development;
- Analyse how these priorities can be promoted and taken into consideration post-2012.

The information and analyses thus produced will be a solid, dependable documentary foundation for the African negotiators. The expected outcome is therefore capacity-building for the negotiators in each of the sectors.

The agriculture sector is one of the first affected by climate change. It is also the number one economic sector for most African countries and employs most of Africa’s population. The development challenges in Africa’s agricultural sector, which is the continent’s overall economic development lever, are very significant and recently have been placed on the agenda again by numerous international institutions, starting with the World Bank.

In this study, we will see what these challenges are and how climate change stresses the issues, without however really creating any new ones.

The report also deals with greenhouse gas (GHG) emissions in Africa, courses of action for reduction, and especially how African countries can benefit from the international climate negotiations: on the one hand by promoting a commitment for maximum reduction of GHG emissions worldwide, and on the other, by positioning themselves for (i) development measures for the preservation of the continent’s carbon sinks (REDD, REDD-plus), and (ii) an adaptation fund with sufficient means to fund emergency measures that will make it possible for the African countries to better deal with the coming changes.

Finally, the report presents a certain number of key actions for agricultural development and adaptation to climate change that can be useful for reflection on priority actions to be implemented for the African agriculture sector.
PART 1

African Agriculture: Strengths, Weaknesses and Main Challenges

Africa is often mistakenly viewed as a stricken area, where poverty is assumed to inexorably rise and where the development dynamics that worked on other continents would not work. With regard to agriculture, we are speaking about nearly 50% of the population being unable to provide for their food needs and the “green revolution”, which has made it possible to reduce famine in Asia but supposedly failed in Africa. For certain analysts, the continent’s formidable demographic growth would render useless every effort undertaken to promote development, reduce poverty and reduce malnutrition.

This perception is often the result of too superficial an analysis of reality. Part 1 will attempt to nuance the analyses by presenting the continent’s demographic and economic dynamics, and through a short historical analysis, place the current situation in perspective (Section 1). We will then describe this Africa’s agricultural diversity, each aspect of which requires specific solutions (Section 2). Finally, this part will analyze three of the main challenges arising today for agriculture in Africa: rising global food needs; the creation of productive jobs in the rural sector; and finally, the competitiveness of African agriculture (Section 3).
I.1. ECONOMIC AND DEMOGRAPHIC TRANSITIONS IN AFRICA

I.1.1 Mainly agricultural countries

Agriculture is the main economic sector for many African countries. According to World Bank statistics, agriculture accounts for 17% of the continent’s GDP and approximately 30% of the GDP of the countries of sub-Saharan Africa, excluding South Africa, and ensures the survival of most of Africa’s population (65%). The differences from one country to another are significant both in terms of GDP and the population working in agriculture. For example, there are countries with a low percentage of the population in agriculture, like South Africa or the countries of the Maghreb, and other countries whose population works primarily in agriculture like the countries of the Sahel and the African Great Lakes.

The region remains a net exporter of agricultural products but is losing stature on the international market where its share has gone from nearly 10% 40 years ago to approximately 3% today. There are major differences between the countries of the oil-producing countries of northern Africa and those in sub-Saharan Africa. The region in fact has experienced a high structural trade deficit for agricultural products since the mid-1970s, when the increase in the price of oil allowed strong growth in imports of agricultural products. Many African countries moreover see their export receipts dependent upon a very limited number of agricultural products (Graph 1). This concentration makes their economies very vulnerable to ups and downs in the market and climate conditions (FAO, 2004).

Graph 1: Examples of dependency on receipts from the export of agricultural products by comparison with a single basic product, 1997-1999

<table>
<thead>
<tr>
<th>Country</th>
<th>Cotton</th>
<th>Coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central African Rep.</td>
<td>12%</td>
<td>4%</td>
</tr>
<tr>
<td>Togo</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Mali</td>
<td>6%</td>
<td>1%</td>
</tr>
<tr>
<td>Benin</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Chad</td>
<td>4%</td>
<td>0%</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Rwanda</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Uganda</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Burundi</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: FAO, 2004

I.1.2 Macro-historic context: Government support to agriculture historically directed toward export crops

Africa became part of international trade starting with colonization, providing raw materials to European industries.

I.1.2.1 1960-85: The interventionist State

Newly independent States maintained this export-oriented direction with a view to obtaining the necessary currency for their development and the resources for the State to operate. However, during the 1980s, the constant downward trend in export products’ prices undermined the terms of trade with developed countries, driving these governments into foreign debt. Next, food production did not keep pace with demographic growth, which led the countries of sub-Saharan Africa to increasingly depend on imports or food assistance.
1985-05: Structural adjustment and liberalization of in the agriculture sector were gradually replaced by more liberal policies.

**Liberalization of agricultural markets**
The State, forced by structural adjustment and the need to revitalize the agricultural production networks, backed out of marketing activities in order to allow the producers to “respond to market signals”, to the benefit of private stakeholders and producer organizations. The results were mixed and variable. In some countries, grain production, which had been stagnating, began to rise again; in less accessible regions, monopolies and buyer’s monopolies formed, causing a rise in the cost of inputs and a drop in the prices paid to the producers.

**Drop in government investment in agriculture and government assistance**
In recent decades, national government stakeholders and international donors have placed dwindling importance on the agriculture sector, visible in the small share of the government budgets allocated to agriculture, which barely reaches 5% for the continent as a whole. This is not unrelated to donor agencies’ lack of interest in the agriculture sector (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Official Development Assistance to agriculture (billions of $)</th>
<th>Total Official Development Assistance (billions of $)</th>
<th>% of Official Development Assistance to agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>6.6</td>
<td>37.1</td>
<td>16.7</td>
</tr>
<tr>
<td>1985</td>
<td>6.6</td>
<td>40.0</td>
<td>16.6</td>
</tr>
<tr>
<td>1990</td>
<td>5.4</td>
<td>44.8</td>
<td>12.0</td>
</tr>
<tr>
<td>1995</td>
<td>3.0</td>
<td>38.9</td>
<td>7.6</td>
</tr>
<tr>
<td>2002</td>
<td>2.0</td>
<td>61.4</td>
<td>3.7</td>
</tr>
</tbody>
</table>


**Limited agricultural financing policies**
Farmers’ access to financing is an essential determinant of their ability to invest in and intensify their production systems. Until the 1980s, this financing was an integral part of agricultural policies implemented by the State. This model was challenged by its poor results and the structural adjustments that limited the means of direct government intervention. Today farmers who have access to financing are generally part of a network. But the supply of agricultural credit in Africa remains very inadequate to deal with the needs of an agricultural world that must adapt its production systems to a rapidly evolving context.

**I.1.3 Present situation in the agriculture sector**

**I.1.3.1 Recently renewed interest in the agriculture sector**
For the last few years, there has been renewed interest in the agriculture sector due to recognition of its key role in world poverty reduction and hunger strategies. In addition, the recent leap in agricultural prices has also underscored the vulnerability of those African countries that are overly dependent on agricultural imports, and which were most affected by the crisis. And so, the New Partnership for African Development (NePAD) requested the African heads of State to make a commitment to increasing agricultural spending to 10% of their national budgets. The World Bank\(^1\) has again also made agriculture one of its main concerns since 2008.

---

I.1.3.2 The new face of relations between the State and agriculture

This fresh interest occurred as part of the renewed relations between the State and agriculture:

**Decentralization**

Many countries have embarked on the path to decentralization. New institutions have been created which often have jurisdiction in essential areas for the agriculture sector for rural communities: land, land development, public infrastructure, etc.

**Producer organizations**

The State’s withdrawal from the sector is often accompanied by a strengthening of producer organizations, which have acquired great autonomy from the national authorities and are often able to organize the producers and dialogue with the government and donor agencies.

**Emergence of regional institutions**

A myriad of regional institutions has come into existence since the late 1980s. Many of them are for the purpose of facilitating intra-regional trade, marking a growing interest for domestic markets. These trade negotiations are a major issue for agriculture, particularly with regard to external customs duties that may then be negotiated.

I.1.3.3 The demand for biofuels

Since the 2000s and the rise in the price of fossil fuels, the demand for biofuels has risen greatly and requires growing volumes of agricultural products. Developed countries import a portion of their needs from developing countries, contributing to a rise in the cost of food commodities and implying that the upward trend in prices will be long term.

This may have a negative impact on poor families as well as on African countries that are net grain importers. Over the long term, high prices are also a major factor in agricultural development, encouraging investment and therefore increased production. It is therefore advisable to accompany this process with massive investment in the sector.

Moreover, establishing large plantations has a direct impact on the local communities and the environment. The development of short networks and productions for consumption at home are however, promising in terms of energy autonomy and creation of local added value.

I.1.3.4 Situation of institutions supporting the agriculture sector

**Agricultural research**

Agricultural research throughout the African continent is mainly conducted by the public sector according to the International Food Policy Research Institute (IFPRI). A number of countries in sub-Saharan Africa have established National Agriculture Research Systems (NARS), which are little-suited to the issues of food self-sufficiency in the face of a drop in government and donor agency allocations over the last 15 years, and the problem of their specialization in export crops.

Today, research institutions must take the social and economic realities of African farmers into greater consideration in order to direct their activities toward the production of appropriate technologies. This is not only a matter of producing “improved” varieties of seeds and livestock breeds, but especially of developing the techniques making it possible to lift the constraints to the development of agricultural systems, and facilitating their adaptation to the rapid demographic, economic and social changes as well as to climate change.

**Occupational training in agriculture**

Occupational training policies in agriculture have been central to agricultural development and the fight against poverty since the 1990s, from the view that agricultural stakeholders can feed the populations, protect natural resources and provide themselves with a decent income that will continue
The fight against drought
The ability to predict natural phenomena, particularly those related to the climate, is very weak on the continent. There are a few regional information mechanisms on the climate, at the initiative of the Comité permanent inter-États de lutte contre la sécheresse au Sable (CILSS) in West Africa, the Autorité intergouvernemental pour le développement (IGAD) in East Africa, and the early warning systems (EWS) put in place through certain regional or international institutions (FAO and WFP). These structures are facing problems related to human resources, equipment and finances that prevent them from operating effectively.

I.1.4 Demographics in Africa

I.1.4.1 A formidable demographic vitality
Between 1950 and 2001, the continent’s population increased fourfold and today accounts for nearly 12% of the world’s population (800 million inhabitants). This ongoing growth at an annual rate of 2.3% means that theoretically the population will double every 30 years\(^2\).

I.1.4.2 Demographic transitions vary by country and region
Though this overall pattern is generally accepted with the necessary caution related to its underlying hypotheses, it nonetheless does not cover significant disparities on the continent. For the sake of simplicity, 2 groups of countries can be identified\(^3\): (i) the countries of central, western and eastern African whose demographic growth rate is still very high, in the area of 2.5% and (ii) the countries of northern and southern Africa, who have begun their demographic transition.

I.1.4.3 Mainly intra-regional migrations
Emigration from Africa to other continents is greatly inferior to the flow coming from Asia, South America and intracontinental migration. A portion of the intracontinental migrations corresponds to the search for better opportunities; some migration is the consequence of conflicts, resulting in refugees settling in neighbouring countries for occasionally extended periods.

Emigration toward the OECD countries is for the most part, qualified migrants, although their countries of origin are woefully lacking a qualified workforce. But the migrations also have a positive impact on the migrants’ countries of origin through the money that they send to their families remaining in the country; this can have a spectacular impact at the local level, exceeding direct foreign investments or official development assistance.

I.1.4.4 Urban and rural populations will continue to grow
The urban population, which in 1950 did not exceed 15% of the total population, is 40% today and should surpass the rural population around 2030. Urban growth is in great part endogenous, and occurs mainly through the growth of a multitude of small cities\(^4\) beside a few megalopolises.

However, very few cities are able to offer formal, well-paying jobs to the migrants. Overall, the migrants swell the informal sector.

---

2 Ferry, Benoît (Under the direction of): "L’Afrique face à ses défis démographiques : un avenir incertain", Karthala-CEPED- AFD, 2007
4 See Africapolis : [http://www.afd.fr/abia/Jahia/Africapolis](http://www.afd.fr/abia/Jahia/Africapolis)
I.1.4.5 The “demographic bonus”

The African countries will soon experience a phase during which the ratio of the working population to the total population will steadily increase under the combined effect of the small number of elderly persons and the decline in births. This “demographic bonus” period may make it possible to devote the greater portion of resources to economic investments and a proportionately smaller share to social infrastructure.

In fact, this demographic bonus will only make economic growth possible if the country has the conditions to productively employ the labour force that surges into the job market. Between 2000 and 2030, the labour force will triple. As shown by the map below, the African countries located in the Torrid Zone will all, with very few exceptions, experience a strong rise in the arrival of young people on the job market during the next 20 years.

Map 1: Arrivals on the job market between 2010 and 2030.
I.2. African Agricultures’ Diversity

I.2.1 The physical environment of the African continent: Distinctive climatological and ecological features

The African continent covers nearly 30 million km², forming a vast zone whose areas are not all subject to the same climates and have different ecosystems. Africa’s climate is essentially tropical. The main determinant of the different types of climate is the amount of precipitation. Thus, 8 biomes can be identified. These are large plant and animal communities that are ecologically similar, based on climate – precipitation in particular – and to a lesser degree, altitude.

1. Mediterranean biome: Located at the extreme north and south of the continent
   - The Mediterranean climate is characterized by hot, dry summers, mild, humid winters, with an average annual temperature of approximately 25°C. This Mediterranean climate permits the growing of grains, fruits and vegetables with or without irrigation, and livestock production.
   - This hot, dry climate together with fairly significant winter rains supports vegetation year-round. Its typical plants are able to withstand drought and survive occasionally harsh winters in the interior zones and those at high altitude. This biome is also characterized by great biodiversity and tremendous organic wealth. Agriculture is mainly grains and livestock.

2. Desert biome: At the tropical level, with the Sahara Desert in the north, the Namibia and Kalahari deserts to the south but also on the Horn of Africa.
   - The desert climate is characterized by low precipitation (less than 25 mm per year on average, but in reality very unpredictable). The daytime temperatures (on average between 15 and 20°C) are very high and the nights are cold, with great differences based on the seasons.
   - The hit-and-miss rains make the development of a steppe possible, including long-lived species, short-cycle annuals and a few shrubs and trees. The biomass of the African deserts is not very significant. A few micro-zones can be identified in the rare drainage areas (wadis) where water appears after rainy spells. These oases are very favourable for agriculture thanks to the intermittent presence of bodies of water, a very warm climate and significant ambient humidity. Grain, truck farming and small livestock can be raised. The surrounding desert areas are essentially used for grazing.

3. Semi-arid biome: Transitional area between the savannah and desert, present in both the Sahelian band and southern Africa.
   - The climate is characterised by low precipitation (250 to 500 mm) and great seasonal and interannual variation. Temperatures are very high (average to 29°C); the semi-arid zones south of the equator and at higher altitudes are cooler.
   - The vegetation in the northern part of the Sahel is steppes, pseudo steppes and savannah, which are dominated by populations of annual graminaceous plants with a strong ability to regenerate after drought. There is little agricultural potential here. The wooded zone consists of acacias and various shrubs. In the southern Sahel, pasture landscapes are enriched by low ground pasture systems, gallery forests, etc. These Sahelian zones have vast systems of continental humid zones in the deltas and on large rivers. Adaptation strategies can be observed in the plants. Short-cycle species can be cultivated (millet, sorghum, cowpeas). However, these zones are primarily devoted to livestock production. The humans and animals must also adapt to these climatic conditions and the resulting vegetation.

4. Dry, tropical climate biomes:
   - This zone, which is also called the Sudanian zone, is marked by relatively significant rainfall (from 600 to 1,200 mm) and two seasons: the dry season and the wet season. The dry season is long (over 6 months) and tends to get longer the farther one goes from the equator. Interannual variations are very pronounced, a factor that limits agricultural activities.
   - Dry savannah: This is found on a vast strip between 10 and 15 degrees latitude north as well as over a good quarter of the southeastern part of the continent.
The flora is long-lived and annual savannah grasses and a variety of ligneous flora, and narrow, discontinuous gallery forests. Dry savannah (or Sudanese savannah) appears where the dry season is relatively long, only supporting sparse trees and short grasses depending upon the amount of rain. There is a variety of large mammals. A portion of these Sudanese zones has low-density population, however, there is often a great deal of pressure on the cultivated agri-systems.

- **Temperate prairies:** This biome is characteristic of the dry tropical climate, modified by the altitude, found in southern Africa where the Drakensberg Mountains create an interior high altitude zone with moderate precipitation. The vegetation is dominated by large expanses of temperate prairies with sparse trees, and is highly dependant upon precipitation. These zones are primarily used for raising livestock.

5. **Moist savannah:** Moist savannah zones are found, in relation to dry savannah zones, in the zones nearest the Equator.
   - The climate of the tropical moist zone (or Sudanese-Guinean zone) is characterized by a peak in precipitation and a short dry season. Average annual precipitation is generally heavy (from 1,100 and 1,800 mm). The temperatures are relatively high, with seasonal variations that are greater than in the equatorial zones.
   - The species found in these zones are primarily long-lived grasses, trees including Sudanese species and depending on the place, dense, moist forests. Forestry, and agricultural activities are the development components in these zones.

6. **Tropical rain forests** are located along the Equator, from Gabon to Uganda as well as in the coastal areas of Liberia, Sierra Leone and on eastern Madagascar.
   - The climate is characterized by precipitation throughout the year (from 1,700 mm to 3,000 mm). Annual average temperature is 25°C. There are short dry seasons favourable to dense, diversified forests.
   - The zones are entirely covered with vegetation, mainly trees. The trees are tall with a dense, closed canopy. Sun does not reach the ground. The vegetation consists of rain forests and vines. The biodiversity there is the richest of all the land biomes. The particular case of the moist high attitude forest, subsisting in isolation in rural, densely populated spaces can also be mentioned. The impact of fires, often used for the regeneration of pastureland of long-lived savannah grass is significant and omnipresent. In Sudanese-Guinean transition zones, the great savannahs are an extremely important accumulation of little developed biomass.

