



CLIMATE-SMART AGRICULTURE

Increased Productivity and Food Security, Enhanced Resilience and Reduced Carbon Emissions for Sustainable Development

Opportunities and Challenges for a Converging Agenda: Country Examples



THE WORLD BANK



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1818 H Street, NW
Washington, DC 20433
Telephone 202-473-1000
Internet www.worldbank.org/ard
E-mail ard@worldbank.org

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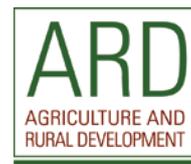


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Abbreviations

AfDB	African Development Bank
AU-NEPAD	African Union-New Partnership for Africa's Development
CAADP	Comprehensive African Agricultural Development Program
CCAFS	Climate Change, Agriculture and Food Security Program
CDM	Clean Development Mechanism
CGIAR	Consultative Group for Agricultural Research
CH ₄	Methane
CIF	Climate Investment Funds
CO ₂	Carbon Dioxide
CTF	Clean Technology Fund
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuria
FIP	Forest Investment Program
GAFPS	Global Agriculture and Food Security Program
GFRP	Global Food Crisis Response Program
GHG	Greenhouse Gases
GNI	Gross National Income (Atlas method from World Development Indicators)
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IFAD	International Fund for Agricultural Development
IFAP	International Federation of Agricultural Producers
IFC	International Finance Corporation
LDCF	Least Developed Countries Fund
NAPA	National Adaptation Plans of Action
NEPAD	New Partnership for Africa's Development
OECD	Organization for Economic Cooperation and Development
PAC	Plan d'Action Communautaire
PMV	Le Plan Maroc Vert
PPCR	Pilot Program for Climate Resilience
SREP	Strategic Renewable Energy Program
PROFOR	Partnership on Forests
REDD+	Reduced Emissions from Deforestation and Forest Degradation
UNFCCC	United Nations Convention on Climate Change
WOCAT	World Overview of Conservation Agriculture
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
WFP	World Food Program

Executive Summary

The purpose of this paper is to summarize the challenges and the practical successes that a selected number of countries are experiencing in moving towards “climate-smart” agriculture while also meeting the food requirements of a growing population, broader economic development and green growth objectives. It complements papers prepared in 2010 on technologies and policy instruments, research, and farmers’ perspectives. The paper summarizes key messages and country experiences. It looks briefly at how the broader policy environment affects country programs, at the newer financing instruments for both food security and climate-smart growth, and the extent to which countries have been able to leverage and combine these.ⁱ It is an updated version of a paper prepared for the Hague Conference on Agriculture, Food Security and Climate Change in November 2010, but brings an additional focus on African countries.

The paper is also intended to provide a broad country perspective to two additional papers produced for a meeting of African Ministers of Agriculture which took place in Johannesburg in September 2011ⁱⁱ. These are described briefly below.

- (i) **A Policy Brief on Climate-Smart Agriculture.** This briefly defines climate-smart agriculture and summarizes good practices. It emphasizes that climate-smart Agriculture seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers’ resilience to climate change, and reduce agriculture’s contribution to climate change by reducing greenhouse gas emissions and increasing carbon storage on farmland. The paper underlines that climate-smart agriculture includes proven practical techniques in many areas, especially in water management but also innovative practices such as better weather forecasting, early warning systems, and risk insurance. It is about getting existing technologies into the hands of farmers and developing new technologies such as drought or flood tolerant crops to meet the demands of a changing climate.
- (ii) **A Brochure on Climate-Smart Agriculture** which includes practical examples of “climate-smart agriculture” projects covering a range of areas including weather-based

ⁱ The paper includes country notes on four additional countries: Ethiopia, Ghana, Burkina Faso and Vietnam. The complementary Papers prepared for The Hague, on Technologies and Policy Instruments, on Research, and on Farmers’ Perspectives, were produced by FAO (Food and Agriculture Organization), CGIAR (Consultative Group on International Agricultural Research) and IFAP (International Federation of Agricultural Producers) respectively. This updated paper, while looking at experience across regions, has a particular focus on Africa. African leaders are committed to addressing agricultural productivity and food security in a changing climate. AU-NEPAD (African Union-New Partnership for African Development) is playing a key role in coordinating this work. The AU has approved an African Agriculture Climate Change Adaptation-Mitigation Framework document, which would facilitate mainstreaming climate-smart agriculture into the CAADP (Comprehensive African Agricultural Development Program). And seventeen African countries are preparing REDD (reduced emissions from deforestation and degradation) strategies.

ⁱⁱ These papers were all prepared collaboratively, by CGIAR, FAO and World Bank staff working with AU-NEPAD, and with inputs from key partners including IFAD (International Food and Agricultural Organization), WFP (World Food Program), PROFOR (Program on Forests) , UNEP (United Nations Environment Program) and the CCAFS (Climate Change, Agriculture and Food Security) CGIAR program..

risk management, conservation agriculture, agro-forestry, watershed restoration, biogas development, livestock and grazing management and improved crop development.

Countries were selected from every developing country region. They include upper middle income agricultural exporting countriesⁱⁱⁱ (Uruguay, Brazil), middle income countries which are facing a range of challenges but which are also making progress in integrating climate into their agricultural strategies (China, Mexico, Morocco), and countries with diverse agricultural sectors (Kenya, Ghana, Brazil, Mexico, Vietnam). They include also countries for which the greatest challenge is water stress, (Uzbekistan, Yemen, Morocco), countries most heavily exposed to climate risks (Albania, Bangladesh, Vietnam, Niger), and lower income countries facing critical food security challenges (Niger, Yemen, Ethiopia, Burkina Faso). More detailed country notes are provided in the Annex. The countries provide diversity in terms of income and agro-climatic challenges as well as natural resource abundance.

The main conclusion is that a number of countries have made impressive progress in integrating “climate-smart agriculture” into broader development and growth programs. Several countries are supporting policy measures and programs to conserve soil and moisture while enhancing productivity and competitiveness, and are addressing the particular concerns of drought-prone semi-arid areas. They are improving agricultural water management and watershed management, and addressing sea-surges, salinity and coastal flooding. Some are tackling the particular challenges of livestock, fisheries, and deforestation. Some of the most land-stressed countries have succeeded in reversing deforestation and several have included agriculture and natural resource management as a core part of their low carbon growth strategies.

Some countries are also including climate-smart agriculture as a core element in broader green growth agendas. These include countries as diverse as Ethiopia and China. Some regions, including Africa, have articulated their commitment to addressing the challenges of increasing agricultural productivity in a changing climate, through commitments made at continental level. And some countries have put in place the enabling policies and incentives that are key for practical success.

Food insecure countries face the greatest challenges of all but have made progress in locally driven development initiatives in both social protection and soil and water conservation, which contribute to resilience. Combining these with support to early warning systems, enhanced agricultural productivity, and value added is a priority. Ethiopia and Northern Kenya have successful programs ongoing in these areas, adapted to farmers’ and pastoralists’ particular priorities, and a similar program is under preparation in Niger. .

Programs which have been successful have been implemented to scale, and over a substantial period, adapting and taking on new lessons as they progress. Successful

ⁱⁱⁱ The countries selected include Uruguay, Brazil and Mexico from Latin America, Albania and Uzbekistan from Europe and Central Asia, Morocco and Yemen from North Africa and the Middle East, Ghana, Burkina Faso, Niger, Kenya and Ethiopia from Africa, Bangladesh from South Asia and China and Vietnam from East Asia.

programs have benefited from strong local farmer ownership and participation, often within decentralized government structures. Integrated landscape approaches have been key to success, together with support measures for managing weather risk, diversifying household income and improving market linkages. Examples include China, Ethiopia and Mexico. Bangladesh and Burkina have made local communities the center of their disaster management and landscape restoration programs. Barriers to large-scale adoption of climate-smart agriculture remain, however, in many countries, particularly as regards overcoming the short term costs often associated with the transition.

The private sector has a key role to play in climate-smart agriculture, especially where the enabling environment has been favorable. Recent regulatory reforms in Brazil, for example, have improved the incentive framework for climate-smart and environmentally responsible investment in agriculture and forest management. And in Vietnam there has been a rapid transition to aquaculture in the low-lying Mekong delta areas which are exposed to saline water intrusion.