7. **Mountain biomes:** These are found on the high mountain plains (1,000 to 3,500 m) of Ethiopia, Kenya, Rwanda, Burundi, and Madagascar. They are located within various climatic zones from dry tropical to equatorial. The altitude has a major impact on the precipitation and temperatures, particularly the differences between day- and night-time temperatures. These mountain zones are relatively isolated, consisting mainly of high altitude forest and prairies. The vegetation adapts to the altitude. The higher the altitude, the fewer plant species. Some of these biomes are made up of unique plant communities.
I.2.2 Distinctive features, strengths and weaknesses of the various agricultural systems

The chapter below presents the main agricultural systems identified on the African continent. It is difficult and certainly simplistic to represent the diversity of the agricultural systems from a continental perspective. The typology presented takes its inspiration from the work carried out by the FAO (2001) and Dufumier (2008) and thus carves out 18 major farming systems. The following table presents the approximate “weight” of the various farming systems from a continental perspective (total area, cultivated area, population affected), established using data from the FAO.5

---

5 Data is only available for sub-Saharan Africa. This is deemed to include 626 million inhabitants and 2,455 million hectares, 173 million of which are annually or permanently under cultivation (FAO, 2001). The percentages given in the rest of this chapter refer to the zones described compared to the region as a whole, i.e. sub-Saharan Africa.
Table 2: Descriptions of the various agricultural systems in Africa

<table>
<thead>
<tr>
<th>No</th>
<th>Biome</th>
<th>Type of system</th>
<th>Main activities</th>
<th>Prevalence of poverty</th>
<th>Total area (Millions Ha)</th>
<th>Cultivated area (Millions Ha)</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Tropical forest</td>
<td>Pioneer front arboreticulture</td>
<td>Cacao, coffee, palm oil, hevea, yams, corn, out-of-season work</td>
<td>Low to Moderate</td>
<td>73</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Tropical forest</td>
<td>Slash-and-burn system, dense forest</td>
<td>Cassava, corn, beans, yams</td>
<td>High</td>
<td>263</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>Highlands, mountains</td>
<td>Rice and arboreticulture in Madagascar</td>
<td>Rice, bananas, coffee, corn, cassava, legumes, livestock, out-of-season work</td>
<td>Moderate</td>
<td>31</td>
<td>2.2</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Highlands, mountains</td>
<td>Highlands farming systems based on perennial crops</td>
<td>Bananas, plantain, Abyssinum bambus, sweet potato, beans, grains, livestock, out-of-season work</td>
<td>High</td>
<td>32</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Highlands, mountains</td>
<td>Mixed farming operations in temperate highlands</td>
<td>Wheat, barley, rice, peas, lentils, beans, rapeseed, potatoes, sheep, goats, cattle, poultry, out-of-season work</td>
<td>Moderate to high</td>
<td>44</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>Moist savanna</td>
<td>Systems based specifically on root crops</td>
<td>Yam, cassava, legumes, out-of-season work</td>
<td>Low to Moderate</td>
<td>282</td>
<td>28</td>
<td>44</td>
</tr>
<tr>
<td>8</td>
<td>Moist savanna</td>
<td>Mixed systems based on grain/root crops</td>
<td>Corn, sorghum, millet, yam, cassava, legumes, livestock</td>
<td>Low</td>
<td>312</td>
<td>31</td>
<td>59</td>
</tr>
<tr>
<td>9</td>
<td>Dry savanna</td>
<td>Mixed-based mixed systems</td>
<td>Corn, tobacco, cotton, castor, goats, poultry, out-of-season work</td>
<td>Moderate</td>
<td>246</td>
<td>32</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>Dry savanna</td>
<td>Agro-pastoral systems with short fallow periods, based on millet and sorghum</td>
<td>Sorghum, millet, legumes, sesame, cattle, sheep, goats, poultry, out-of-season work</td>
<td>High</td>
<td>198</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>11</td>
<td>Mediterranean</td>
<td>Mixed grain systems, livestock production in southern Africa</td>
<td>Corn, legumes, sunflower, cattle, sheep, goats, transfers from abroad</td>
<td>Moderate</td>
<td>123</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>12</td>
<td>Mediterranean</td>
<td>Mixed dry land farming systems of southern Africa</td>
<td>Grain, sheep, out-of-season work</td>
<td>Significant (for small farmers)</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>13</td>
<td>Mediterranean</td>
<td>Mixed rain-fed farming systems</td>
<td>Sub-arctic grain, legumes, out-of-season work</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>14</td>
<td>Semi-desert</td>
<td>Pastoral and nomadic livestock production systems</td>
<td>Cattle, camels, sheep, goats, transfers from abroad</td>
<td>High</td>
<td>346</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>15</td>
<td>Semi-desert</td>
<td>Large irrigated areas</td>
<td>Rice, cotton, truck-farming, rain-fed crops, livestock, poultry</td>
<td>Low</td>
<td>35</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>Oasis systems</td>
<td>Oasis systems</td>
<td>Irrigated corn, truck-farming, date palms, out-of-season work</td>
<td>High</td>
<td>429</td>
<td>0.7</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>Oasis systems</td>
<td>Farming systems based on traditional fishing</td>
<td>Sea fish, coconut, cashews, bananas, rice, fruits, goats, poultry, out-of-season work</td>
<td>Moderate</td>
<td>38</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>18</td>
<td>Oasis systems</td>
<td>Horticultural areas, outside the city or off-season</td>
<td>Fruits, truck-farming, dairy products, cattle, goats, poultry, out of season work</td>
<td>Moderate</td>
<td>38</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>
I.2.2.1 Mediterranean Zone

Mixed dry land farming systems in Northern Africa
These are located in dry, sub-moist areas receiving low annual rainfall (150 to 300 mm). Density of the population is relatively low for farming operations whose average size is relatively large. Crops are mainly rain-fed cereal grains (barley, wheat) which use fallow systems. Livestock production tends toward small ruminants that are herded and cattle. Their weakness is the inability to grow crops with greater added value (fruits and produce) due to the scarcity of water. Poverty is prevalent among the small farmers.
**Mixed rain-fed system farming operations**
This system brings together annual crops (grains and protein crops) and perennial crops (vines and arboriculture); there are approximately 8 million animals. It is mainly rain-fed but benefits from total or supplemental irrigation techniques. It makes a very dense population possible. Many species are cultivated (grains and protein crops). Sheltered crops with supplemental irrigation are also found here (potatoes, produce and flowers). Arboriculture (olives, fruits, melons, grapes) is practiced in the wettest zones (600 to 1000 mm of rain per year). Small-scale livestock production is a complement, using the dry season grazing land. The complementation caused by the incomes of seasonal migratory workers should be noted. The main problems are economic, especially when markets are far away. Poverty is very prevalent; in some areas the natural resources tend to be degraded.

**Mixed cereal grain-livestock production farming systems – southern Africa**
This system extends through the northern part of the Republic of South Africa and the southern part of Namibia in semi-arid and dry sub-moist zones. This system covers 123 million hectares, 12 million of which are cultivated. Approximately 4% of the population of sub-Saharan Africa lives under this system. The crops are mainly corn, sorghum and millet. Livestock production includes cattle (roughly 11 million head) and small ruminants; the level of agriculture-livestock production integration remains low. The two distinct sub-systems are also observed: small, scattered operations (the incomes from which are insufficient for the farmers) and large commercial operations (more economically efficient).

Vulnerability is high as a large portion of this production system is done on poor soil subject to dryness. Moreover, the fields are planted frequently, often after only short fallow periods, which causes the mineralization of the soil and leads to lower water and mineral retention. The heavily worked soil tends to degrade.

The prospects for agricultural growth are moderate and the opportunities for poverty reduction are limited. The issue here is preserving soil fertility by, for example, changing agronomic practices and better interaction between the farming and livestock production systems.

---

**Box 1: Extensive grain farming**
This is a distinct sub-system from the previous systems in semi-arid and dry sub-moist zones. They use highly mechanized and irrigated extensive production systems, use synthetic fertilizers and phytosanitary products and are not very labour intensive. Land policies of these countries and the frequent government support are rather favourable. As the main constraint, the fields lying fallow are often planted after only short periods, leading to a reduction of water and mineral retention. The ploughing in these systems is often too deep and leads to mineralization of the humus and low structural stability of the soil. The parcels are subject to intense and extended periods of poor rainfall. This system’s success with regard to production is due much more to the expanse of areas farmed than any particular intensification of agricultural techniques.

---

**I.2.2.2 Deserts**

**Oasis systems**
These are found in the most arid areas (mainly in the Sahara). The operations affected are very localized, small oasis systems covering very small areas, where productions are highly integrated: primarily truck-farming, livestock and date palms. Six million people use these systems, which are first and foremost, intensive and highly based on irrigation. They use fossil water, access to which is often facilitated by the existence of intermittently present bodies of water or artesian wells. There is little threat to these reserves of water, considering the small volume that is removed. The oasis systems are thus relatively stable. Irrigated crops and fodder are produced in a number of interdependent strata. These systems are based on the use of suitable plant species and produce. Livestock production also depends on the amount of fodder produced. Finally, demographic pressure is relatively limited despite heavy expansion. Agriculture is just one of the components of a multiple activity system heavily based on trade and exchange. These systems must deal with growing tension over rare resources.
I.2.2.3 Semi-desert, Sahel

Large, irrigated areas
Governments and international development projects have driven their construction. They are supplied with surface water or underground, fossil or renewable water from wells. Often, dry cultivation and livestock production complement irrigated cultivation. The size of the irrigated operations ranges from several dozen hectares to less than 1 hectare. In northern Africa, these areas produce highly profitable crops and high-value export crops and intensively cultivated fruits and vegetables. In Sahelian Africa, they generally focus on rice production for the domestic market. They enable grain production to be secured in regions with significant unexpected climate variations.

These systems have two important limitations: (i) institutional aspects, including water management, (ii) over-use of non-replenishable groundwater aquifers, lowering of the water table, salinization and sodification of the soil. Harvests are rarely lost but subsistence conditions are subject to water shortages, technical incidents and the deterioration of the cost of inputs/product price ratio. Poverty is relatively low.

They have significant development potential and contribute to food security at the national level and to the diversification toward high added value crops. They reduce the risk of losing crops that are sensitive to drought and foster the use of inputs and intensification. The choice between crops intended for food security and greater value crops to increase profitability depends on the country’s priorities. From the technical perspective, the main challenges are rehabilitation, re-equipping and modernization of irrigation and drainage systems, improvement of how the areas are managed, decentralization of agricultural support services and the accountability of water users’ associations.

Pastoral and nomadic livestock production systems
These systems are found in the Sahelian band, Eritrea, northern Namibia, northern Kenya and southern Africa (see Map 3). Pastoral nomadism consists of frequently moving the animals over vast areas in order to sustainably exploit the relatively scarce and scattered water and grazing resources. In the Sahel, movements are staggered between periods when water and grazing are available in pasture areas. These movements are in response to the very detailed circumstantial observations of the shepherds and are governed by ongoing social agreements. This system is used over approximately 346 million hectares. The system supports roughly 27 million people and 21 million head of cattle.

Pastoral nomadism and the skill of these producers are irreplaceable in these dry areas of rare and scattered biomass. These systems are highly adapted to their environment, very modern and capable of great adaptation to an environment in perpetual evolution.

The agricultural needs are such that agriculture tends to move from the most arid zones at the expense of areas used for pastoralism. This occasionally leads to conflicts, mainly concerning the common grazing land when livestock production develops among the farmers.

The problems are related to the reduction of the vegetation cover and the acceleration of wind and water erosion. At the macro level, proposals likely to check these problems and to develop the assets could be the easing of the regional conflicts, setting up inter-country management and negotiation instruments, and at the local level, development of hydraulic installations in grazing areas, and establishing dialogue forums among users of the same space.

I.2.2.4 Dry savannah

Agropastoral systems with land growing millet and sorghum, and that is uncultivated for short periods
These systems are found in the semi-arid zones of western Africa and in significant portions of eastern and southern Africa. The integration of the production of ruminants in the agricultural production systems is considered to be the best way to promote the development of spontaneous grasses, use the remnants of crops and increase soil fertility through the transfer of organic matter. This system would
cover 198 million hectares in sub-Saharan Africa, 22 million of which are cultivated. Approximately 33 million people live on these systems.

The animals make the most of the fields and wander during the dry season. A significant portion of the arable land is cultivated. The general farmers can entrust their animals to transhumant herders. Use of draught animals increases the cultivatable areas. Rain-fed sorghum and millet are the main food crops. This system encompasses nearly 25 million head of cattle, goats and sheep; these animals are used for transportation and subsistence.

The system’s main constraint is the drastic reduction of the biomass due to the shortened fallow periods. This system requires that reserves of fodder be created.

The demographic growth observed in certain zones causes a great deal of pressure on the land, which translates into a serious encroachment onto exclusively sylvo-pastoral zones. The depletion of forage causes poorer protection of the soil against erosion. This system must deal with problems related to shrinking vegetation cover and the land’s loss of productivity.

**Mixed corn-based systems**
This system is very present in South Africa and eastern Africa. It covers 246 million hectares, 32 million of which are cultivated. An agricultural population of 60 million lives off it. The system has the advantage of two growing seasons.

Incomes from corn production are topped up by other agricultural products and the incomes collected by migrants. These systems are based on strong interactions between livestock production and agriculture. Thus, 36 million head of livestock are raised for ploughing and the production of milk and manure. The existence of local markets, making it possible to upgrade the products, is predominant and occasionally a major limitation. These systems are also based on a low use of inputs, due to their unavailability, resulting in a drop in soil fertility, shrinking yields and the expansion of cultivated areas. Drought and price instability are the two main causes of these farmers’ vulnerability. These systems are extremely dependant on rain and the climate. They are relatively well integrated into the ecosystems affected. They are universally expanding in terms of area.

**I.2.2.5 Moist savannah**

**Grain and root crop mixed systems**
These systems are found from Guinea to northern Cameroon. Intercropping is routine and a large range of crops is grown and marketed (grains and root crops).

Arable land is abundant and relatively underutilized due to the low-density population, poor communications and lack of labour in the absence of draught animals. Poverty is low with the number of poor remaining modest and potential for poverty reduction moderate.

The tsetse fly restricts the amount of livestock, with the result that tubers are a major crop. A drop in soil fertility and rising acidity related to the use of chemical fertilizers and the reduction of organic matter are noted by location. The drop in the use of mineral fertilizers on grains due to the unfavourable input price/product price ratio has also led to lower soil fertility, whereas weeds like striga have become more difficult to control. In the northern part of the zone, the long-term use of mechanization for preparing the ground has led to the loss of soil structure and organic matter. Provided transportation infrastructure is developed, the zone could become Africa’s granary. However, population growth will increase pressure on the land resources. In the absence of corrective measures, soil fertility problems can be expected.
Box 2: The large sugar cane plantations

The sugar cane plantations form a distinctive sub-system within the grain-root crop mixed systems. From Guinea to Mozambique, large agro-industrial companies in moist savannah zones grow sugar cane. The plantations’ specialization is the predominant element of these systems, which are pools of production drawing seasonal workers. Normally cultivated for producing sugar, there is an additional interest in sugar cane related to biofuels and its great potential for the production of ethanol. Price fluctuations are the main source of vulnerability.

System based specifically on root crops

This extends into the sub-moist and moist agro-ecological zones located between the driest zone with the grains and root crops based mixed system, and the moist zone with its arboriculture and forestry system (see Map 3). Root crops/tubers form the basis of this system. These products are consumed by the producers. Only surpluses are marketed.

These systems are not very vulnerable. The rainfall is bimodal or practically continuous and the risk of crop loss is low.

On the other hand, farmed areas are very limited. Trees (fruit, wood) provide additional income. Despite that, farmers’ income is limited.

With urban demand growing rapidly, one of the main issues is intensification of the system, while there have been relatively few technical innovations developed on these crops.

1.2.2.6 Tropical forest

Dense forest slash-and-burn system

This encompasses all operations using the slash-and-burn system for agricultural purposes. Agriculture is not the exclusive activity, but is integrated with many hunting, fishing and gathering activities. Manual tools are used for land improvements. This system is found in Africa’s forest regions. The farmers practice “sustainable” rotation based on land clearing, cultivation and a fallow period. In sub-Saharan Africa, this system covers approximately 263 million hectares, 6 million of which are affected by slash-and-burn. This system supports approximately 28 million people.

This system makes it possible to cultivate the same parcel for a number of years in a row and offers a good ratio of natural resources to collected resources. It is suited to low-density populations. The advantage is that it benefits from the high availability of humus helping to retain water. The land is not subject to exclusive ownership. Improvement is authoritative.

This system is constrained through the extension of agriculture and arboriculture areas blocking migration to new forests, and the density of the population; these lead to too-intensive use of the parcel and gradual conversion to savannah.

The system is dependant on a fragile ecosystem and can quickly be in crisis. This can translate into major risks for the area’s food security.

Pioneering front arboriculture agriculture

This system corresponds to the passage from slash-and-burn systems to arboriculture plantations found in Ghana and Ivory Coast. It is based on the felling and burning of trees to establish seedlings for food crops intended for local consumption with the gradual advancement of the pioneering fronts. The parcel boundaries are very distinct and regularly distributed.

When the forest regions are still not densely populated, the conditions are favourable to accepting migrants. These farming systems are relatively well-paying compared to the amount of work invested but additional income is necessary.

However, the coffee and cacao systems have been experiencing a crisis in their development model for a number of years. Fertility is gradually disappearing, and there is less area to clear; this results in tension for access to farmland and is a source of social conflict and poverty.
Despite the constraints, this system has great potential through diversification of crops and improvement in the quality of the products and post-harvest operations.

**Rice and arboriculture in Madagascar**
This production system is specific to Madagascar. The system covers 31 million hectares, 2.2 million of which are, in fact, cultivated. The irrigation systems are relatively well developed. Livestock production is important. This system is based on complementarity between the productions. Due to natural resources and climate, its agricultural potential is significant but the opportunities for agricultural growth are nonetheless limited due to the small size of the operations.

**I.2.2.7 Highlands, mountains**

**Highland farming systems based on perennial crops**
This system is found in Ethiopia, Uganda, Rwanda and Burundi where it occupies sub-moist and moist agri-ecological zones. Rainfall is significant and temperatures moderate. This system is based on herding integrated with a number of plant species. Eleven million head of livestock are raised for milk, manure, dowries, savings and social security. The crops are grown on arable land on an ongoing basis. Fertility is transferred through penning the animals. This system has a great deal of labour available. Poverty is significant in terms of severity and absolute numbers. Despite the favourable conditions with regard to natural resources and climate, there appear to be very limited opportunities for increasing agricultural production and reducing poverty due to the small size of the farms, under-utilization of resources and the lack of suitable technology, infrastructure, markets and employment opportunities outside agriculture.

One asset of the system is co-cropping in the parcels. This makes it possible to limit pressure from adventitious plants and dissipates the risk of very poor yields. Another asset is ideal management of a family-based workforce and recycling of crop remnants.

This system has the highest density rural population in the region. Land use is intensive and the farms are very small. The current trend is reducing the size of farms, reduced soil fertility and greater poverty and hunger. The population tries to compensate with more intensive working of the land but income from this work is low. There is no opportunity for economies of scale due to the many activities going on.

The richness of this system stands out through the resilience of co-cropping. The system’s challenges pertain to intensification in conserving the “sustainability of the systems.”

**Mixed farming operations in the temperate highlands**
This system is mainly located at an altitude between 1800 and 3000 meters on the highlands and mountains of Ethiopia. Cereal grains are the main food crops and are complemented by peas, lentils, beans, colza, teff (in Ethiopia) and potatoes. Livestock is abundant and used for ploughing and the production of milk and manure. Sale of sheep, goats, wool, beer, barley, potatoes, legumes and oil seeds are the main sources of income, occasionally augmented through money sent from outside.

The main strength of these systems is found in the great number of productions, which make it possible to resist the vulnerabilities they are subject to.

The main constraint pertains to a drop in soil fertility due to erosion, lack of biomass and inputs in the case of grain productions. Climate risks are relatively high; however, the options for diversification with temperate crops are very substantial.

Poverty is moderate to severe. There is little potential to reduce poverty or increase production due to the high density of the population and the small size of the farms.
I.2.2.8 Dispersed systems

**Horticultural areas that are outside the city or out-of-season**

These are found in the outlying areas of densely populated urban areas, with structures allowing irrigation or the use of a stream driving the system. They are based on the small-scale production of horticultural products, fruits and intensive truck-farming. They have close-knit ties with the geographic area of their urban consumption pools, particularly the capitals. These horticultural systems require intensive work and a great deal of chemical inputs. Certain “fresh” products are exported (Europe, Asia) during the winter.