Within the broader policy environment, secure land rights, a focus on research and knowledge dissemination, a pattern of public policy measures which favor sustainable land and water management rather than price support or energy subsidies, and which provide an enabling environment for value added, commercialization and trade, all play a role. For the poorest countries productive social safety nets which support investment in land management are key. A challenge in some countries is to match sound legal and policy frameworks with practical incentives and support measures for implementation by farmers, in order to overcome the short term costs that may be barriers to adoption.

Achieving Climate-Smart agriculture needs an integrated approach, tackling productivity and food security, risk and resilience, and low carbon growth together, but integration and institutional coordination remains a challenge in many countries. Agencies charged with agriculture, forestry, environment, water resource management and weather forecasting often face challenges in designing and supporting implementation of integrated programs. Services such as weather and climate services or financial and risk management mechanisms often also need to be strengthened and adapted to meet the needs of diverse stakeholders. Budgeting arrangements and financing sources often do not facilitate coordination. Coordination between different levels of government and participation of citizens in decision making society more broadly is also sometimes a challenge. Development partners often also face similar challenges.

A number of new funds have been developed to support agriculture and food security, including GAFSP (the Global Agriculture and Food Security Program) and GFRP (The Global Food Crisis Response Program). Climate funds also supporting agriculture and forests include the Pilot Program for Climate Resilience (PPCR) and the Forest Investment Program

(FIP) under the Climate Investment Funds^{iv}, as well as the Climate Funds supported by GEF and UNDP and other development partners, and the Global Fund for Disaster Risk Reduction.

Development partners including the Multi-lateral Development Banks, WFP and IFAD as well as foundations such as the Gates Foundation are also scaling up support for climate-smart agriculture and agricultural research. Bilateral partners such as Norway and the United Kingdom also have a particular focus on climate change issues. Norway is a leader on the REDD plus agenda (reduced emissions from deforestation and forest degradation)^v. The CGIAR is preparing a report on the topic for Durban in cooperation with UK support, and has embarked on a major program addressing Climate Change, Agriculture, and Food Security (CCAFS). Most importantly, as noted above many countries are themselves investing in climate-smart agriculture. This paper focuses on these programs and development support for them, with a particular focus on that provided by the World Bank.

There is growing recognition that since agriculture, including forestry, livestock and land-use changes, account for over 30 percent of GHG (global greenhouse gas emissions), the sector needs to be included in future climate change agreements. Emissions reductions from improved livestock practices are eligible for carbon finance under the CDM (Clean Development Mechanism), while the work is well advanced for including REDD+ (reduced emissions from deforestation and forest degradation) in future climate agreements. More broadly also REDD plus, acknowledging that agriculture is the main driver of deforestation, recognizes the interface between sustainable agriculture and reduced deforestation. Soil carbon and carbon sequestration from improved agricultural practices are not yet eligible, however. And at country level there is often insufficient integration between forestry and agriculture agendas despite the recognition that “re-greening landscapes” is a key element of climate-smart agriculture. In Africa emissions from land use, land use change and forest egradation/deforestation account for nearly 70% of GHG emissions.

The challenge and the opportunity for countries is to bring different funding mechanisms together and combine them with public, private and international development financing to invest at the scale needed to achieve the goals of climate-smart agriculture and food security.

^{iv} The Climate Investment Funds also include the Strategic Renewable Energy program, which can support biomass energy, and the Clean Technology Fund.

^v REDD plus expands the concept of REDD to include conservation, sustainable forest management and enhancement of carbon stocks in forests. It recognizes the key role of local communities and indigenous peoples in the REDD agenda.

2. Key Messages

The key messages are the following:

1. Sustainable intensification and productivity enhancement are key elements of climate-smart agriculture, but need to be combined with broader landscape restoration measures.

- As large, diverse countries whose farm sectors are largely made up of small farms, Mexico and China are meeting their climate-smart development objectives through a mix of measures. China's focus is on supporting technologies for sustainable intensification, on improving the productivity of agricultural water management, on managing its livestock sector to enhance soil fertility, diversify rural energy sources and reduce emissions, and on addressing agricultural pollution. China has also had a long term program of watershed and agricultural landscape restoration and is now a net carbon "sequesterer" from land-use changes. Mexico's agricultural and water sector programs, while supporting sustainable productivity enhancement, focus on adaptation, with public support for a number of measures to increase resilience. There is support also for improved animal waste management, forest fire management and reforestation. Both countries combine support for intensification and value-chain enhancement with broader watershed and landscape restoration.
- Vietnam, land-scarce like China, has initially focused on food security, and, largely through intensification, has not only largely achieved food self-sufficiency but is also a major exporter of a range of rice, aquatic products and other commodities. It has succeeded also in reversing deforestation through a re-greening program. The priority now is to move up the value chain and to manage environmental challenges. Ghana has also achieved food security broadly, but agricultural growth has been largely through area expansion and there has been rapid deforestation and broader landscape degradation. Its priority is to support productivity increases and enhanced value-added throughout the production, processing and marketing value-chain, while also supporting landscape restoration and improved on-farm soil and water management.

2. Successful programs need a long term commitment and strong local ownership, through bottom-up approaches that are adapted to local circumstances. They need to be implemented to scale to have impact, and landscape restoration and social protection measures can often advantageously be combined. This approach has been successful even in highly challenging environments.

- The Arid Lands program in Kenya was implemented over a twelve year period. It combined community led approaches to risk management, food security and social safety nets with measures to enhance pastoral and crop resilience. It evolved in the light of lessons learnt, introducing early warning and livelihood diversification approaches. Burkina has also had a long-established program of participatory local

development with natural resource management as a key element. The watershed restoration programs in China have adapted in the light of lessons learnt.

- In Ethiopia the Productive Social Safety nets program has sought since 2005 to enhance food security by increasing the resilience of populations living in food-insecure areas to drought and other shocks. It has combined cash for work with early warning systems and social safety net measures, and has focused interventions on erosion control and other soil/moisture conservation measures as well as local public works. Adapting, taking account of lessons learnt, and taking advantage of advances in information technology, it has introduced weather-based risk reduction mechanism using different technological and geospatial applications. Program funding totals US\$ 4.4 billion over a 10 year period.
- Studies on adaptation undertaken in Europe and Central Asia emphasized the need for public awareness, information dissemination and solutions adapted to local circumstances.

3. The quality of public policies and support measures is as important as the quantity. Patterns of public support which focus on research, support for investments in soil and water conservation, weather and climate services, land tenure, technology and value chain development rather than on commodity or input support are generally more effective, benefit more farmers and are more sustainable in the long run. The exception is where input use is currently very low.

- Brazil for example has a low overall level of state support for agriculture (5.7% compared with an OECD average of 26%). But it has focused on support measures which enhance the value of its natural capital and provide an enabling environment for sustainable private sector investment. A major focus has been public investment in agricultural research by Brazil's national research organization EMBRAPA, with accompanying investments in soil fertility enhancement, land and water management systems, and crop and livestock breeding for varieties adapted to Brazil's climate and ecosystems. Over half Brazil's grains are now grown using minimum tillage, an approach which conserves water and organic matter in the soil. These investments have been complemented at the state level by measures to enhance competitiveness and environmental sustainability through support for improved value added chains and producer organizations for family farms, innovations, food safety enhancement measures, rural infrastructure development, and support to improved water, environmental and biodiversity management. A lesson from Brazil is that the pattern of public support, investing in research and support measures which are adapted to tropical soils and restore rather than mine them, as opposed to providing commodity subsidies, is highly effective in increasing productivity in a "climate responsible" way.
- Where input use is low, as in a number of African countries, initial support for use of modern inputs up to a certain level may be justified. Kenya for an example has a targeted program to support fertilizer use. And many countries support initial use of

improved seeds. Vietnam, while encouraging water and fertilizer conservation, promotes use of improved seeds.