Production – consumption proximity is the main strength of the system. High added values compared to the small areas farmed and many jobs are generated. There is also strong vitality and considerable potential for growth, provided the issues related to inputs and access to land can be overcome. The economic situation of these systems is in general good.

Their main constraint pertains to the potential damage to the environment, conflicts over land use and in the future, greater transport costs.

These systems have a significant and growing potential market – they are often described as the systems “of the future”.

**Integrated agricultural-traditional fisheries systems**

These systems are very widespread. Their main resource is fishing, complemented with farming activities. These operations occupy nearly 38 million hectares, 5 million of which are cultivated. They provide a living for roughly 13 million people. 4% of the cultivated area is irrigated. Domestic livestock production is an important source of additional income or is consumed by the farmer. Population density in these areas is fairly high. These systems are based on traditional fishing and complemented by small-scale cropping and livestock, or alternatively, tiered crops in gardens and tree farming (fruits and root crops), with occasional income from tourism.

The disappearance of the mangroves, an important fish habitat, is a major threat to these activities. The rise in the sea level associated with climate change is also a threat. Only political action for protection or joint management of the space will be able to resolve these issues.

**Flooded rice-production systems**

These are scattered over a large part of the continent, particularly in the dry tropical zone. Rice growing takes place of flat or flattened parcels of land that are surrounded with small dikes. This enables the growers to maintain water coverage and make it possible to develop low ground and floodplains. Growing rice in flooded paddy fields makes it possible to cultivate the same parcels every year by maintaining the soil fertility and controls competition from adventitious plants. Yields from this technique remain, however, highly random. Terraced rice fields only occur in highly populated regions. These small systems are very widespread. Rice growing carried out in this way requires a great deal of labour, which is the main challenge of these systems.
I.3. CHALLENGES FOR AFRICAN FARMERS

I.3.1 Growing needs for food around the world

Over the coming decades, Africa will have to handle a triple food challenge:
- Feeding an ever-growing population;
- The need to improve current food levels in order to resolve the problems of chronic under-nourishment and qualitative malnutrition;
- Changes in eating habits.

For 22 African countries, the growing food needs resulting from these factors correspond to multiplying their needs for plant-based energy by between 8 and 16 times over the period 1995 to 2050, i.e. an annual growth rate between 4 and 5% (Map 4). Only 8 countries in southern Africa and northern Africa have with multiplication coefficients of less than 4.

Map 4: Evolution of plant-based energy requirements by country between 1995 and 2050

Source: Ph. Collomb 1999

I.3.2 Creation of productive employment in the rural sector

As we have seen, African cities have limited capacity to generate jobs in the industry or service sectors in most countries. The primary sector, and agriculture in particular, must therefore productively absorb a large portion of the labour that will arrive on the job market over the coming years. This productive insertion is all the more essential because the active workforce in rural areas will have to feed an ever-growing number of individuals living in cities.

With regard to agriculture (the primary source of jobs in rural areas), by “productive employment” in the rural sector, we mean jobs that enable farmers to cover basic family needs but also to renew their production apparatus and even improve it. When production or the income derived from it are insufficient, farmers are forced to consume their production capital in order to maintain family consumption, i.e. not renew soil fertility or production equipment.

A good indicator of this is labour productivity. African agriculture, which is mainly manual, has the lowest productivity in the world. The surpluses are low and farmers’ incomes make it impossible for them to develop their production. This explains in great part why the continent remains in a state of perpetual under-development.
Data from UNCTAD\(^6\) show a slight 14% improvement in agricultural productivity of LDC in 20 years (1980-83 to 2000-2003), whereas the increase in productivity in the same sector was 47% for other developing countries and 141% for developed countries! Among the African countries for which data are available, one-third showed a decrease in agricultural productivity, one-half had an increase that was less than average for LDCs and less than 10% had growth that was above the average of other developing countries. This is to say that productivity has increased little over the period and that the difference between most African countries and the rest of the world is instead growing.

\textbf{I.3.3 Competitiveness of African agriculture}

Another important challenge to be considered is the markets for African agricultural products. The market for tropical agricultural raw commodities is the traditional market for African agriculture (cotton, peanuts, sugar cane, cacao, coffee, rubber). These products are traditionally exported but they are subject to competition from the products of developed countries’ crops (and, increasingly, of developing countries’) and synthetic substitutes. The long-term trends are lower prices and degradation of the terms of trade on these products. These products are limited by their weak competitiveness, related particularly to substantial marketing costs, but also to the difficulty of processing the products further in order to capture a larger share of the added value produced along the chain. Today, the progressive system of duty implemented by developed countries limits the African countries to the role of raw agricultural products supplier.

African agriculture also faces competition on its domestic food market, as many imported products are less expensive when they arrive in major urban centres (corn imported from the United States, frozen chicken and onions imported from Europe, Asian rice, etc.) and compete against local productions. African producers must in fact deal with high transaction costs due to the lack of infrastructure (the absence or poor condition of roads, storage structures or weak markets, no cold chain, etc.). However, competition from imported products is not simply related to infrastructure issues but especially to the difference in labour productivity mentioned previously (and strengthened by export assistance for certain countries) which undermines the competitiveness of African products on their own market. Certain products that are more specific to African dietary habits, suffer less from competition but may be replaced by less costly, easier to prepare imported products.

I.4. CONCLUSION

This short summary shows that the challenges the African continent and its agriculture face are many and complex. And we still have not responded to the governance crises that have shaken Africa over recent decades – and continue to explode today – and which also explain a good portion of the limitations to its development.

A new challenge should also be added: The challenge that climate change will place on economies that are, as we have shown, very dependent upon natural resources for their development. What will the actual changes be? What will their impacts be on agricultural systems and economies? What actions should be undertaken to deal with them?

The second part of this study will take stock of current knowledge on climate change and what the issues will be for the continent. The third part will provide courses of action dealing with the overall challenges that exist in the context of a changing climate.
This part will first present Africa’s contribution to climate change in terms of greenhouse gas (GHG) emissions. Although these emissions are very limited, their profile must be studied in order to see how Africa can contribute to the international effort to reduce GHG emissions. Although the outlook in this area remains very speculative, a synthesis of the changes expected by major regions then gives an idea of the type of changes to be expected. Finally, we will make a detailed presentation of the negotiation process in progress and the main issues and challenges since the Copenhagen conference, with special emphasis on the issues related to agriculture and what Africa can hope for from these negotiations.
II.1. GREENHOUSE GAS EMISSIONS IN AFRICA AND DISTINCTIVE FEATURES OF EMISSIONS FROM AGRICULTURE AND SOIL DEGRADATION

This first section presents the levels of emissions from the African continent and their regional disparities as well as agriculture’s contribution to Africa’s emissions in order to enable negotiators to correctly establish the weight of Africa’s agriculture sector in the international negotiations.

II.1.1 Greenhouse gas (GHG) emissions

II.1.1.1 General information and methodology for calculating GHG inventories

Methodologies for estimating greenhouse gas emissions and absorption were developed under the auspices of the Intergovernmental Panel on Climate Change (IPCC) in 1996 and then updated in 2006. Internationally recognized, they divide these estimates into economic sectors, clustering related procedures, sources, and GHG sinks: (i) energy (production, transport, etc.); (ii) Industrial Processes and Use of Products (IPUP); (iii) Agriculture, Forestry and Other Land Uses (AFOLU); (iv) Waste; (v) Other.

II.1.1.2 World trends

Under the effect of human activities, atmospheric concentrations of the main GHGs (carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O)) have greatly accumulated since 1750. The primary cause of the rise in the CO₂ concentrations is the use of fossil fuels, and to a lesser degree, changes in land use. The rise in CH₄ concentrations is very likely due to agriculture (livestock enteric fermentation, evacuations, rice growing) and the use of fossil fuels. The rise in N₂O is also related to agriculture (mainly organic nitrogen fertilizers and minerals).

Five countries (China, United States, Russian Federation, India and Japan) are responsible for more than half of the world’s total GHG emissions. By 2025, most of the growth in emissions will come from countries in transition (China, India, Brazil and Mexico).

II.1.1.3 Africa’s contribution to the world’s GHG emissions

Map 5 illustrates the disparities between the various regions in the world with regard to GHG emissions, and in particular Africa’s minimal contribution (4% of total emissions and 2.5% of CO₂ emissions).

Map 5: CO₂ emissions of regions around the world (Cumulative 1960-2004)
Historic responsibility for GHG emissions for the period from 1750-1800 to 1990 indeed belongs to developed countries. These past emissions are also important to the extent that absorption capacity of future emissions is a residual function of past emissions.

II.1.2 GHG emissions in Africa

II.1.2.1 Main sources of GHG in Africa

According to report\(^7\) FCCC/SBI/2005/18/Add.2\(^8\) (2005), in 1994 the continent of Africa emitted approximately 1,600,000 Gteq. of CO\(_2\) of the three main GHGs per year, outside of Change of Land Use and Forestry\(^9\) (CLUF). Details of the declarations by country and GHG are presented in a table in Annex 1 of the full version of the report in French.

Most of Africa’s parties (56%) indicated that CH\(_4\) was the main GHG. The main source of GHGs was the energy sector (70 Parties), agriculture (45) and waste (6). Agriculture was the second main source of emissions for most of the Parties. The CLUF sector is a net GHG sink for the region, or in other words, the production of biomass remains greater than the losses due to harvesting wood and the conversion of forests into prairies or cultivated areas.

In terms of emissions, the production of electricity increasingly uses thermal energy. In the future, the choices of energy supply will be dictated more by environmental and climate issues in a context of very high demand for energy by Africa’s populations.

Finally, agriculture is the main source of GHGs in Africa, particularly with regard to methane (CH\(_4\)). Nitrous oxide (N\(_2\)O) is related to land use and nitrogen inputs in agriculture but these remain limited.

II.1.2.2 Sub-regional trends

With a relatively high level of industrialization, GHG emissions from the countries in the Mediterranean region are dominated by the energy sector and will in all likelihood increase greatly. The potential for mitigation of GHGs in the region is therefore tied to this sector (transport included).

GHG emissions from the desert regions of the Sahara and the Kalahari Desert are particularly low and disparate. The net change in carbon stores resulting from agricultural use of various types of soil is likely to be a limited GHG sink for the region.

The agriculture sector as well as forests and changes of land use are the leading sources of GHG emissions in the dry tropical and tropical moist regions. Fluctuations in biomass stores of forest systems as well as the conversion of forests make the land use and forest sector a significant source of CO\(_2\) emissions as well as a major carbon sink.

The equatorial region has particularly dense forest cover, which gives it very significant carbon sequestering potential, which should be further developed.

The African islands (excluding Madagascar) present very different geographic and economic situations that greatly influence their GHG emissions, which mainly arise from fossil fuel.

---

\(^7\) See part II.3.1.1 of this title for further details on the United Nations Framework Convention on Climate Change

\(^8\) UNFCCC, 2005: Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention. Note by the secretariat. Addendum. Inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases. (FCCC/SBI/2005/18/Add.2).

\(^9\) The main calculations of emissions originating from change of land use and forestry (CLUF), according to the IPCC methodologies, pertain mainly to three types of activities, which are sources either sources of or sinks of, carbon dioxide. This is (i) evolution of the forest’s wealth and other ligneous biomass (annual growth of the biomass less harvest of wood), (ii) the conversion of forests into prairies and (iii) abandonment of farmland, which sequester carbon. Immediate residues of trace gases other than CO\(_2\) coming from the combustion associated with the conversion of forests into prairies is also calculated. It is important to note that these calculations inherently contain many uncertainties and errors.
Due to its degree of development, South Africa is particular. 75% of this country’s emissions come from the energy sector, 11% from agriculture and 9% from industry (in 1994).

II.1.3 GHG emissions from the agriculture sector

II.1.3.1 Agriculture’s place in climate change in the world

Worldwide, N₂O levels should increase 35-60% by 2030 following the growing use of nitrogen fertilizers and greater production of animal waste. The global production of methane from livestock production should rise 60% by 2030.

In non-Annex I countries to the UNFCCC (i.e. developing countries, cf II.3.1) that are highly agricultural, agriculture's relative share in total GHG emissions is higher than in Annex I countries (developed countries), at 74% as opposed to 26% on average (Smith et al., 2007a). N₂O (44%) and CH₄ (52%) are agriculture’s leading GHG emissions, not CO₂ (4%). These countries’ growing future emissions from agriculture cannot be ignored. Although more intensive agriculture will probably translate into a reduction of GHG emissions per product unit or protein unit (FAO, 2008), the overall increase in production will increase total emissions unless effective mitigation measures are implemented that are custom designed for each farming system (Van Beck et al, 2009).

II.1.3.2 Emissions sources in agriculture and mitigation potentials

According to the US Environmental Protection Agency (US-EPA, 2006a), the agriculture sector contributes overall 10-12% of anthropogenic GHG emissions in the world and 47% and 58% of total anthropogenic emissions of CH₄ and N₂O, respectively.

Soil and vegetation protect three times the volume of carbon present in the atmosphere but land clearing and soil degradation are likely to transform these sinks into a major source of GHG emissions. This compromises Africans’ potential to play a first-rate role in the fight against climate change.

The N₂O from the soil, enteric CH₄ and CH₄ resulting from burning are the main present and future sources of emissions from agriculture in Africa. It is therefore advisable to first concentrate on mitigating these three types of emissions related to the use of fertilizers and agronomic practices, the development of livestock production and burning practices.

Globally, the agriculture sector has three main options for helping to mitigate climate change:

- Reduce its emissions, mainly through appropriate soil and livestock management practices;
- Foster the absorption of carbon by the soil (increasing organic matter) and trees;
- Prevent (or shift) emissions by using biomass as an energy source (wood, biofuels).

Though every type of farming system calls for different solutions, the IPCC estimates that globally the most valuable practices for reducing GHG emissions are to be found in improved management of crop and grazing land (e.g., improved agronomic practices, management of nutrients, tillage, remnant management), in the restoration of organic soil, restoration of degraded land, improved water management and rice production, fallowing, change of land use (e.g., by the conversion of arable land into prairies) and agro-forestry, as well as through improved management of livestock and its waste. Globally, the potential is significant for mitigating all the practices studied by the IPCC combined, particularly in Africa. But for this potential to become reality, major work in training and outreach, and major investments, will be necessary.
II.1.3.3 Africa’s position in world agricultural emissions

The data presented in this part are from a report by the U.S. Environmental Protection Agency (US-EPA, 2006a) published in 2006. Using the data in that same report, the IPCC created the graph below making it possible to compare the regions.

Graph 2: Estimated historic and projected N₂O and CH₄ emissions from the agriculture sector for the world's 10 regions over the period 1990-2020

Nitrous oxide emissions from farmland should increase globally, due to increased emissions from Africa, Latin America and the Middle East related to the expected increase in grain and meat productions and the use of synthetic fertilizers.

Total methane emissions from enteric fermentation should increase 32% by 2020. Management of animal feed could allow significant reductions of these emissions.

Methane from rice growing produced by the anaerobic decomposition of organic matter in flooded rice fields. Though Africa only represents a small portion of world emissions of this type, the quantity of methane produced should increase significantly by 2020 if there are no suitable mitigation measures.
Management of livestock effluents (animal wastes) producing CH₄ and N₂O. Methane is produced during the anaerobic decomposition of livestock wastes, while nitrous oxide is produced by the nitrification and denitrification of organic nitrogen contained in manure and urine.

Global emissions from animal wastes should increase 21% between 1990 and 2020. Though these emissions mainly come from OECD countries, the expected growth will come primarily from other regions, particularly Africa (+66%).

World nitrous oxide emissions from animal wastes should also increase in the coming years. They represented 200 MtCO₂eq in 1990. Southeast Asia is mainly where the increase should be greatest in nitrous oxide emissions from animal wastes. Africa remains a minor contributor, even if it will not escape this upward trend.

Finally, burning agricultural biomass, including grass fires and burning crop remnants as well as forest fires for the purpose of land use change, is a source of CH₄ and N₂O. Latin America, Africa and Southeast Asia are the largest emitters of these sources of GHGs.
II.2. STATE OF THE ART OF CLIMATE CHANGE IN AFRICA

Although Africa’s GHG emissions make a very minor contribution to global warming, the continent will probably be the most affected by climate change. Though many uncertainties persist with regard to the extent of the phenomena, all the studies agree that the warming will be more significant in Africa than in the other continents. The subject of this chapter is to assess the main changes expected in Africa’s climate and to assess the possible impacts of these changes on the agriculture sector in the main regions of Africa.

II.2.1 Climate change forecasts

II.2.1.1 Approach

For the study of the expected future climate changes, General Circulation Models (GCM) of the atmosphere are used in connection with socio-economic scenarios for future evolution of human activity. The horizontal resolution of current GCMs makes it possible to show the expected climate changes in a way that is appropriate for the world scale only. To show the process at a finer scale, a Regional Climate Model (RCM) with a higher resolution than the GCMs is generally used. The principle is to simulate a given region’s climate based on the information provided by the GCMs at the edges of the area considered while also integrating the various components of this region’s climate system.

II.2.1.2 Limitations

The GCMs of the atmosphere are planetary models. Accordingly, all attempts to over interpret their results on a regional scale are intrinsically flawed. From a scientific perspective, many aspects of the climate system are not yet well known or well understood. By the same token, there are many uncertainties when we attempt to model the interactions between the various components of the system.

Two main obstacles for small-scale climate research in Africa are identified:

- Lack of reliable meteorological information. The monitoring networks are often in poor condition and there are not enough of them, particularly for precipitation. The lack of historical data is also a major problem;
- Capacities in terms of human and IT resources for increasing the available data are greatly inadequate and support from certain institutions (such as the ACMAD and the ICPAC) to make them genuine centres for climate modelling would be necessary (SEI/Rockefeller Foundation, 2008).

II.2.2 The expected changes in Africa

The climate change scenarios for Africa indicate that the currently experienced climate variability is likely to increase and intensify. Droughts, floods and storms are likely to increase in both frequency and intensity. There is a chance that levels and forms of precipitation will change and temperatures increase. In the coastal zones, the sea level is rising, as are marine temperatures. This is a threat for the coastal zones and the ecosystems, and the expected effects on society and the economies are very significant, particularly impacting the poorest populations.

II.2.2.1 Temperature change

In some regions of Africa, the change already observed is faster than in the rest of the world. Current world projections for the period 2090-2099 show an increase in temperature from 1.1°C to 6.4°C above the average temperatures recorded for the period 1980-1999. In Africa, the increase in average temperature between 1980/99 and 2080/99 could be 1.5 times greater than for the rest of the world. This rise should be less pronounced in coastal and equatorial spaces (+3°C) and highest in the western portion of the Sahara (+4°C) and southern Africa.
The effect of the temperature change on the continental areas is likely to lead to a multitude of direct impacts on the vegetation, soil moisture, the water cycle, etc. not to mention the probable impact on monsoon dynamics.\textsuperscript{10}

\textbf{II.2.2.2 Rise in the sea level}

Rising sea levels follow increases in temperature around the world. This is due to variations in ocean density and circulation changes. The sea level rose on average 1.8 mm per year from 1961 to 2003. World projections predict rises of 18 to 59 cm toward 2090-2099, over the 1980-1999 levels. Map 6 presents the degree to which sea level will change for a given region compared to the global average. We can see that locally, the change in sea level will be comparable to the planet's average.