4. Aligning strategies and policies with enabling measures, incentives and institutional support mechanisms is key to the success of climate-smart agriculture. These need to be adapted to country circumstances and provide incentives for responsible private sector investment both large-scale and small-scale

- Following severe droughts in the 1970s and early 1980s, Niger undertook three key policy reforms. First, it gave land-users (private farmers) the rights to the trees on the land they farmed and grazed; second, it put in place simple land registration mechanisms; and third, it began a policy of decentralization. These reforms, combined with modest support measures for forest regeneration, laid the framework for the farmer management forest regeneration program, a ‘regreening program’ covering 5 million ha that has increase soil organic matter, fertility, reduced erosion and conserved moisture, and provided fodder for animals.
- The successful Loess Plateau landscape restoration program in China similarly included two key policy enabling measures: farmers agreed to fence their goats and stop free grazing; and they had user rights over restored lands. Similarly in Albania a successful landscape regeneration program included provision for clarity over community land-user rights and decentralized decision making as well as a matching grant mechanism to overcome short term barriers to adoption.
- Brazil has instituted regulatory policies requiring lending for forests and agricultural development by its largest development bank to be conditional on satisfactory environmental protection measures which avoid deforestation and land and water pollution.
- In Uzbekistan land privatization together with some liberalization in marketing has enabled a doubling of wheat yields in recent years.

5. Water management is a critical challenge in water stressed countries; Measures to enhance agricultural water productivity are often most helpful if combined with measures to support broader economic diversification

- In Morocco private farmers are making great progress with water conservation technologies in high value irrigated agriculture, but broader support to social protection and broader socio-economic development measures as well as to sustainable land management is the priority in the rainfed areas. In Yemen also broader socio-economic diversification and food security measures combined with support to water harvesting are key, together with policies that encourage water conservation.
- In arid areas of China the concept of “total water productivity” is being supported; the aim is for less evapo-transpiration, through improved monitoring, just-in-time water

application and development of less water demanding varieties. The “sustainable rice intensification” approach of rice cultivation using less water, well tested in more drought prone parts of Bangladesh, and mixed rice-fish systems in both Bangladesh and Vietnam, are examples of combining improved agricultural practices with water management.

6. In the countries most highly exposed to climate variability and change, disaster management and a climate resilient, diverse agricultural sector are closely linked.

- For Bangladesh flood and cyclone management is key to food security and climate resilience but agricultural diversification and technology development are also major development pillars. For Albania watershed and water resource management and improved flood risk mechanisms go hand in hand with agricultural innovation and enhanced value added on the more fertile lands.
- Vietnam is improving its water resource management policies and structures and adapting its cropping and aquaculture regimes to manage flood risk and increasing salinity levels. It is also supporting enhanced value added and diversification strategies.
- Ghana’s agricultural strategy includes programs for sustainable and water management and emergency preparedness.

8. Integration of the productivity, adaptation and mitigation agendas remains a challenge and must be addressed if climate-smart agriculture is to achieve the triple wins, both in strategies and in financing mechanisms

- Integration between agendas remains a challenge, both within countries and within development partner and financing organizations. Agriculture, water, environment, forestry and weather and climate services often have different institutional structures and funding channels. Food security, adaptation and mitigation benefits are often addressed separately, while for climate-smart agriculture these objectives should be addressed together. The green growth agenda may provide an additional opportunity for integration.
- The new funds for food security and climate-smart agriculture will be most effective if blended with ongoing support programs and there is scope for focusing more on synergies between the two agendas. Niger is both a PPCR (Pilot Program for Climate Resilience) and GFRP (Global emergency Food Response Program) country for example, and Yemen and Bangladesh are all PPCR and GAFSP (Global Agriculture and Food Security Program) countries. Ethiopia is participating in both GAFPS and SREP (Strategic Renewable Energy Program). Carbon finance has worked well when combined with other development finance (e.g. fuel wood plantations as part of the Community Action Program in Niger, carbon finance to off-set part of the costs of biogas development in China, carbon sequestration as an additional benefit of reforest

and pasture regeneration in Albania, or agricultural productivity enhancement in Kenya).

- Carbon finance has supplemented other finance so far to a limited extent, and mostly in middle income countries. Lower income countries need faster access, and inclusion of soil carbon in addition to REDD and reduced emissions from livestock is a priority.