\textbf{Map 6:} Local elevation of sea level (in meters) due to ocean density and circulation changes compared to the global average (i.e., a positive value indicates a greater change than the global average) during the 21st century, calculated as the difference between the averages for 2080/2099 and 1980/1999.

\textit{Source:} Salomon, S. et al., 2007: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Figure 10.32.

Increases in sea level will lead to intrusions of salt water, floods and accelerated erosion in coastal areas. The destruction of man-made infrastructure and destabilization of the ecosystems’ wealth may be very significant and result in serious damage.

\textbf{II.2.2.3 Changes in rainfall}

Precipitation trends have increased significantly since 1900 in the western parts of North and South America, Europe and northern and central Asia, while the trends were downward in Mediterranean and southern Africa and in certain parts of southern Asia. Worldwide, an increased frequency of heavy precipitations and storms and an increase in the area affected by drought have been observed since the 70s (Trenberth, K et \textit{al}, 2007). For the 21st century, projections predict a downward trend in precipitation in northern, western and southern Africa and an upward trend in eastern Africa.

\textsuperscript{10} In this regard, see the AMMA project (www.amma-eu.org), which has been working on African monsoon dynamics for a number of years.
II.2.2.4 Greater frequency of extreme events

According to the IPCC report, the frequency and/or intensity of extreme weather events (floods, droughts, storms, sudden changes in temperature) have changed over the last 50 years. The environmental and socio-economic costs of extreme events are often excessively high. Moreover, the number of extremely wet seasons is expected to increase from once every 20 years in the late 20th century to once very 5 years during the 21st century\textsuperscript{11}.

\textbf{II.2.3 Climate projections for the various regions}

The following description of the expected changes by region is based on the 4th report of the IPCC. The estimated projections of average annual temperature and average annual precipitation are obtained by the difference (average of the models) between the forecasts for the period 2080-2099 and the data observed over the period 1980-1999. The GHG emission scenario used for these projections is scenario A1B of the SRES.

II.2.3.1 Expected climate changes in the Mediterranean region

The Mediterranean region should record the greatest temperature increase in the entire continent (probably 3.5°C), along with the Sahara and Kalahari desert regions, and greater variability. The rise in temperature will be greater in the continental regions than in the coastal regions. As a whole, the models converge to predict a moderate drop in the average annual volumes of precipitation (probably -12%). There will be a marked contrast in this decrease between the seasons, which is expected to be -6% during the winter, while plummeting -24% during the summer; this will be greater in the continental regions than in the coastal regions.

II.2.3.2 Expected climate changes in the desert regions

Along with the Mediterranean region, the Sahara and Kalahari deserts should be the regions in Africa most affected by increases in temperature (probably 3.6°C), with the effect being more pronounced in the continental regions than in the coastal regions. Regarding precipitation, the Sahara and Kalahari desert regions show contrasting trends and the models do not always agree. However, it is very likely that the future precipitation patterns will be more variable with a decrease in the winter.

II.2.3.3 Expected climate changes in the Sahelian region

The Sahelian region is a transition zone between the desert regions and the tropical regions. Already, the rise in the average temperature in the Sahel (0.2°C to 0.8°C since the late 70s (ECOWAS-SWAC/OECD, 2008)) is occurring at a faster pace than in the rest of the world. Since the 1960s, the Sahel has undergone a 20% to 40% decrease in precipitation, which is accompanied by a 200 km southward slide of the isohyetal lines, as shown on Map 7. The region’s precipitation has risen again slightly since the early 90s but with great year-to-year variability.

The rise in temperature is expected to be between 3°C and 3.5°C and will be more marked in the summer. Only the year-to-year variability trend seems to be reliable.

\textsuperscript{11} Christensen et al., 2007
II.2.3.4 Expected climate changes in the dry tropical and moist tropical regions

Overall, the upward trend in temperatures in these regions is moderate compared to other regions of Africa (probably 3°C). This increase is not expected to vary much from season to season and the continental regions would be more affected than the coastal regions. An increase in precipitation is predicted for 18 of the 21 models over the regions of eastern African and the Horn of Africa.

II.2.3.5 Expected climate changes in the equatorial region

This is the region of Africa where the rise in temperature will be the most moderate (probably between 2.5°C and 3°C); it will be uniform from season to season and more pronounced in the continental regions than in the coastal regions. The cumulative average annual precipitation for the region should not change significantly. The same holds true for the seasons, where few significant changes are expected.

II.2.3.6 Climate of the African islands (excluding Madagascar)

By virtue of their geographic distribution and their remoteness, these islands enjoy relatively different climates, with one constant factor, however: the marine influence.

Thus, for the Comoros and the Seychelles, a moderate rise in temperature is expected (on the order of 2.5 °C), which will be tempered by the sea’s proximity. With regard to precipitation, few changes are expected.

The Cape verde Islands have a Sahelian maritime climate. Like the Sahelian region, the expected change will be difficult to estimate for such a small region.

Located in the middle of the Gulf of Guinea on the Equator, the islands Sao Tomé and Príncipe will experience moderate increases in temperature (on the order of 2.5 °C), which will also be tempered by the sea’s proximity.

In fact, rather than the rise in temperatures or even the precipitation patterns, the rise in the sea level is the main risk for all the African islands.

* * *

In conclusion, Africa’s climate will experience significant changes over the years to come, with much higher average temperatures, more frequent extreme weather events, and often, the likelihood of more
droughts. At this point, the biggest problem is predicting the changes to expect on a fine enough scale so that appropriate adaptation actions can be planned. The long-term trends are also very uncertain. That said, most of the models converge with regard to the short-term forecasts and if they are used prudently, they can provide sufficient scientific information for decision makers.
II.3. INTERNATIONAL NEGOTIATIONS ON CLIMATE CHANGE AND THE ISSUES FOR AGRICULTURE

During the first World Climate Conference held in Geneva in February 1979, the international science community for the first time warned governments about climate changes caused by human activities. In 1988, the IPCC was created in order to provide a synthesis of knowledge about climate. Governments also mobilized with the Hague Declaration on the Environment in May 1989 in which 24 heads of State and government made a commitment to fight to prevent the greenhouse effect from worsening. In November 1990, 137 countries as well as the European Community, confirmed their concern about climate change during the second World Climate Conference and drew up the guidelines for the future United Nations Framework Convention on Climate Change (UNFCCC), adopted in Rio in 1992. In 1997, the international climate negotiations culminated with the adoption of the Kyoto Protocol, setting the estimated commitments for reducing GHG emissions. Negotiations then continued with a view to a post-Kyoto international agreement. This was one of the major issues of the Copenhagen Summit in December 2009, which did not fulfil its mandate on this very important aspect.

II.3.1 The international framework

II.3.1.1 Introduction of the UNFCCC

Signed by more than 180 countries, the UNFCCC went into effect in 1994. Its ultimate objective was the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. Responsibilities are shared by all countries, with objectives varying depending upon the group they belong to:

- Annex I parties: These are primarily developed countries, among which the 24 most developed countries must, in addition to their objectives, support the efforts of the LDCs;
- Non-Annex I parties: These are primarily the LDCs.

All signatories are committed to completing national inventories of GHGs and climate change mitigation programs. Only Annex I countries undertake to reduce their GHG emissions. However, the UNFCCC is a general framework and is not legally binding.

II.3.1.2 The Kyoto Protocol

The Kyoto Protocol was adopted in 1997 and became effective in 2005. Signed by more than 150 countries, it is legally binding and sets estimated objectives for reducing GHG emissions between 2008 and 2012 for Annex I countries. The protocol also determined the Clean Development Mechanism (CDM) among other things, which enables Parties to Annex I to obtain carbon credits by investing in projects for reducing emissions produced in emerging and developing countries that are signatories to the Kyoto Protocol. Concluding an international agreement concerning the countries’ commitment for the following periods seemed necessary in order to prevent a legal vacuum and political loss of interest after 2012.

---

14 List of Annex I countries: http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php
15 List of non-Annex I countries: http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php
II.3.1.3 The Bali Action Plan (COP13, December 2007)

This action plan was established in order to make a post-Kyoto agreement possible during the 15th COP in 2009. It defines five building blocks (a shared vision, mitigation of climate change, adaptation to the effects of climate change, development and transfer of technology, funding mitigation and adaptation actions), which still structure the negotiations. With regard to developing countries, this is progress in that it allows integration of actions undertaken by them to help mitigate climate change.

II.3.1.4 Poznán: One step on the Copenhagen road (COP14 - December 2008)

The 14th Conference of the Parties at the UNFCCC in Poznán in December 2008 ended with:

- Creation of a fund for adaptation projects in developing countries particularly vulnerable to climate change;
- An agreement on a certain number of improvements to be made to the Clean Development Mechanism (CDM) (environmental integrity, transparency, quality of the auditors’ work);
- A technology transfer program for developing countries adopted and funded from existing resources of the Global Environment Facility (GEF).

II.3.2 The negotiation process since Copenhagen

The much-awaited Copenhagen summit in the end did not enable the Parties to agree how to proceed post-2012. According the France’s ministry of energy, the ecology, sustainable development and the sea, the final Copenhagen agreement is a political agreement marking a collective awareness at the highest level which provides essential arbitration and is a starting point for framing all countries’ actions for combating climate change and solidarity with the countries most vulnerable to its effects16. In the absence of a binding post-Kyoto agreement, the major issues of the Copenhagen negotiations still remain.

II.3.2.1 The major issues

Four main types of issues for the negotiations can be distinguished at this time.

Environmental issues

The environmental issues related to climate change pertain as much to the management of natural resources and the impacts of climate change as to the combination of the effects of climate change with other environmental challenges (desertification, loss of biodiversity), or with difficult socio-economic conditions and poor adaptation capacities.

Political issues

While the negotiation process is getting nowhere in achieving an agreement for a new treaty, the real question is to know the extent to which this new treaty will be viable, will unify all the partners and be up to the task of making it possible to limit the average increase of Earth’s temperatures. This will require seeing that the following major political issues are taken into consideration:

- A new fair and equitable treaty among all the countries.
- A new, unifying treaty, involving all partners (countries, civil society, private sector, NGOs, local communities) in its development and implementation.
- A new treaty including the commitments for the new emerging economic powers (China, India, Brazil, Russia, etc.), which are major GHG emitters.

Social issues

Climate change is a challenge for all humanity in the medium and long terms. Only new social models that are not based solely on economic gain, are less energy-hungry and more directed toward sustainability will be able to deal with climate change.

Development issues

Climate change has a direct impact on all economic and social sectors of African countries (OECD, 2005). Thus, taking these phenomena into account in the design of development related programs, projects and policies is crucial for the resilience of the actions taken in the face of changes and the profitability of donor agencies’ investments.

These viewpoints are in agreement with the NECTAR project vision for a new development model for Africa built around:

- Compliance on the part of populations through increased awareness about the risks related to climate change in Africa and the need to adapt immediately;
- Transfer of technology suited to the situation of each country in Africa;
- A cultural approach based on using local know-how.

II.3.2.2 Main focuses of current negotiations

These issues can be synthesized around five focuses going back to the Bali Road Map:

**Shared vision**

This vision is built around an objective to reduce GHG emissions, which first affects Annex I countries, but emerging countries as well. In order to limit global warming to 2°C by 2100 (objective recommended by the IPCC), the issue is to agree on the pace for reducing world emissions (50% or 80% compared to 1990 levels).

**Mitigation**

Mitigation of GHG emissions was the key component of the Kyoto Protocol and most likely will remain so post-Kyoto. The issue here is a compromise between the commitments of developed countries and an equitable “commitment” from emerging countries that are major GHG emitters, combined with a voluntary contribution from developing countries.

From the technical perspective, the discussions will mainly pertain to:

- Establishing commitments or measurable, reportable and verifiable actions by all developed countries, by assuring comparability of efforts among these countries;
- Actions by developing countries, supported by transfers of technology and funding;
- The integration of Land-Use Change and Forestry in the world mitigation effort;
- Openness to cooperative sectoral approaches.

Africa’s incentive would be:

- To promote achieving an ambitious objective in terms of reducing GHG emissions which will limit the impacts of climate change on the continent;
- To negotiate its support to the developed countries in exchange for support for CDM and adaptation funding.

**Adaptation**

All developing countries, and especially the African countries, are trying to give adaptation to climate change more of the emphasis it deserves, considering how important it is for natural resource-dependent activities, like agriculture.

It should be noted that there are differences of opinion regarding the very definition of adaptation, which could encompass environmental and development issues. A combination of adaptation to

---

17 OECD, 2005. *Bridge Over Troubled Waters: Linking Climate Change and Development*

18 In its Adaptation Policy Framework which appeared in 2006, the UNDP defined adaptation as “[translation] a process whereby strategies are improved, developed and implemented in order to moderate the effects of climate change, cope with them and benefit from them”.

In its 4th report, the IPCC defines adaptation as being “[translation] the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. A number of types of adaptation are identified: anticipatory and reactive, private and public, independent and planned. By way of example, we cite the construction of dikes along streams or coastlines and the replacement of fragile plants with species resistant to temperature shock.
climate change and development could prejudice funding for adaptation. It would also be useful to develop a standardized methodology making it possible to define a concept similar to the baseline for CDM projects, an estimate of additional costs caused by the effects of climate change, and a follow-up and audit.

At the institutional level, an entity for national adaptation planning could be created following the example of the Designated National Authority, responsible for coordinating CDM activities.

Finally, the National Adaptation Programmes of Action (NAPA) put in place by many countries and which establish adaptation priorities for each country, require updating, or indeed, revision using the appropriate methodologies. Their funding is also an important matter.

Transfer of technology
This aspect is the core element of post-Kyoto negotiations. Five categories of activity may facilitate the transfer of clean technologies to developing countries. These are:

- Assessment of technological needs;
- The exchange of information on technologies;
- Creation of an environment conducive to the transfer of technologies, particularly toward developing countries and countries in the process of economic transition;
- Capacity building;
- Setting up the mechanisms for the transfer of technologies.

Funding for creating a framework for the transfer of technologies could come mainly from the GEF through the Special Climate Change Fund.

The transfer of technologies raises questions of funding and intellectual property. Sustained North-South, South-South and “triangular” cooperation, for example, is envisioned by the parties. This cooperation could occur through closer networking of regional and national “centres of excellence” or sharing technology road maps. Finally, certain institutions, such as the United Nations Development Programme (UNDP) place particular importance on capacity building as a means for enhancing and perpetuating the transfer of technology.

II.3.3 The issues related to agriculture

Issues specific to the agriculture sector, forestry and land use are integrated into the current negotiation process. This stems from this sector’s significant GHG emissions, its absorption capacity and carbon inventory, as well as its economic and social importance for developing countries. To describe these issues, we are using the recent FAO report.

II.3.3.1 Agriculture: Major potential for the reduction of GHG emissions

http://unfccc.int/ttclear/jsp/Forum.jsp

20 The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights affecting trade negotiated during the Uruguay cycle from 1986 to 1994 (article 66:2), sets out that the governments of developed countries must offer incentives to their companies to promote the transfer of technology to the least developed countries. Having this agreement implemented has been a struggle, as observed by developing countries during the Doha cycle, November 9-13, 2001. Thus, the TRIPS-Council Board Decision of February 19, 2003 on the implementation of article 66.2 of the Agreement on Trade-Related Aspects of Intellectual Property Rights attempted to remedy this by asking the developed countries to provide annual reports on the measures they have taken or plan to take pursuant to their commitments under article 66:2.

21 FAO: “Anchoring Agriculture Within a Copenhagen Agreement” Briefing document for the parties at the UNFCCC, 2009.
Agriculture contributes 14% of the world’s GHG. Moreover, these emissions are rapidly increasing. Major potential exists (on the order of 74%) for mitigating GHG emissions in the agriculture sector in developing countries.

This potential offers a unique opportunity to African countries, especially those whose economy is dominated by extensive agriculture, to play a significant role in the world effort to mitigate climate change, take ownership of a new treaty on the climate and work toward a unifying treaty.

II.3.3.2 Can agriculture be better integrated under the CDM?

The rapid growth in the number of CDM projects and the volume of certified emission reductions (CER) exchanged testifies to this mechanism’s success over the first few years of the carbon market’s operation. Nonetheless, adjustments to the mechanism are being considered for accessing undeveloped pools of emissions reductions in certain sectors or small projects presenting with significant transactional unit costs, through “programmatic” approaches in particular. While awaiting the outcomes of these negotiations, the post-2012 carbon market suffers from a lack of visibility that hampers the development of new CDM projects.

The Clean Development Mechanism in Africa

Africa is considerably behind in implementing CDM projects. A number of gaps are the cause of this delay in Africa, the most significant of which pertain to:

1. The structure of African countries’ economy. These economies are primarily rural with traditional farming practices that are not of a nature to generate large CDM projects that are economically competitive with those of China and India, for example;
2. African countries’ limited capacities in terms of CDM project development and ability to shoulder transaction costs.

Africa is therefore called upon to take a firm position regarding two points in particular:

3. A geographically equitable distribution of CDM projects;
4. The profitability and grading of CDM projects must not be measured solely in economic terms but also by taking into account the environmental services rendered.

Agriculture in the CDM

Agriculture and afforestation/reforestation are two of the 15 fields of CDM activities. But the exclusion of activities related to “carbon trapping by the soil” in the agriculture sector has greatly reduced the sector’s options for contributing to reducing GHG emissions.

Agricultural products that are CDM candidates come up against obstacles at the national level:

- Inadequate public awareness and information, particularly information that has been confirmed locally on the economic, social and environmental benefits of this type of project or their advantages over traditional activities;
- A lack of capacity to develop and implement CDM projects;
- Institutional and political limitations. The government organizations responsible for agriculture are barely beginning to contemplate using the CDM. Some NGOs are against it.

Obstacles at the international level are also encountered:

- In its current version, the CDM does not offer farmers adequate incentives;
- The investors are not demonstrating tangible interest in investing in CDM projects, notably due to the high transaction costs;
- Investors prefer to deal with a single partner, at the expense of small operators as part of a group program.

Furthermore, two approaches seem to emerge from current negotiations on the CDM:

- A sectoral approach23, begun by the International Energy Agency (IEA)24 proposing four main types: i) Global action; ii) A global agreement with targets; iii) National policies and measures; and iv) sectoral credit mechanisms;

- A non-binding approach based on negotiation between Annex I Parties and Non-Annex I parties for reduction targets. This approach requires binding audit procedures. A number of countries feel that this approach is too lax and has limited enforceability.

**Perspectives**
Obstacles related to investors and market mechanisms are governed by an economic logic that is difficult to overcome. Thus, the African countries should negotiate a consensus based on political considerations:
- The assurance of the political support of the most committed developed countries (countries of the European Union, Scandinavia) in exchange for Africa’s political support on other matters;
- Emphasis on the need for a new treaty unifying all the parties through the active participation of African farmers.

From a technical perspective, the following arguments should be highlighted:
- Support to a sectoral approach likely to minimize the differences between the sectors;
- Extending the area of CDM agriculture sector activity to soil carbon sequestration;
- Developing/testing suitable methodologies for this new technical aspect.

**II.3.3.3 Integration of agriculture in NAMAs in developing countries**
The developing countries that are parties to the UNFCCC can contribute to enhanced action on mitigation by taking nationally appropriate mitigation actions (NAMA). These measures should be driven by the countries, voluntarily taken, taking into account the priority needs of sustainable development and eradication of poverty, and should be determined and fine-tuned at the national level. NAMAs would be supported and made possible by technologies, funding and capacity building. They would be implemented in a way that was measurable, reportable and verifiable, as would be the corresponding support measures.

NAMAs are therefore a significant niche through which developing countries could contribute in a nationally appropriate way to the world’s mitigation efforts. Agriculture will have to play a very important role in developing countries’ mitigation strategies and the development of NAMAs.

On the basis of the high investment and transaction costs of agricultural mitigation projects, it is relevant to promote gradual approaches, first emphasizing capacity building and the development of national strategies that could make it possible to transition toward low-emission sustainable development systems.

---

23 The sectoral approach is based on either agreements between producers of a manufacturing sector (e.g., steel, aluminium, cement, automobiles) or the policies adopted individually by a country with a view to limiting the emissions from a sector of its national economy (electricity, manufacturing, transportation, building, agriculture, etc.)
II.3.3.4 Developing REDD projects, supporting an REDD-plus process?

The purpose of the REDD program is to equalize the economic balance in favour of the sustainable management of forests so that their economic, environmental and social products and services benefit the forests’ countries, communities and users while also helping to significantly reduce GHG emissions. The UN-REDD program (UN-Reduced Emissions from Deforestation and Forest Degradation Programme) supports the volunteer countries for inclusion of the REDD in a post-2012 United Nations climate agreement. The Copenhagen Accord, moreover, is already heading in this direction.

Consideration is also being given to expanding the REDD system to an REDD-plus system, i.e. an expanded system that would include agriculture and other land uses (AFOLU).

The continent is divided on what the REDD system should mean. There is reason to fear that Africa’s fragmented position reduces its weight in the negotiation process on this topic. In addition, in the event that Africa reaches a consensus in favour of an REDD-plus procedure, a political decision will be necessary to develop the methodological aspects that are the only guarantors of its effective implementation.

II.3.4 Funding adaptation and mitigation

Adaptation activities demand investments and cash flows that are in addition to Official Development Assistance (ODA). It is estimated that developing countries would require a 15% increase in investments and flow of funds devoted to this sector in a climate change scenario (FAO, 2008). Some estimates give an idea of the amounts at stake:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Estimate of annual funding need</th>
</tr>
</thead>
</table>
| Adaptation | Oxfam 2010: At least $US 100 billion\(^{26}\)  
UNDP 2007: $US 86 billion from now until 2015  
UNFCCC 2007: $US 28-67 billion from now until 2030 |
| Mitigation | UNFCCC 2007: An additional $US 176 billion from now until 2030  
Oxfam 2010: At least $US 100 billion |

Many programs and funds have been, or will be, created at the initiative of various organizations. All these initiatives’ objectives and actions may overlap but this mobilization of international development stakeholders is encouraging, even if the expected funding levels still have a long way to go. It is strategic for developing countries to be well aware of the opportunities they offer.

International post-2012 negotiations will be especially involved in these aspects and the countries active in this area. For the time being, nothing has changed in terms of developing a funding architecture for adaptation to climate change, reducing GHG emissions and technology transfer. It should be noted that a single fund runs the risk of seeing a large portion of its resources used for the mitigation of GHG emissions to the detriment of adaptation and transfer of technology. Beside the multiplicity of multilateral funding sources, bilateral funding remains an important option.

Developing countries’ problems in access to funding
Developing countries’ and poor populations’ access to these funds is, actually, limited. Therefore, a number of priority areas should be considered:

- Establishing a link between adaptation and mitigation, through the creation of “top quality carbon credits”, i.e. those resulting from programs making it possible to sequester carbon while also fostering adaptation. The higher price of these credits could considerably increase the flow of funds for agriculture’s adaptation.
- Clustering small projects to make them profitable and attractive for carbon credit buyers.

II.3.5 Integration of agriculture in negotiations

With a view to integrating the issues related to agriculture in a future agreement on climate, the FAO has put forward some proposals that we will take up below:

1/ Including agriculture in developing countries’ NAMAs
Many agricultural management practices and some types of agricultural land use may be priority candidates for inclusion in NAMAs due to their many benefits.

2/ Providing the funding for agricultural mitigation
- Expand the scope of the CDM so that potential sequestering of above- and below-ground carbon can be carried out. AFOLU activities could include: REDD, sustainable management of forests, restoration of wetlands, sustainable management of farmland and hay and pasture crops, as well as other sustainable uses of the soil.
- Establish new funding mechanisms using expanded, more flexible approaches that integrate various funding sources and innovative programs for payment/incentives/execution making it possible to reach the producers, including small owners.
- The importance of R&D and incentives for agricultural mitigation is fully recognized but may have to be properly reflected in the sections of the negotiations text devoted to mitigation and funding.

3/ Heading toward a global approach to land management
The transition toward a global approach to all land uses could foster the management of synergies, mutual benefits and the leaks that occur in the mitigation of GHGs from land and sink sources.

Annex 2 in the complete French version of the report provides a table summarizing the major negotiation issues for Africa and its agriculture, and the positions that the continent could support.
II.4. CONCLUSION

This second part presents a synthesis of the climate change situation in Africa. Though the changes to be expected on the continent are very significant, and in some regions, troubling, Africa’s own contribution to greenhouse gas emissions is very limited and the continent is therefore primarily a victim of this phenomenon.

That said, the evolution of Africa’s emissions presents some risks that should be prevented and some potential to be developed. Risks, because the continent’s economic development – which is desirable – will produce strong growth in the demand for energy; because the growing population and its even limited wealth will considerably increase food needs and therefore cause agricultural production to intensify and increase, with its attendant consequences (rise in N₂O emissions through greater use of fertilizers, CH₄ emissions from increased livestock production, expansion of agricultural zones through deforestation, etc.). Potential, because many areas in Africa are, or may become, important carbon sinks thanks to the possible production of considerable biomass in these regions.

On the one hand, GHG emission mitigation measures should be designed and disseminated that are suited to each region and each sector, without however, limiting their development; on the other hand, the wooded areas and dense forests’ potential for mitigation should be developed. Therefore, a major issue in the present negotiations is to include in the post-2012 agreement a carbon sink improvement system, not only for non-deforestation but also for mixed terrain areas. This would offer the dual benefit of contributing to the carbon stock and fostering the reconstitution of degraded ecosystems and soil; in other words, a very effective mitigation/adaptation measure.

The main issue for Africa, however, remains funding for adaptation to climate change. In the face of enormous development, infrastructure, education and research needs – not only for the agriculture sector but for every other sector of the economy – the international community will have to be pushed to their limits so that it makes financial commitments worthy of the stakes. Part 3 will present in greater detail the main courses of action for development of the agriculture sector in Africa, as well as the priorities with regard to climate change.
PART 3

Effects of Climate Change on Agriculture and Recommendations for Adaptation and Development

Bearing in mind the various climate scenarios published for each region of Africa, and the countries’ various degrees of susceptibility and capacity to adapt, it is very difficult to predict the impacts the resulting new conditions and extreme events may have on Africa’s farming systems. However, it is clear that climate change will make the challenges agriculture is faced with even greater. The possible negative impacts include land degradation and soil erosion, changes in the availability of water, losses of biodiversity, more frequent attacks of disease and pests, as well as natural disasters which will have varying effects on farming systems depending on their vulnerability, ability to adapt and resilience.

Long-term agricultural productivity and food security will very likely be affected by climate change, while world food production will have to double over the next 30 years to feed the planet’s growing population.

This last part will therefore first present the expected effects of climate change on the various African farming systems. Bearing in mind the uncertainties of climate scenarios at the sub-regional and local levels, and the very different farming situations, this exercise is very difficult and can only be quite general. We will thus strive to present the major trends highlighted in the literature, illustrated by specific examples.

The second section is devoted to adaptation strategies that can be developed in each of the farming systems in order to deal with the expected impacts. For the same reasons, it is impossible to provide ready-made “recipes” and each local situation will require the formulation of its own relevant and effective adaptation strategies.

The last section will propose a certain number of exemplary actions for mitigation, adaptation and agricultural development with an overall objective of food security, economic and social development and environmental protection.
III.1. EFFECTS OF CLIMATE CHANGE ON AFRICAN AGRICULTURE

III.1.1 Effects of climate change and the increase in CO₂ concentrations on plant production

The effects of the main cause of climate change – i.e., the atmospheric concentration of CO₂ – will be considered here.

III.1.1.1 The effect of atmospheric CO₂

As a matter of fact, atmospheric CO₂ is expected to double in the next 50 years. Because CO₂ stimulates photosynthesis, the increase will have an a priori beneficial effect on plant growth. Increased biomass and the resulting production vary depending on the plants. Cereal grain yields would be likely to rise considerably. The rise in the atmosphere’s CO₂ content causes a greater stomatic closure, which limits the transpiration rate. The consumption of water is reduced as a result, which is particularly important when considering that climate change is likely to cause aridification of certain climates.

III.1.1.2 Effect of temperature and the availability of water

Achieving this photosynthesis potential will greatly depend on climatic variables. The increase in temperatures has an overall positive effect on biomass production, particularly in temperate and mountainous zones. In tropical zones, this effect will probably be negative as there is a strong chance that the ideal temperature for photosynthesis will be exceeded. Other physiological functions, such as corn pollen viability, are also less effective beyond certain temperatures. On the other hand, higher temperatures will accelerate crop development, which will translate into shorter growing cycles but an overall increase in water needs. Hydric supply is therefore a component that will determine how crops and grazing land respond to changes in conditions caused by increased CO₂ concentrations and warmer temperatures; however, precipitation is the area where uncertainties are greatest. So, it is very difficult at this time to determine at the local level if climate changes will cause an increase or a decrease in biomass and crop yields.

III.1.2 Impacts on agriculture and farmers’ life systems

According to the FAO\textsuperscript{27}, the main climate changes that have to be expected could affect the agriculture, forestry and fishing sectors as follows:

<table>
<thead>
<tr>
<th>Phenomenon and trend in weather events</th>
<th>Possible impacts on agriculture, forests, fishing and ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer and milder cold nights; more warm days and nights in most regions (statement qualified with “nearly certain” by the IPCC)</td>
<td>Increased yields in the coldest zones; lower yields in the warmest zones; greater pressure from insects</td>
</tr>
<tr>
<td>More frequent warm period periods and heat waves over most regions (“very likely”)</td>
<td>Smaller yields in the warmest regions due to excessive heat; greater danger of brush fires</td>
</tr>
<tr>
<td>More frequent occurrence of heavy precipitation events in most regions (“very likely”)</td>
<td>Crop damage; erosion, soil rendered uncultivable due to excessive moisture</td>
</tr>
<tr>
<td>Greater area affected by droughts (“probably”)</td>
<td>Soil degradation and erosion; smaller yields for crops affected; greater losses of livestock; greater risk of brush fires; loss of arable land</td>
</tr>
<tr>
<td>Increased intense tropical cyclone activity</td>
<td>Crop damage; trees uprooted; damage to coral</td>
</tr>
</tbody>
</table>

\textsuperscript{27} FAO, Conference June 3-5, 2008: Climate change adaptation and mitigation in the food and agriculture sector
Greater incidence of very high tides, not counting tsunamis (“probably”) & Salinization of irrigation water and fresh water; loss of arable land and increased migrations

*From IPCC research, 2007*  
*Source: FAO, 2008*

Uncertainties are great on the continental scale and even more so on regional scales, where climate models are highly ineffective and very divergent. The impacts of climate change depend not only on the magnitude and duration of the expected changes but also on these systems’ vulnerability and their capacity for adaptation to the changes.

**Vulnerability to climate change**

A system’s vulnerability is defined as its susceptibility to adverse changes. Ecosystem vulnerability studies show that ecosystems in semi-arid zones most likely have greater ability to adapt than forests in moist tropical and equatorial zones. Ecosystem resilience – i.e., the ability to regain its initial state after a more or less extended stress – is also a major aspect to be considered. Ecosystem vulnerability depends as well on the initial condition.

Social vulnerability is also crucial and is affected by a complex set of social, economic, political, technological and institutional factors.

Overall, Africa is considered particularly vulnerable to climate change for the following reasons:

1. African economies are highly natural resource-dependent (see Part 1) and their farming systems are highly dependent on natural conditions;
2. The demographic structure of the African countries has a high ratio of non-working individuals (who are most sensitive to climate) to the economically active population (see Chapter 1). Certain diseases (particularly HIV/AIDS) have a major impact on the economically active population’s resilience.
3. Poverty – in all its forms, is a critical factor of social vulnerability.
4. Institutional instability and governance problems weaken the economic and social abilities of populations to react to major climate events.
5. The weakness of Africa’s government infrastructures further increases countries’ vulnerability by limiting the circulation of people, goods, services and information.
6. Chances are that the climate changes expected on the continent will be greater than in other regions.
Adaptation is considered a natural or human system’s ability to adjust to present and future changes in such way as to benefit from them, be able to tolerate them or limit their negative effects. Spontaneous adaptation, which is first and foremost a reaction to ecosystems’ and human systems’ new conditions, can be distinguished from planned adaptation, which is the result of a conscious decision in the face of changes in climate conditions and their impact.

### III.1.3 Spontaneous adaptation

The farmers did not wait for the international negotiations to adapt to climate changes. The Sahel’s case is exemplary in this regard as the region experienced major droughts in the 70s and 80s that caused a certain amount of desertification. Many studies have shown a “regreening of the Sahel” today. Though this went along with an upward trend in precipitation starting in the mid-80s, it is clear that it is also related to man’s actions to adapt to the demographic, economic and climate conditions.

### III.1.3.2 Planned adaptation

However, chances are that the looming changes will be fast, intense and random and it will be increasingly difficult for the already economically vulnerable farmers to adapt appropriately by themselves. Therefore, assistance with the adaptation process is advisable.

Many studies deal with the agriculture sector’s adaptation to climate change but they often settle for providing very vague recommendations on a continental scale due to the uncertainty regarding the effects of climate change. The dominant trend is to plan for an exacerbation of existing problems even though there is nothing that makes it possible to make that statement.

### National Adaptation Programmes of Action (NAPA)

Most of the least developed countries (LDC), including a good number of African countries, have prepared National Adaptation Programmes of Action (NAPA), including some projects dealing with improving the resilience of the agriculture sector. NAPAs are an interesting starting point but often remain generous and of limited quality. They are paths to be explored for determining the strategies, methods and practices that are best suited to the regional farming systems, thanks to relevant institutional organization, qualified personnel and adequate technical support.

In the Sudanese-Sahelian zone, for farm production, NAPAs give priority to irrigation, development/distribution of better-suited varieties, the use of inputs and support to grain stocks. With regard to livestock production, the priorities go to projects for protecting grazing regions and fodder production/storage. In a number of countries, support to developing fish farming projects is also a priority. This development may provide the populations with a substantial source of protein.

The main farming systems affected are:

- Agropastoral systems that are uncultivated for short periods and based on millet and sorghum;
- Mixed cereal grain-root crop systems;
- Pastoral and nomadic livestock production systems;
- Flooded rice production systems.

Improvements to weather information and crisis prevention systems are also an important demand of the countries in this zone.

---


29 The floods in 2007 in the Sahel show the complexity of the phenomena to be taken into account.

30 UNFCCC, National Adaptation Programmes of Action, Summary of Projects on Food Security identified in Submitted NAPA as of September 2008
In countries in moist savannah and tropical forest zones, where “pioneering front arboriculture agriculture,” “root crops” and “mixed grain-root crop” farming systems are prevalent, the main priority urgent actions identified in NAPAs are:

- Diversification of farm productions;
- Intensification, development of irrigation and restoration of hydro-agricultural infrastructure, in particular for rice production;
- Improvement and dissemination of more suitable seeds;
- Intensification of livestock production (small ruminant, short cycle animals);
- Establishing early warning, weather and food security systems.

In the semi-desert and dry savannah zones of eastern Africa (pastoral and nomadic livestock production systems), where livestock production has a predominant place, the countries affected have recommended projects for improving livestock production and grazing land management first.

Finally, during climate negotiations, it is important for African countries to make sure that NAPA procedures are simple and flexible enough to facilitate the eligibility of their projects, accelerate their funding and do everything possible to prevent red tape (see Annex 3 of the complete report in French).

Other planned adaptation initiatives
For their part, non-LDC countries (that do not have NAPAs) have for the most part formulated sectoral adaptation strategies, either on the national scale (e.g., like in the Maghreb and South Africa) or on the regional scale (African and Mediterranean regions).

III.1.4 Findings on the effects of climate change and adaptation
As shown in Part 1, the situation of African agriculture poses many challenges and will have to deal with growing needs related to demographics. In addition, the agriculture sector will still have a role as a driving force in the development of African countries. Chances are good that this already-critical situation will worsen with the consequences of global warming, which will be all the more significant because most of the countries are extremely vulnerable due to their social and economic structures.

It is impossible to handle agriculture’s adaptation to climate change independently from agriculture’s overall issues. That is why in the next section we will give an overview of the development prospects for agriculture in Africa in the context of climate change, including all the challenges it faces.
III.2. PROSPECTS FOR AGRICULTURAL DEVELOPMENT IN AFRICA IN THE CONTEXT OF CLIMATE CHANGE

Before trying to see how agriculture can face all these challenges, we will analyze a certain number of “non-agricultural” adaptation options, including:

- Migration of populations,
- Development of non-agricultural rural activities,
- Rising food imports.

**III.2.1 Non-agricultural alternatives**

**III.2.1.1 Migrations**

In addition to seasonal migrations and permanent migrations toward the cities, the spatial redistributions of populations between rural zones in search of jobs or land, are part of the commonly adopted strategies, particularly in sub-Saharan Africa. These migratory phenomena are most often spontaneous but may be encouraged by the government authorities (development policies). They are greatly constrained by national borders, particularly when host countries begin to face an economic crisis or depletion of land resources. Therefore, the capacity for these displacements of population must not be overestimated as a genuine remedy to food and employment problems.

International migrations are but a very small portion of migrations (cf. Part 1).

**III.2.1.2 Development of non-agricultural rural activities**

The development of non-agricultural activities historically accompanies the development of agriculture in many countries. The FAO’s Rural Income Generating Activities (RIGA) study showed that non-agricultural rural activities in sub-Saharan Africa are mainly complementary to agricultural activities (20% to 40% of household income) in periods where agricultural activities are few.

However, development of the non-agriculture sector in Africa is closely correlated to development of the agriculture sector itself31 (supply of inputs or support services to farmers, development of agri-food industries downstream, the crafts, health, education, etc.). The risk is therefore great that if the agriculture sector develops insufficiently and farmers’ incomes are low, the non-agricultural rural sector will not be very productive.

Rural activities that are not related to farming or services to farming populations are often small businesses, especially in sub-Saharan Africa. Diversification toward manufacturing or industrial activities is limited by:

- Precarious and intermittent wages worsened by labour legislation that is either missing or ignored;
- Little occupational training for trades practiced in the rural setting and weaker skill levels and human capital than in urban settings;
- A weak local market, related to low-density population and limited purchasing power;
- Weak economic fabric often related to a shortage of infrastructure (roads, access to energy, etc.) making rural space unattractive;
- Farming’s dependency on the workforce’s seasonal availability.

**III.2.1.3 Imported food products**

Many African countries fill the gap between their food needs and national production through an import strategy. However, though this strategy may have appeared relevant in the 60s and 70s, it lost its effectiveness during the 80s. Due to the growing population, the costs of food imports rose while

---

receipts from exports plummeted (see Part 1)\(^{32}\). The 2008 food crisis, linked to the rise in the cost of agricultural products, showed the danger of dependency on imports. Faced with the ensuing “hunger riots”, many governments and international organizations acknowledged the importance of government agriculture policies for ensuring their food sovereignty.

**III.2.2 African agriculture production potentials**

Certain discourses deem the growth of Africa’s population in the coming decades to be the cause for the rise in poverty and the degradation of natural resources (Figure 1).

*Figure 1: Illustration of the theory mechanically tying population growth and rising poverty*

However, the capacity to maintain a strong farming population is not determined by natural elements but first and foremost determined by the social systems and methods that make it possible to develop the various ecosystems. Faced with the growing population in a given region, two major types of strategy are possible and are examined below: increasing the cultivated areas and increasing production per unit area.

**III.2.3 Available land resources for expanding farming areas**

Rural societies tend to accommodate a rise in population by expanding the areas cultivated. This strategy makes it possible to maintain good labour productivity and is not synonymous with degradation of the environment so long as the natural resources are sufficient to allow reproduction of the system. Beyond the threshold of 20 inhabitants per square kilometre\(^{33}\), there is the risk of decreased land and labour productivity that can lead to soil degradation and poverty.

South America and Africa have the greatest reserves of arable land. The areas currently cultivated are barely 20% of the arable land\(^{34}\). Climate change will cause certain changes in the agricultural potential of the land, particularly with regard to soil moisture. Virtually every model predicts that the total area of arable land will diminish. Despite everything, expansion potential remains very great (Graph 3).

---

\(^{32}\) Among the factors that may explain the persistence of the policies, we can cite urban bias on the part of government concerned about providing the poor in the cities inexpensive food in order to prevent social problems. But it must also be taken into account that import duties are a major source of income for States and that in a context of decreasing public resources, there is interest in maintaining an import/export system rather than favouring local production.


However, the available land is not uniformly distributed on the continent. Comparison of the anticipated population growth and the available areas show:
1. Countries with no more available land for increasing rain-fed farming areas: these are countries located around the Mediterranean and the densely populated countries of central Africa;
2. Countries with insufficient available areas to deal with the rise in food needs: nearly all the countries in western Africa and a few in eastern Africa;
3. Countries whose areas make it possible to approximately meet the rise in food needs;
4. Countries not having enough land for rain-fed farming, but that could increase their irrigated areas: Algeria, Libya, Somalia and Mauritania;
5. Countries that can meet the demand for food, provided forest ecosystems are cultivated (Liberia and Democratic Republic of Congo);
6. Countries having sufficient land to deal with the increased demand.

III.2.4 Land and environmental limits to the expansion of agricultural areas

The expansion of cultivated land in Africa is not done on virgin land. In most cases, land use is modified, sometimes implemented by different social groups that can have simultaneous economic, social (conflicts between livestock producers and farmers) and environmental (threat to soil fertility) impacts.

In cases where expansion of crops is not done at the expense of other agricultural systems, there is nonetheless the risk that significant modifications are made, like, for example, reducing the length of time land lies fallow due to demographic pressure, endangering reproduction of fertility or cultivating marginal land, which can lead to gradual desertification.

The extension of cultivated areas obviously also poses land problems. Ownership and use rights often overlap on the same parcel and increasingly dense populations translate into growing tension and competition over land, particularly between natives and migrants.

The table below gives a synthesis of the expansion options for the various farming systems described previously.
Table 5: Potentials and limits for expansion of the various farming systems

<table>
<thead>
<tr>
<th>Biome</th>
<th>Capacity for expansion of farming systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical forest</td>
<td>The pioneering front arboriculture agriculture system has high population density (34 inhab./km²). In many countries, the options for expansion are limited as there is no more forest to clear. However, pioneering front agriculture can expand to the detriment of slash-and-burn dense forest systems which still occupy sparsely populated areas (11 inhab./km²). The forest ecosystems that host these slash and burn systems would then lose a large portion of their ecological functions.</td>
</tr>
<tr>
<td>Highlands, mountains</td>
<td>These are the continent’s most densely populated areas, with densities reaching averages of 60 to 90 inhab./km². The agricultural areas are small and the options for expansion a nearly nil. Increasing production must be by means of intensification of the existing systems, which are already very intensive.</td>
</tr>
<tr>
<td>Moist savannah</td>
<td>Moist savannas have relatively low-density populations (between 15 and 20 inhab./km²) compared to their productive potential. The potential for growth for agricultural systems is significant and can be greatly accelerated if the areas can be freed of endemic diseases, which limit the options for animal-draught power.</td>
</tr>
<tr>
<td>Dry savannah</td>
<td>Dry savannah populations are already dense (17 to 24 inhab./km²) if we consider the climate’s aridity and the quality of land available. Expanding the cultivated areas is still possible but chances are it will be done increasingly on marginal land or at the expense of other uses, particularly livestock production, which may cause conflicts with the livestock producers. Expansion therefore is primarily through development of bottom lands, which also makes intensification possible.</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>In the Mediterranean area, populations are already very dense and the available land for increasing the cultivated area is non-existent. The only possibility for expanding crops is irrigating areas that are too dry for rain-fed agriculture. It should also be noted that irrigation can make it possible in already-cultivated areas to “expand” crops to seasons in which it would be too risky.</td>
</tr>
<tr>
<td>Semi-arid</td>
<td>Pastoral and nomadic livestock production systems are the only ones in semi-arid areas. These farming systems allow very low density (8 inhab./km²) but can be extended by promoting the mobility of people and herds and by promoting resolution of the conflicts that limit livestock producers’ access to certain areas or countries.</td>
</tr>
</tbody>
</table>

III.2.5 Is intensification impossible?

Intensification can be called for, preventing expansion for the purpose of preserving the “natural” environment, or because it can be more economically effective to intensify, provided the technical, human and financial means are available. Increasing the production per hectare can be obtained through various strategies but within productive systems, changing one factor results in rearranging the entire system. Given the speed with which populations are growing and changes are occurring in the ecosystems, the effort required for African agricultural systems to adapt will be considered. These are not only technical changes but also ecological, social and economic.

III.2.5.1 Yields and intensification

Increasing soil productivity is generally obtained at the cost of a greater investment in labour or capital per unit of area, which leads to intensification. Intensification through capital characterizes the recent
agricultural development of developed countries. Intensification through labour is generally the only option available to the societies of developing countries that have little capital.

These two intensification mechanisms have a dual difficulty:

- Intensification through capital greatly restricts the amount of labour necessary while farming should provide productive jobs to the growing work force;
- Intensification through labour often causes labour’s productivity to drop, while it absolutely must increase to allow both development of the countryside and feed a growing number of city-dwellers.

### III.2.5.2 The narrow path for intensifying Africa’s agriculture

According to the FAO (Table 6), intensification of production due to greater cropping intensity and increased yield is what is responsible for most production increase on the continent. We note that to date there is a great difference in the size of increasing yields between northern Africa and sub-Saharan Africa. This difference is due to the types of cropping systems; we will come back to this.

<table>
<thead>
<tr>
<th></th>
<th>Increases in areas</th>
<th>Increased crop intensity</th>
<th>Increased yields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>31</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td>Northern Africa and the middle east</td>
<td>17</td>
<td>22</td>
<td>62</td>
</tr>
</tbody>
</table>

*Table 6: Origin of increases in production between 1961 and 2005, by regions, in %*

Source: Jelle Bruinsma, *The resource outlook to 2050: by how much do land, water and crop yields need to increase by 2050? Presented at FAO Expert Meeting, 24-26 June 2009, Rome on “How to Feed the World in 2050”.

#### Increasing yields

The “green revolution” implemented in Latin America and Asia has led to a spectacular increase in yields thanks to technology packets consisting of highly productive seeds, able to be cultivated in greatly artificially created environments and dependant upon external inputs. Could this type of increase in yield also occur in Africa? The “green revolution” is primarily concerned with wheat, rice and corn, the three most highly consumed grains in the world. Many very important production systems in Africa are not based on one of these 3 grains. These are:

1. **Farming systems based on secondary grains**, particularly millet and sorghum. These cereal grains, which are more resistant to drought than corn, are very important in semi-arid areas as a whole. Overall, they represent 56% of areas and 39% of grain production in sub-Saharan Africa.
2. **Systems based on tubers and arboricultural systems**, typical of moist savannah and tropical forests

In fact, these foods have not been subject to extensive agronomic research (Weldeghaber Kidane et al, 2006). The potential for increasing yields through a strategy of the green revolution type is therefore limited by the lack of adapted genetic material.35

Moreover, other factors limit increasing grain yields. First of all, in order for “improved” varieties to achieve their genetic high-yield potential, particularly favourable production conditions are necessary in terms of irrigation, protection from predators, etc. Now, Africa is characterized by the great amount of naturally poor soil, rapidly losing its fertility, and areas where there is little and variable precipitation, that are unfavourable to the development of these “improved” varieties. Of course, hydro-agricultural developments are possible, but there are still few of them (see box). As for farmers’ use of chemical inputs, this has stalled and even decreased since the early 80s, due to lack of availability and high degree of uncertainty, which halts investment.

Improving yields is possible particularly for rice and corn, but clearly depends on economically favourable policies and conditions, starting with prices paid.

**Towards a new green revolution for Africa or towards complexification of production systems?**

---

35 This is what explains the difference in involvement in increasing production yields between northern Africa and sub-Saharan Africa.
Today, certain experts are urging a new green revolution for Africa. In a context of climate change, risk management becomes even more crucial than in the past. On the one hand, the effects of climate change on precipitation, which is crucial for farming, are still very uncertain today. On the other, the likelihood is strong that more frequent extreme weather events will have to be dealt with. In these conditions, it is advisable to avoid production specialization (use of varied ecosystems, crop diversification and combining farming and livestock production), integrated crops and livestock production systems (systems that bring together species having different cycles and nutritional needs on the same piece of land) and species cultivated and breeds raised.

In addition, the most productive systems – those that allow the greatest population densities – are the most complex, including intercropping, agri-forestry, and combinations of agriculture and livestock production (farming operations in temperate highlands; farming operations in highlands based on perennial crops). Unlike the simplification, specialization and chemicalization of production systems advocated by the “green revolution”, it is possible to intensify production thanks to agro-forestry-pastoral systems making it possible to take better advantage of the carbon, nitrogen and mineral cycles without depending on expensive inputs.

**Hydro-agricultural developments**

The potential for expanding cultivable areas through irrigation is limited: These areas are less than 3% of the arid and semi-arid land that is unsuitable for rain-fed agriculture. Half of this land is already irrigated today. Countries having the greatest potential in terms of area are those already making abundant use of irrigation (Map 8).

On the other hand, irrigation makes it possible to intensify cropping systems by making it possible to double or even triple crops and improve average yields. The production systems in the dry and moist savannahs (mixed cereal grains and root crop systems, mixed corn-based systems and agro-pastoral systems) are those whose productivity could be improved and secured through irrigation.

**Map 8: Irrigation intensity in Africa**

![Map 8: Irrigation intensity in Africa](image)

*The irrigation potential only takes renewable water resources into account. Algeria and Chad also use non-renewable resources (underground fossil water), which may explain values greater than 100%.

**Source:** CDEAO-CSAO/OCDE, 2007.
Remunerative prices – the indispensable and essential condition
Many other components conditioning the improvement of productivity can be mentioned, however, none of them will be effective if the prices paid to the farmers are not adequate to enable them not only to meet their needs but also to be able to invest their work or capital in developing their agricultural production system (box 3).

Box 3: The impoverishment of third world farmers
Let’s consider a grain farmer having manual tools worth a few dozen dollars producing 1 tonne of grain net (seed deducted), without fertilizer or treatment products. Fifty or so years ago, he would receive the equivalent of $30 2001 dollars per 100 kg of grain. So, he had to sell 200 kg of grain to replace his equipment, clothing, etc., and he was left with 800 kg to modestly feed 4 people; by scrimping a bit, he could even sell an additional 100 kg to be able to purchase a few new, more effective tools.

Increases in productivity resulting in the agricultural revolution and the green revolution in developed countries and favourable regions of developing countries have been so great that they have caused a very sharp drop in real farm prices in these countries that are felt in other countries, lowering farmers’ incomes.

Today our grain farmer only receives $10 per 100 kg of grain, so he would have to sell 600 kg to replace his equipment, leaving him only 400 kg to feed 4 people, which is impossible. In fact, he can no longer renew his equipment completely, eat enough and renew his strength to be able to work. He is condemned to indebtedness and exodus to the under-equipped shantytowns where unemployment and low wages rule.


Guaranteeing remunerative prices means that systems having labour productivities that are too different must not be put into competition against each other. The regional markets (or common agricultural markets at the sub-regional scale), by determining sufficiently high import tariffs for agricultural products crossing their borders, can make it possible to both guarantee remunerative prices and foster trade between countries with the same productivity and often complementary productions.
III.3. KEY ACTIONS FOR MITIGATION, ADAPTATION AND AGRICULTURAL DEVELOPMENT

There are 3 types of complementary strategies for limiting the impact of climate change: 1) Limiting the range of the climate changes themselves. These are mitigation measures; 2) Reducing the vulnerability of systems to the expected changes; 3) Fostering possible adaptation to the changes. We will examine the general lines of these 3 strategies one after another.

**III.3.1 Can mitigation and adaptation be reconciled?**

The continent’s economies being greatly dominated by agriculture (see Part 1), this is one of the sectors that emits the most GHGs. However, Africa only contributes 2.5% of the world’s GHG emissions (see Part 2) and Africa’s agriculture can play a very important role as a carbon sink, as was mentioned in Part 2.

Synergies can exist between mitigation and adaptation. Among possible adaptation options, nothing is preventing the choice of those that emit the least GHG, which can make this type of action more effective and easier to fund. These strategies are multiple (see Table 7) and involve techniques such as fighting erosion (dikelets, contour stone lines, half-moons, etc.), improved use of manure and compost production, green fertilizers, agro-forestry, etc. However, all these techniques require training, technical support, demonstration, discussion among producers and research in order to adapt the advice to the local conditions, practices and know-how, as well as investments and flow of information. All this support must be organized locally, through voluntary agricultural policies, and significant support to agricultural expansion services.

Direct funding to producers for purchasing small equipment could prove to be inexpensive and very effective. Besides traditional development assistance, the agriculture sector must be much more eligible for financing, adaptation and mitigation mechanisms for new climate patterns than it is with the current CDM (see Part II.3.3).

These mitigation/adaptation synergies are often specific to one region or a particular system and must be assessed on a case-by-case basis. Nonetheless, in the table below there are courses of action making it possible to reconcile adaptation and mitigation for the major systems identified previously.

**Table 7: Techniques and actions allowing the reconciliation of mitigation and adaptation**

<table>
<thead>
<tr>
<th>N°</th>
<th>Biome</th>
<th>Type of system</th>
<th>Techniques or actions for reconciling mitigation and adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Tropical forest</td>
<td>Pioneer front arboriculture</td>
<td>The agricultural use of land is a critical motivation for deforestation in Africa, which releases significant quantities of CO₂ every year that is stored in the biomass and soil. The spread of agro-forestry can play an important role as it 1) strengthens resilience to extreme weather events, thanks to improved water retention capacity and soil fertility; 2) allows diversification of income sources; 3) increases the ecosystem’s productivity; 4) allows a greater amount of carbon to be sequestered in the soil and biomass.</td>
</tr>
<tr>
<td>3</td>
<td>Tropical forest</td>
<td>Slash-and-burn system, dense forest</td>
<td>When the population is low-density, these systems are not net GHG emitters because the carbon emitted by soil breaking is compensated for by the forest regrowth in the plants. In addition, their high biodiversity ensures that they are highly resilient to climate change. When the population density increases and does not allow sufficiently long rotations, it is important to promote the transition to agri-forestry systems guaranteeing that a high degree of biodiversity is maintained, if necessary by paying the farmers for the environmental services rendered by these ecosystems.</td>
</tr>
<tr>
<td>4</td>
<td>Rice arboriculture</td>
<td>In Madagascar</td>
<td>The techniques promoting crop diversification and improved fertility management are recommended but these systems are already both very intensive and highly diversified. The use of chemical fertilizers for producing more organic material may be a rewarding option, but it must be checked to see if it produces more GHG than it stores when using nitrogen fertilizers.</td>
</tr>
<tr>
<td>5</td>
<td>Highlands farming</td>
<td>Systems based on perennial crops</td>
<td>When the population is low-density, these systems are not net GHG emitters because the carbon emitted by soil breaking is compensated for by the forest regrowth in the plants. In addition, their high biodiversity ensures that they are highly resilient to climate change. When the population density increases and does not allow sufficiently long rotations, it is important to promote the transition to agri-forestry systems guaranteeing that a high degree of biodiversity is maintained, if necessary by paying the farmers for the environmental services rendered by these ecosystems.</td>
</tr>
<tr>
<td>6</td>
<td>Mixed farming</td>
<td>Operations in temperate highlands</td>
<td>Physical and organic methods for fighting erosion must be developed as they make it possible to both adapt to extreme weather risks (heavy precipitation) and promote carbon storage in the soil and biomass.</td>
</tr>
<tr>
<td>Region</td>
<td>System Type</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Semi-desert and desert</td>
<td>Large irrigated areas</td>
<td>Irrigation promotes intensification of systems and must both make improved yields possible and return more organic material to the soil. However, energy costs must be limited as well as N2O emissions related to fertilizer use. From this perspective, high added value per hectare crops (fruits, vegetables, etc.), which allow better management of water resources, must be favoured over extensive grain crops. However, the switch to high added value crops allowing the localized use of irrigation seems out of the question in many regions due to both their distance from markets and the importance of national food security objectives. In rice production areas, the selection of varieties together with cropping techniques such as the drainage of parcels during the growing cycle allow a great reduction in methane emissions and improved rice production by limiting disease and</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Oasis systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Oasis systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 12                  | Pastoral and nomadic livestock production systems | Mobility is what makes pastoral livestock production systems able to adapt to climate change. Their movements enable them to better take advantage of fodder resources available every year. Grazing land that is neither over- or under-exploited accumulates the most carbon in the soil. Moreover, by allowing the animals to have access to better quality pastures, travel also promotes the reduction of methane emissions related to enteric fermentation. To promote pastoral mobility, the following are important:  
   i) Access to weather forecasting systems as well as ecosystem monitoring information (pasture conditions);  
   ii) Multiplication of pastoral hydraulic works allowing optimized use of fodder resources.  
   Restoration of degraded pasturalend makes it possible to both improve fodder production for the animals and to store more carbon in the biomass and soil. |
| 11                  | Agro-pastoral systems with short fallow periods, based on millet and sorghum | These methods allow carbon storing in the soil and biomass and increased yields, i.e. both adaptation and mitigation. We note however that storing carbon in cultivated soil is limited by the intensive use and high degree of recycling of crop remnants as well as by the short growing cycle. Reinforcement of integrated agriculture and livestock production therefore seems to be the preferred method for showing adaptation and mitigation. |
| 10                  | Mixed grain systems, livestock production in southern Africa | Monoculture models based on the intensive use of fertilizers and pesticides are heavy GHG emitters. In these cases, increasing the use of nitrogen hardly helps increase the organic material in the soil. A profound change in land ownership through the distribution of government land holdings to family farmers could make it possible to limit the major use of motorized farm machinery (high power tractors and combine-harvesters) that have a very negative impact on soil structure when they repeatedly go over it. |
| 15                  | Mixed dry land farming systems of northern Africa | As for the Sahelian systems, the mitigation and adaptation synergies occur here as well through improved integration of rain-fed agriculture and livestock production, developing methods for combating soil degradation, but also through conservation agriculture techniques that make it possible to maintain ground coverage and limit ploughing. |
| 9                   | Corn-based mixed systems              | The main risk is that climate change worsens desertification of the intrinsically fragile soil and ecosystems that are over-worked by agriculture and livestock production or, alternatively, for the production of energy (heating wood). It is therefore critical to promote methods making it possible to fight the degradation of agricultural land: dikes against erosion, “zais” and half-moons, improved land-clearing, etc. Developing the bottom land also allows intensification of production in the moistest, most fertile areas, which reduces agricultural pressure on more fragile land. |
| 8                   | Mixed systems based on grain/root crops | In these regions, measures allowing adaptation and mitigation to be reconciled must aim to promote the transition to systems with shorter fallowing periods by proposing adaptations to the current fertility management systems guaranteeing high percentages of organic matter in the soil. Regarding the accumulation of organic material and restoring the nutrients in the deep layers of soil made possible by the root networks of the large grasses and trees left in the fields (Acacia, shea butter, African locust), new fertility management methods will have to be developed. This includes the use of crop remnants and esp. manure, made possible in the case of climatic aridification and the eradication of animal parasites, by larger herds and animal draught-power development. |
| 7                   | Systems based specifically on root crops | In sufficiently moist regions, systems promoting ground coverage and limiting tillling (no till, catch crops, cultivated fallowing, mulching) must make carbon accumulation possible in the soil and improved fertility. Development of legumes in the rotations can promote low use of nitrogen fertilizers and thus limit N2O emissions. For sugar cane monocultures, stopping the burning of the cane leaves when harvesting allows better restitution of organic matter to the soil but in return requires mechanized harvesting. |
| 6                   | Moist savanna                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 5                   | Dry savanna                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 4                   | Mediterranean                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3                   | Semi-desert                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2                   | Mediterranean                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1                   | Mediterranean                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 0                   | Mediterranean                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
Reducing vulnerability to climate change naturally occurs by strengthening ecosystems’ resilience but also, and perhaps especially, through reducing the vulnerability of socio-economic systems. Thus, many institutions define the fight against poverty as the central strategy for adaptation to climate change.

### III.3.2.1 Protecting the ecosystems

Ecosystems are more or less resilient to climate change based on their own characteristics and their fragility at the time when these changes, as well as intervening human activities, occur.

Deforestation is a human activity that weakens ecosystems. Forests produce a set of environmental services, including their role as “carbon sinks”, that are essential for mitigating climate change and thus for the long-term future of agriculture. A number of mechanisms can be put in place to fight against deforestation and foster the sustainable management of forests: national and local policies for protecting forest ecosystems, wood traceability systems, management and development plans, and REDD certification and process systems.

Energy access policies also have an important role in protecting ecosystems. In sub-Saharan Africa, the biomass is 80% of the energy consumed. Implementing decentralized systems of electricity production and the production of local biofuels can be solutions fulfilling the needs of populations and the environmental issues.

Over-fishing, water acidification and pollution, and degradation of the aquatic flora are all problems affecting the health of marine and riparian ecosystems and make them all the more sensitive to climate change. Protection of mangroves as spawning areas is crucial here as well as compliance with international rules on fishing, pollution restrictions, etc.

### III.3.2.2 Managing humanitarian crises and preventing disasters

The many humanitarian crises that have shaken Africa over the last 50 years have had a devastating impact on populations’ food security as well as on countries’ institutional capacity to foster development. Climate change is likely to increase these crises but also to cause massive population displacement. Instruments such as early warning systems must be put in place at the national and sub-regional level to prevent or limit the consequences of these crises.

### III.3.2.3 Managing the food supply at the international level

The food security of African populations is not determined solely by its agricultural production capacity (FAO, 2008). It is also depends on the volume and prices of world inventories of foodstuffs. The likely increase in the frequency of extreme events will cause great fluctuations in the prices of foodstuffs from one year to another. Protecting African agriculture from the ups and downs of world markets thanks to voluntary regional economic and agricultural policies would appear to be absolutely
necessary for fostering steady support for local food markets, guaranteeing populations’ food security and giving producers a “price signal” stable enough to enable them to invest in agriculture.

III.3.3 Key adaptation actions for the agriculture sector

Planned adaptation to climate change will only be effective when the available information becomes reliable enough to guide decision makers and climate change is taken into account at all levels of programming. Recommendations by climate zone are presented at the end of the chapter so as to emphasize the main courses of action to be studied for each.

III.3.3.1 Strengthening the research institutions

Institutional strengthening at every level is obviously a key factor for adaptation. Here we will give courses of action for strengthening the research institutions that will be on the front lines for providing the necessary knowledge for individual and collective decisions about adaptation to climate change.

Climatic forecast

Forecasting the weather is a crucial component for adaptation in the agriculture sector. Africa lacks historic and real-time information on temperatures and rainfall (see Part 2). Recommendations would be (SEI/Rockefeller Foundation, 2008):

- To improve and expand climate change projections in Africa through initiatives to collect sets of historic data and train African scientists;
- To create exchange opportunities among meteorological data producers and users to improve the users’ understanding of what the projections can and can’t do, and enable the meteorologists to properly determine the users’ needs; and
- To improve abilities to interpret and use the meteorological data.

Tracking the relationships between climate change and the associated changes in ecosystems is also crucial while expanding these observations to the agro-ecosystems in order to be able to understand the resilience mechanisms and develop adaptation policies.

Agronomic research

From now on, agronomic research will have to seek to strengthen the resilience of agricultural systems and no longer just develop “improved” varieties. This involves the following changes:

1. Fostering every aspect of biological diversity (genes, species and ecosystems) to increase resilience to changes in environmental conditions and stress.
2. Establishing selection criteria for new varieties on the basis of their capacity for good production despite certain climatic or edaphic constraints.
3. Including agronomic risk management (developing/fine-turning diversified agricultural systems that are resilient to environmental changes) and economic risk (promotion of diverse income sources and minimizing dependency on purchased inputs and major investments).
4. Disseminating existing knowledge among rural populations at the local level and try to improve existing production systems by fostering better resiliency and making them more able to promote food security and rural incomes.
5. Forming environmental and social sciences alliances because the impacts of climate change depend on the reliance of ecosystems and human systems, and reinstating multifactor analyses.

III.3.3.2 Integrating climate change at every level of programming

The scale of the coming changes is such that taking them into account for programming at every level and every sector is critical. Moreover, for the banks this is a matter of return on investment.

Therefore, climate change must be integrated in medium- and long-term development planning and in poverty reduction strategies; it must be an integral part of capacity building for political decision makers, technical services and local stakeholders so that each is able to adapt its work to climate change and proceed with institutional reforms for donor policies and procedures. The Africa Partnership Forum held in Addis Ababa in November 2008 recommended actions in this direction for
African countries. For the agricultural sector, this is through greater awareness of the Ministry of Agriculture and agricultural extension services regarding the coming changes, and the review of all laws, regulations and programs concerning the agriculture sector with a view to improving populations’ resilience.

III.3.3.3 Securing and democratizing access to land and water

Securing access rights to land and use of natural resources (fauna, grazing land, lumber, water, etc.) is currently being demanded by many African farming communities. Countries also need to implement land legislation that is better able to encourage producers to invest in more productive and environmentally-friendly systems. The first step would be defining a cooperation and negotiation framework between the government and the main social categories involved (farmers, livestock producers, loggers, etc.).

Access to water is particularly sensitive matter in view of climate scenarios predicting that the climate in many regions will become drier and the matter arises on the local scale and the drainage basin scale. This matter comes up on a local scale as well as on the drainage basin scale. Many hydraulic engineers and socio-economists concur today regarding the need for institutional subsidiarity, and establishing management units at the drainage basin or ground water level that are able to regulate access rights to water and arbitrate any usage conflicts that may arise with the support of user associations (Dufumier, 2008).

III.3.3.4 Modifying the choice of cropping and livestock production methods

In a context where the costs of fossil fuel and petroleum-based products could still rise, the choice of methods should favour those that limit recourse to pumped water, synthetic fertilizers and phytosanitary products.

Developing new “adapted” varieties and promoting biodiversity

There is a risk that this constraint will particularly limit the use of high genetic potential photosynthetic yield per hectare varieties (that are sensitive to water stress, vulnerable to pathogenic agents and requiring large amounts of minerals) outside regions where it was possible to irrigate land, use chemical fertilizers and protect crops. In other areas, it would be advisable to opt for farming methods that are more suited to the prevailing ecological conditions in the various growing and livestock production regions - adaptation to the soil, microclimates, predators, insects, weeds, etc.

Restoring and protecting the soil

As a whole, African soil is rather poor. Maintaining a high organic content makes it possible to 1) preserve the soil’s fertility in a context where farmers’ physical and economic access to chemical fertilizers is very limited; 2) foster resilience to water stress and therefore periods of drought related to aridification of the climate; 3) store carbon in the soils to help in mitigation of climate change.

In Sudano-Sahelian regions, integrating livestock production and cropping can make the effective management of organic matter possible. In regions with highly contrasting rainy and dry seasons and where annual crops predominate, no till and sowing under plant cover are of genuine interest from the perspective of protecting the land from erosion, protecting soil biology and preserving the percentage of humus.

There are many complementary measures to protect the soil from erosion while preserving its fertility at the parcel or drainage basin level. Farmers have a great deal of know-how in this area that has to be gone back to, improved and funded by specific government policies.

Optimizing the use of rainwater and developing “sustainable” irrigation

In many regions of Africa, rainfall will most likely become less abundant and more irregular, which will involve optimizing the use of rainwater in areas with rain-fed agriculture. Resorting to irrigation will also be necessary (cf. III.2.5.2) through the use of small, localized irrigation structures with limited negative impact and facilitated management (Dufumier, 2008). These techniques are expensive, have

ecological risks and are not suitable for all crops. Effective water management at the drainage basin level also requires good governance between governments and water users.

### III.3.3.5 Recommendations for a few major types of agrarian systems

It is critical to assist farmers to build and implement their own adaptation strategies. Doing this requires an initial understanding of the local climatic, agronomic, social and environmental realities as well as analyzing the initiatives that have already been implemented locally.

**Mediterranean zone**
- Mixed dry land farming systems in northern Africa
- Mixed grain-livestock production systems in southern Africa
- Extensive grain farming of large state-owned properties
- Mixed rain-fed farming systems

The systems that are most vulnerable to climate change are those located in areas of dry land where annual rainfall ranges from 150 to 300 mm and the system as a whole is sensitive to annual and seasonal time and space fluctuations in rainfall.

Adaptation to aridification of the climate should take the following components into consideration:

1. Strengthening the protection of the soil against erosion and protecting the percentage of humus: repeated tillage for fallowing and deep ploughing are to be avoided as they contribute to weakening the soil. Intervention that should be developed includes: i) conservation methods such as using windbreaks to control wind erosion; ii) water collection; iii) plant cover for the ground and minimal/non-tillage; and iv) the use of shrubs as fodder; v) integrated management of drainage basins by local communities.

2. Better integration of rain-fed agriculture, irrigated agriculture and livestock production and their interactions.

3. Irrigation must allow systems to be intensified.

4. Large state-owned pieces of property should be distributed to family farmers. When there is an inverse relationship between the size of the farms and the economic effectiveness (Dufumier, 2008), the available land and water would probably be more advantageously employed by farmers whose best interest is in intensive farming systems and greater creation of added value per hectare. This change in land ownership could make it possible to limit the repeated use of machinery, which has a negative impact on soil structure.

**Deserts and semi-deserts**

**Oasis systems**

Climate change should not affect this agricultural system that is independent of rainfall. The rise in temperature should not pose a problem as Saharan oases have a great deal of intercropping on the same space, each one shading the ones below it. Increased evapotranspiration should not pose any more problems, considering that the available reserves of water are significant compared to the volume removed.

**Large irrigated areas**

Climate changes that will impact these areas are paradoxically less the change of the local climate than that of the regions where watercourses have their source. The major risk for these irrigated systems is the reduction in river flows and thus, the water available for irrigation. This decrease in available water would first affect projects for expanding developed areas as well as new dam projects. There is also the risk that existing hydro-agricultural developments would face the question of increasing their efficiency in water use. The transition to high added-value crops making it possible to use localized irrigation seems out of the question in many regions, both due to their distance from markets and the importance of national food security objectives. However, the rise in CO₂ concentrations in the atmosphere and a moderate increase in the temperature could lead to increased yields (in rice paddies in particular), also a factor for improving irrigation efficiency.
Questions linked to area and regional water management will certainly figure among the challenges that will be exacerbated by climate change.

Pastoral and nomadic livestock production

Nomadic livestock production is especially well suited to the changing conditions of the semi-arid climate. It has demonstrated its resilience faced with extreme and repeated events during the droughts in the 70s and 80s. Though a severe and prolonged aridification could threaten the survival of transhumant livestock production, moderate aridification of the climate and occasional droughts don’t seem to be enough to endanger this system. Important adaptation measures would include:
- Access to weather forecasting systems and ecosystem tracking information;
- Multiplication of pastoral hydraulic works allowing fodder resource usage to be optimized.

The major challenge for pastoral livestock production could come from the rise in average rainfalls and expansion of rain-fed agriculture at the expense of grazing area that this would probably lead to. These developments have been the source of conflicts between livestock producers and farmers and this trend could worsen in the event that the climate becomes moister. Important adaptation measures would then involve conflict mediation, support in redefining the rules for the use of shared resources, demarcation of the transhumance corridor, etc.

We note that aridification – even moderate aridification – of the climate would be deadly to the ranching systems in southern Africa except in the case that the irrigated production of fodder were both possible and profitable. On the other hand, an increase in precipitation could facilitate the production of fodder and foster their development.

Dry savannah

Agropastoral systems with short-cycle fallow seasons, based on millet and sorghum
Mixed systems based on corn

These systems are typical of the zones located between 400 and 800 mm isohyets. The rainy season lasts from 50 to 110 days and can vary by more than 30% from one year to another. This area has all the disadvantages of rainfall that is both structurally weak and quite variable. Significant areas of ground are infertile and fragile. The agriculture is therefore risky and highly dependent on the climate even if the existence of special topographies and deeper and moister soil also plays a significant role.

Experience gained over the course of the 20th century in the Sahelian zone gives a good idea of the consequences of climate aridification on these systems and the adaptation capacities. First of all, the systems are already suited to climate variability. For example, during drier spells when agricultural production is poor, if not nonexistent, the sale of livestock ensures the food security of farmers having animals.

A major medium-term risk is desertification, related to the intrinsic fragility of the soil and the risks of over-exploitation of the biomass when its production decreases from climate constraints. Many techniques have been perfected for combating the degradation of farm land: anti-erosion dikelets, “zais” and “half-moons”, improved clearing, etc. Development of bottom lands also makes it possible to intensify production in moist, more fertile areas, reducing agricultural pressure on fragile land.

Shorter rainy seasons could partially be compensated for by the shortening of growing cycles caused by higher temperatures, especially if supported by agronomic research.

Corn being sensitive to drought, mixed systems based on corn are greatly threatened by climate aridification. The development of irrigation may secure production thanks to back-up irrigation during periods of drought. But it is important to review the choice between hybrid seeds that only give good yields in ideal situations, and local seeds having genetic variety more able to adapt to uncertain climate conditions.

Finally, we emphasize that animals are an important factor in the resilience of these systems because they make it possible to have income for the purchase of grain. Access to livestock production for the poorest households is therefore critical to reduce their vulnerability.

It should be noted that the climate models for the semi-arid zone diverge greatly and their aridification is far from certain. On the other hand, greater climate variability is likely and must lead to adapting the systems by promoting (see III.2.5) the integration of agriculture and livestock production and the internal diversification of cropping and livestock production systems based on a broad combination of species and varieties or breeds. From a more macro perspective, the early warning systems and post-crisis recovery plans are the preferred adaptation tools.

**Moist savannah**

- Mixed grain-root crop systems
- System based specifically on root crops

Climate forecasts regarding these ecosystems predict slighter variations in rainfall than in the dry savannah areas, without however being able to say in which direction. A slight aridification of the climate could make it easy to eradicate parasites affecting cattle and enhance the use of draught animals, facilitating grain crops (corn, sorghum, millet) at the expense of tubers (yams and cassava). In the medium term, development of animal-draught cultivation and the integration of cropping and livestock production could result in a greater area cultivated per household as well as greater yields from the cropping systems and work productivity.

More intense precipitation would bring out the risk of the physical erosion of the soil. This degradation risk increases when animal-draught cultivation develops and is accompanied by the removal of roots.

The threats related to climate change to these systems are more likely to be the arrival of “climate migrants” in these sparsely populated areas than local climate changes, involving greater pressure on the natural resources.

Growing densification of occupation of the space will combine to reduce the length of time fields are fallow and problems of soil fertility are a risk, while there are already threats to the renewal of stands of aging fruit trees (Acacia albida, shea butter, African locust).

Adaptation measures will therefore have to favour agricultural transition to shorter-cycle fallow systems by recommending adaptations to current fertility management models. Regarding the accumulation of organic matter and restoring the nutrients to the deepest layers of soil made possible by the root network of high grasses and trees left in the fields, new fertility management methods will have to be developed that include the use of crop residues and especially manure, made possible by herd growth and animal draught power.

**Sugar cane plantations**

Sugar cane is highly sensitive to heat stress. Large industrial sugar cane plantations are mono-specific and therefore extremely vulnerable to climate change when these combine higher temperatures and aridification. There is limited room to manoeuvre through changing varieties. Irrigation can help with adaptation when it is technically possible but the investment is not always profitable.

Another important risk is the appearance of new parasites and pathogens, particularly in the event of a warmer and moister climate. The large plantations being often monovarietal, parasites and harmful insects can proliferate obstacle-free over the entire area. Phytosanitary treatments can be multiplied but there is a good chance of compromising both the environment and profitability of the crop.

**Tropical forest**

Tropical regions seem to be those least at risk from climate change. The expected increases in temperature are among the lowest on the continent (+2 to 2.5 °C) and the average rainfall variation is moderate or zero.
Dense forest slash-and-burn system

Sparsely populated areas of dense forest have complex ecosystems that are only partially known and it is not very well understood how they may be affected by even minimal climate change. In fact, the regeneration of many plant species involves fauna following a real variety of procedures. Many forest species need shade in the early stage (Goussard & Labrousse, 2008).

The main risk for these systems seems to be greater deforestation. The annual rate of deforestation in the Congo basin is moderate today (on the order of 0.4%) but could increase under the impact of the arrival of “climate migrants” causing either a significant increase in the population living from the slash-and-burn system, or the advancement of the pioneering front arboriculture agriculture system. The question of fertility management and weed control in a context of gradual reduction of uncultivated forestland would then be asked. In the absence of draught animals (the area is infested by the tsetse fly), the bush fire solution is necessary and causes gradual savannization with the development of grassy ground cover that is not eliminated by periodic fires but helped by them instead to extend it. This being the case, population densities are currently low and this savannization is fairly marginal for the time being. It would even seem that the rise in the atmosphere’s CO2 content and temperatures promotes the forest’s recovery on the edge of certain dense African forests.

Adaptation mechanisms would be through the gradual development of agro-forest systems whose dense plant cover, composed of a number of species and varieties, hinders the spread of weeds and restores fertility through the transfer of nutrients from the deep layers of soil toward the surface layers. These very productive systems can tolerate very dense populations and would make it possible to reconcile the necessity to preserve biodiversity not only in terms of specific wealth but especially the functional and structural integrity of these natural systems. Payment to farmers for environmental services rendered by the forest ecosystems or carbon stocks is an attractive course of action for making the development of agro-forestry systems (REDD/REDD-plus, see Part 2) viable. However, the main constraint to their development is generally due to land problems, the farmers often having no interest in protecting trees over which they have no right in terms of national law or customary rights.

Pioneering front arboriculture agriculture

In the intertropical moist zone where arboriculture agriculture predominates, the forests have in great part disappeared under pressure from the development of large plantations or various industrial crops. This ancient phenomenon has worsened with the migrations of populations from countries with more arid climates and the race to make land claims. It could still worsen in the event of greater aridification in dry savannah areas.

These arboriculture systems are undergoing a crisis in their economic and ecological model today (see Part 1). Cacao plantations, for example, are not shady today and thus contain a very limited diversity which makes them all the more susceptible to the effects of climate change (disease, higher temperatures and more sun, increased humidity or aridification, etc.) now that they are aging.

Adaptation mechanisms would be a return to more extensive systems under protective shadow and the expansion of “box” agro-forestry models that would allow:

1. Better protection of the soil, while the frequency of extremely violent rain is likely to increase;
2. Compatible forest production (Ivory Coast almond/fraké (Terminalia superba)) guaranteeing a support income and greater carbon stocks
3. Better adaptation to the various climate risks (shade from higher temperatures, maintenance of greater soil moisture);
4. Improvement to the biodiversity and similar decrease of phytosanitary risks;
5. Lesser dependency on export crops

---

38 A reduction in the prevalence of disease interfering with livestock could foster massive clearing of the forest for the purpose of pioneering Amazonian front arboriculture agriculture.
**Highlands and mountains**

Highland farming systems base on perennial farming systems

Mixed temperate highland farming systems

These farming systems do not seem to be negatively affected by climate change. In fact, they could benefit from the increased CO₂ concentration and higher average temperatures.

The warming of the climate could have adverse effects on certain crops in temperate zones. In fact, although the rise in temperatures overall limits the risks of early and late frosts, it also causes earlier blooming which paradoxically makes plants more vulnerable to freezing. On the other hand, for certain perennial species, the mild winter could create physiological problems (dropped blossoms, aborted fruit). Or alternately, soil degradation can occur in a context where rainfalls can become more abundant as well as more violent.

The expected changes, even low magnitude, run the risk of having very significant consequences considering the high social vulnerability of these areas. In fact, the highland farming systems have very dense rural populations, the farms are very small and there is virtually no available land. There is danger that all decreases in the production of these very intensive systems will cause famines, migrations and conflicts.

Changes in crops may be necessary to adapt these systems to the new climate conditions. The main issue is to protect, indeed, increase the production per area unit of these systems, which is already very high, while also protecting the high resilience that makes intercropping possible with a large number of crops. Management of soil fertility as well as protection against erosion are the crucial components of adapting these systems along with crop diversification.

**Dispersed systems**

Horticultural areas outside the city or out-of-season

These systems are led to develop quickly based on the growing demand from the cities. Due to the fact that they are scattered among a great variety of ecosystems, it is difficult to specify the climate risks they will be subject to.

However, considering the importance of irrigation for the operation of these systems, it is clear that one of the main threats is aridification and a reduction of water resources. In terms of adaptation, this means that systems with localized irrigation systems will have to be favoured as they allow increased efficiency in water use and the prevention of all types of pollution.

In the event that precipitation increases along with higher temperatures, the main danger would be one of health with an increase in disease and pests. The priority would then be to develop organic farming methods or integrated pest management making low production costs possible and limiting the negative consequences of pesticide use.

Farming systems based on traditional fishing

The sustainability of traditional fishing is highly threatened today by the disappearance of the mangroves, destabilization of marine ecosystems and over-fishing. Climate change will have two serious impacts on these systems: modification of marine ecosystems related to the rise in temperature, modification of salinity and acidity of the oceans; and the rise in water levels. In addition to habitat destruction (coral and mangroves), climate changes could also cause a drop in tropical and middle latitude ocean resources caused by a mismatching between the early stages of life of fishes and their prey, tied in particular to changes in the life cycle of plankton.

Adaptation will occur through the preservation of the mangroves and coral reefs that are necessary for coastal systems to function, maintaining the diversity of fish populations and through tracking mechanisms that only allow catches that do not affect the sustainability of fishing.

Finally, the development of aquaculture will have to be encouraged because it reduces the pressure on natural productions and produces fish and shellfish in conditions that are less subject to climate change.

We also note that the rise in sea levels is already causing heavy marine erosion, which destroys entire villages and destabilizes marine ecosystems. It also has significant impacts on the farming practices in
these systems as the rise in water levels also causes the salinization of surface and ground water, making it unsuitable for farming purposes. Unfortunately, adaptation options seem highly limited compared to the challenges.

III.3.3.6 Findings on the development of the agriculture sector in a context of climate change

Climate changes and development are highly linked; climate changes have already had and will continue to have increasing effect on the development of societies, just as the development methods chosen have had and will have an impact on climate change. Actions intended to promote development and those intended to limit climate change or foster adaptation therefore cannot, and must not, be thought of separately. All actions that compete in the reduction of poverty or the improvement of governance reduce social vulnerability and enhance resilience to the effects of climate change. That is why policies and strategies already implemented as part of “traditional” development actions are among the recommendations generally cited for adaptation to climate change.

For the agriculture sector, this means:
- Guaranteeing remunerative prices (cf. Chapter III.2.5.2);
- Fostering access to credit, enabling economic stakeholders to invest in order to develop and adapt their systems, with the development of tools limiting the financial risk;
- Facilitating market access upstream and downstream from the agriculture sector, notably by improving transportation infrastructure and the dissemination of information;
- Developing agricultural training and extension actions, particularly directed toward women, who play a critical role in most of the agricultural systems;
- Strengthening rural organizations.
As we have seen, the impacts of climate change on the agriculture sector are very difficult to predict and all the more so in Africa where climate forecasts are sorely missing the historical data and local capacities necessary to have a minimum of consistency and reliability. But though the agricultural development issues are amplified by climate changes in progress, these changes do not fundamentally modify the recommendations that can be made in this regard and they amplify the urgency and need for massive investment.

Implementation of policies related to market protection, access to credit, strengthening of organizations, and more, is therefore all the more urgent. But climate change pushes us to particularly emphasize the importance of research and agricultural extension, climate research, securing access procedures for land and water and the adoption of farming techniques suited to the specific contexts of each farming system. Major potentials exist in terms of expanding agricultural land and intensification and strong, coordinated policies at the continental level should make possible consistent political and financial choices for the purpose of greater food security for the continent and greater resilience to climate change while respecting local populations and the environment. Awareness on the part of politicians and funders, of the urgency of development and adaptation to climate change actions in the agriculture sector is of the utmost importance.
Conclusion

The objective of the NECTAR project is the sustainable development of Africa to be taken into account in climate negotiations. This “agriculture” sectoral study offers the individuals involved in agricultural development, international climate negotiations and decision-makers a synthesis of the main development issues in African agricultural development, the impact of climate change on the sector, the climate negotiation issues for agriculture in Africa, and suggests a certain number of key actions for agricultural development in the context of a changing climate and increasingly expensive fossil fuels.

The challenges to Africa’s agriculture and the continent as a whole are many and complex. The liberalization of agricultural markets has had effects that vary from country to country and the structural adjustment has resulted in a massive disengagement of the State in organizing the sector and related funding, as well as a drop in official development assistance for agricultural development. But the organization of producers in certain clusters has also been promoted and its global balance is moderate. Today’s context is new, with more decentralized administrations, better-organized producers and many regional economic integration institutions, but also with highly deficient agricultural research and professional training, the new demand for biofuels and a demographic “bonus” that is both a challenge and an opportunity for the continent’s development. Africa’s agriculture sector is highly diversified, with varied sets of problems based on environmental, socio-economic and historic conditions that are very different from one region to another. It is, however, useful to classify the major types of farming systems in order to analyze the main strengths and weaknesses and to attempt to identify the main hindrances to their development as well as their resilience in the face of climate change both now and in the future. Besides the new situation created by climate change, we have highlighted three main challenges facing agriculture in Africa:

- Growing food needs around the world
- The creation of productive jobs in the rural sector
- Competitiveness of African agriculture

Though the climate changes to be expected on the continent are very significant, and disturbing in certain regions, Africa’s contribution the greenhouse gas emissions is very limited. The continent is therefore primarily a victim of this phenomenon. That said, the evolution of Africa’s emissions has risks to be prevented and potentials to be developed. Risks, because the continent’s economic development, while desirable, will result in strong growth in the demand for energy; because the growing population and its even limited growing wealth, will considerably increase food needs and therefore produce intensification and increases in agricultural production, with its attendant negative consequences. Potentials, because many areas in Africa are, or may become, important carbon sinks thanks to the considerable production of biomass possible in these regions.

Therefore mitigation measures for GHG emissions that are adapted to each region and each sector should be designed and disseminated, without however, limiting their development, and on the other hand, the mitigation potential of wooded areas and dense forests should be developed. A major issue in the current negotiations is therefore to integrate in the post-2012 agreement a system for developing carbon sinks, not only for non-deforestation purposes but also for developed wooded areas (REDD and REDD-plus). This would offer the dual advantage of contributing to carbon storage and promoting the restoration of ecosystems and degraded soil; in other words, a very effective mitigation-adaptation measure. This can occur through:

- Better integration of agriculture in the Clean Development Mechanism (CDM), thanks particularly to a sectoral, non-binding approach;
- Integration of agriculture in the Nationally Appropriate Mitigation Actions (NAMA) in developing countries.
But the main issue for Africa remains the funding of climate change adaptation. In the face of enormous needs for development, infrastructure, education and research for the agriculture sector and every other sector of the economy, the international community will have to be pushed with regard to its cutbacks so that the community will commit to funding envelopes that measure up to the issues.

Finally, the impact of climate change on the farming systems is very difficult to assess, on the one hand because climate change predictions are neither reliable nor on a suitable scale at the present; on the other hand, because the farming systems are very complex, each with its own resilience and that many factors other than climate change intervene in their development. Therefore, it is impossible today to give ready-made recipes for adaptation to climate change but we can attempt to plan adaptation actions that foster systems’ resilience, as has been started through the National Adaptation Programmes of Action (NAPA).

In order to respond to the many challenges facing Africa’s agriculture, it will have to develop through increasing the areas cultivated where this is possible, and through intensification of the systems in place, each on the basis of its own characteristics and potentials. In most regions and systems, intensification will be through increasing productivity of labour through, for example, developing the integration of cropping and livestock production; through development of varieties of crops that are typical of the area (e.g., millet, sorghum, cowpeas), focusing on hardy varieties that are sufficiently resistant to climate fluctuations to make it possible to prevent poor yields and thus secure an acceptable average yield; through establishing agro-silvo-pastoral systems making it possible to better benefit from carbon, nitrogen and mineral cycles without depending on costly inputs.

In order to reduce African agriculture’s vulnerability to climate change, a multi-dimensional approach is necessary. The ecosystems, their diversity and their balances must be protected to facilitate their adaptation. Humanitarian crises must still be managed; warning must be given when there is the risk of disasters through the establishment of early warning systems and managing the food supply at the world level. And a certain number of key actions must be launched that are likely to secure populations and their food resources:

- Strengthening the research institutions: improving climatic forecasts, increasing and improving research in agronomics and its dissemination;
- Integrating climate change at every level of programming of local, national and regional government and among donors;
- Securing and democratizing access to land and water;
- Restoring and protecting the soil, particularly through the necessary increase in organic matter content and protection from erosion;
- Turning toward cropping and livestock production choices that favour biodiversity, limiting to the greatest extent possible external costly inputs and preserving the balance of the ecosystems;
- For each farming system, locally identifying hindrances to its development and evolution, not by seeking to apply a “modern” standardized model but by favouring diverse models that are respectful of the inhabitants and their environment.

All these actions of course complement traditional development policies that should be reinforced as well, because populations will first become resilient when they can emerge from poverty. A policy for protecting regional agriculture markets, access to these markets, thanks to suitable infrastructures and organizations, access to credit, institution building, education, gender equality, etc. are all necessary for increasing populations’ ability to adapt.

Faced with poverty, growing food needs and climate change, it is therefore time for policy-makers, international funding agencies and the development stakeholders to become aware of the urgency for massive and diversified, autonomous and integrated agricultural development that is up to the challenges that agriculture and farmers must face.


18. UNFCCC National Communications (http:// unfccc.int/national_reports/non-annex_i_natcom/items/2979.php).


32. FAO: The State of Food and Agriculture 2005, Rome, 2005
34. FAO: Cartographie de la pauvreté, de l'eau et de l'agriculture en Afrique subsaharienne, 2008
42. FAOSTAT, http://faostat.fao.org
43. Ferry, Benoît (under the direction): "L'Afrique face à ses défis démographiques : un avenir incertain". Karthala-CEPED-AFD, 2007
46. Food and agriculture organization (FAO), 2008: "Climate change and food security: A framework document"
47. Food and agriculture organization (FAO): April 2009, Press release 09/54 FR.
49. Food and Agriculture organization, 2009, "Enabling Agriculture to contribute to climate change mitigation".
64. IEPF (Organisation internationale de la Francophonie), September 2009, Nouvelles Francophones du Marché du Carbone et du MDP, Numéro 166 – September 20, 2009
67. International Institute for Sustainable Development (IISD), 2009, "Encouraging Developing Country Participation in a Future Climate Change Regime"
68. International Institute for Sustainable Development (IISD), March 2009, MEA Bulletin No. 65
69. International Workshop on Adaptation to Climate Change in West African Agriculture, April 2009, Ouagadougou, Burkina Faso
70. IPCC, 2007. Climate change 2007, Synthesis report


83. OECD, 2005. Bridge Over Troubled Waters: Linking Climate Change and Development


86. Organisation internationale de la Francophonie, 2009, Guide des négociations 4 "CdP-14 et CdP/RdP-4 sur les changements climatiques, 1er au 12 décembre 2008 - Poznań, Pologne"


91. UNEP/WMO, 2007, Fourth Assessment Report of the IPCC (AR4)

93. Government of France, November 2008, "Réaliser un projet MDP ou MOC de réduction des émissions de GES".


95. Réseau des ONG francophones, June 2009, Tunis Declaration (www.rac-f.org and www.energie.enda.sn)


111. UNFCCC: Technologies for adaptation, 2006

112. UNFCCC, 2005: Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention – Addendum: Inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases (FCCC/SBI/2005/18/Add.2)

113. UNFCCC, National Adaptation Programmes of Action, Summary of Projects on Food Security identified in Submitted NAPA as of September 2008


118. Van Beck, C., Meerburg, B., Schils, R., Verhagen, J., Kuikman, P., 2009: Feeding the world’s increasing population while limiting climate change impacts; decoupling agriculture’s N2O and CH4 emissions from population growth
The International Organisation of La Francophonie (OIF) is an institution founded on sharing a language - French - and common values. It currently groups 77 States and governments, including has to date 57 members and twenty observers.

The OIF carries out political and cooperation actions on all five continents in the following priority areas: French language and cultural and linguistic diversity; peace, democracy and human rights; education and training; sustainable development and solidarity. OIF pays special attention in all its actions to young people and women and to access to information and communication technologies.

The Secretary General runs the political action of the Francophonie as its international spokesman and official representative. Abdou Diouf has been the Secretary General of the Francophonie since 2003.

57 member States and governments
Albania • Principality of Andorra • Armenia • Kingdom of Belgium • Benin • Bulgaria • Burkina Faso • Burundi • Cambodia • Cameroon • Canada • Canada-New Brunswick • Canada-Quebec • Cape Verde • Central African Republic • Chad • Comoros • Congo • Côte d’Ivoire • Cyprus • Democratic Republic of Congo • Djibouti • Dominica • Egypt • Equatorial Guinea • Former Yugoslav Republic of Macedonia • France • Gabon • Ghana • Greece • Guinea • Guinea-Bissau • Haiti • Laos • Lebanon • Luxembourg • Madagascar • Mali • Mauritania • Mauritius • Moldavia • Principality of Monaco • Morocco • Niger • Qatar • Romania • Rwanda • Saint Lucia • São Tomé and Principe • Senegal • Seychelles • Switzerland • Togo • Tunisia • Vanuatu • Vietnam • Wallonia-Brussels Federation.

Twenty observers
Austria • Bosnia Herzegovina • Croatia • Czech Republic • Dominican Republic • Estonia • Georgia • Hungary • Latvia • Lithuania • Montenegro • Mozambique • Poland • Serbia • Slovakia • Slovenia • Thailand • Ukraine • United Arab Emirates • Uruguay.

INTERNATIONAL ORGANIZATION OF LA FRANCOPHONIE
19-21, avenue Bosquet, 75007 Paris France
Tel.: +33 (0)1 44 37 33 00
www.francophonie.org
The Francophonie serving sustainable development

The Institut de l'énergie et de l'environnement de la Francophonie (IEPF - Energy and Environment Institute of the French-speaking World) was born in 1988 from a desire of Heads of State and Government for cooperative action to develop the energy sector in member countries. This action was expanded to the environment in 1996.

Based in Quebec City, the Institute today is assisting in:
- training and capacity-building in sustainable development of various categories of development players in French-speaking countries in the energy and environment sectors;
- developing partnerships in the energy and environment sectors for sustainable development.

Its 2010-2013 programme, in synergy with other programmes of the International Organization of La Francophonie, especially under mission D of the Ten-year strategic framework of the Francophonie - "Developing cooperation to ensure sustainable development and solidarity" - IEPF:
- helps to prepare national sustainable development policies and strategies and implement them in the energy and environment sectors; trains and enhances the ability of supervisors and professionals to use and master environmental management tools for sustainable development.
- supports the participation of countries in international negotiations on the environment and sustainable development and the implementation of conventions, through discussions, technical support and mobilization of experts.
- develops partnerships, publishes guides, specialist journals and scientific and technical works in French in the energy and environment sectors.
- coordinates information and expertise networks for sustainable development.
- carries out any other function entrusted to it by the competent OIF bodies.

Institut de l'énergie et de l'environnement de la Francophonie (IEPF)
56 rue Saint-Pierre, 3rd floor
Quebec (Quebec) G1K 4A1
CANADA
Telephone: 1 418 692-5727 / Fax: 1 418 692-5644
iepf@francophonie.org
www.iepf.org
www.mediaterre.org
This synthesis was prepared from a more voluminous study, published also by the IEPF. As for the study, this document has been prepared by Baastel Consulting Group and Iram.

How climate change exacerbate the problems Africa will face, especially in the field of agriculture? This is the subject of this book. It also discusses issues of greenhouse gas emissions on the continent, the reduction pathways, and how African countries can benefit from international negotiations on climate change, promoting a commitment to reduce GHG emission, the only way to reduce global warming and its consequences. The establishment of valuation measures - for their preservation – of carbon sinks on the continent (such as REDD, REDD-plus), and an adaptation fund adequately equipped to finance emergency measures that will better cope with future changes, will play a very important role for the future of Africa.

Finally, this synthesis presents a number of key actions for agricultural development and adaptation to climate change, which can be used to reflect on the highest priority actions to be implemented for the agricultural sector in Africa.