9. Climate-smart agriculture must play a core role in GHG emissions reduction and strategies to facilitate this are being developed in some countries

- Agriculture and land-use change account for over 50 percent of GHG emissions in Uruguay, of which methane from farm animals constitutes the great majority. Uruguay is taking a holistic approach to the issue, improving pasture-land and hence animal nutrition, supporting improved livestock breeding, reduced tillage practices on cropland together with improved crop breeding, and promoting afforestation, shelter and protection of native forests. Uruguay also has a number of subsidized climate-related crop insurance schemes in place. This combination of measures to support resilience and reduced emissions is already contributing to reduced CO₂ and CH₄.
- Agriculture and forestry form part of the low carbon growth strategies of Brazil, China and Mexico. Approaches combine adaptation and mitigation benefits. Brazil has supported large-scale minimum tillage and broader soil conservation measures, is introducing integrated livestock/crop systems and has adopted a series of measures sharply to reduce deforestation. Mexico also supports integrated landscape management and conservation, fire management, energy efficiency, methane capture from livestock and reforestation. Both Brazil and Mexico are participating in the Forest Investment Program, and Brazil is also benefiting from substantial support to address REDD (reduced emissions from deforestation and forest degradation), while also channeling local investment and policy support to this agenda.
- Low income countries have focused on adaptation rather than mitigation, but are increasingly adopting integrated approaches. Ethiopia, Ghana, Burkina Faso, Niger and Kenya, for example, all recognize that “regreening” agriculture and broader landscapes is essential for resilience and reduced carbon growth strategies as well as for providing the foundation for long-term soil fertility and productivity. Ghana and Burkina Faso are both participating in the Forest Investment Program, and for both the interface between improving agricultural land-use practices and reducing deforestation is a core part of the agenda.

3. Country Summaries

This section summarizes some of the climate-smart agriculture and natural resource strategies and programs of the countries selected for this paper.

Albania: Managing agriculture in a mountainous country highly exposed to climate risks and change.

Albania's economy has grown rapidly in recent years: with growth rates of over 7% annually, poverty levels have halved since 2000. Per capita GNI is estimated at US\$ 3,900 and 53% of Albania's 3 million people live in rural areas.

Agriculture accounts for 21 percent of GDP but 58 percent of employment and 20 percent of exports. 56 percent of agricultural value added is from livestock, much of it raised in the highlands. The share of primary agriculture in GDP has declined as services and construction sectors have grown. The flatter coastal areas are dominated by crop production, with most value added from vegetables, and the mountainous areas by forestry and pasture. South Eastern Europe is one of the regions most affected by climate change; Albania is already highly vulnerable to floods and droughts, and over the next 40 years mean temperatures are predicted to increase by 2 degrees Celsius and precipitation to decline by 8 percent. Rainfed areas will be relatively more vulnerable than the irrigated land on the plains. 46 percent of GHG emissions come from agriculture, land-use change and forestry.

Albania's Inter-Sectoral Rural Development strategy (2007-2013) prioritizes enhancing competitiveness through strengthening agro-food chains and higher value added production. A recently closed agricultural services project has supported these initiatives. Albania's forests and pastures play a key role in landscape and watershed conservation as well as in provision of fodder and fuel, and there has been a successful community based reforestation and pasture management which has also benefited from carbon finance through the Biocarbon fund. Land reform has supported development of a clear land rights system, and this has facilitated private investment in land productivity and in pasture and forest restoration. The recent water resources program has focused on dam safety, irrigation and drainage restoration and river bed restoration to help reduce vulnerability to climate risks. A grant for disaster preparedness is strengthening institutional capacities in this area, and Albania, highly dependent on hydro-power, is addressing broader water resource management also in the context of its energy strategy.

Albania's "climate-smart" agricultural strategy will focus on increasing resilience (in upper as well as lower watersheds), on continued rehabilitation of pasture and forest-land on hillsides, on improved irrigation and drainage management and on increasing intensification and value added for higher value livestock and horticultural products. These areas were also identified as priorities following an analysis of adaptation priorities in agriculture which included widespread consultations. The EU accession process provides opportunities in scaling up investments in climate-smart agriculture and green development more broadly.

Bangladesh: Meeting food security goals in a densely populated country highly vulnerable to natural disasters.

With a population of 160 million, per capita GNI of US\$ 580, with arable land of only 8 million hectares, and with agriculture accounting for 63 percent of employment and 20 percent of GDP, Bangladesh has one of the highest “man-land” ratios in the world while a highly productive agricultural sector is key to food security. Despite these challenges the economy has shown robust growth and poverty levels have declined from 57% in 1990 to 32% in 2010. 72% of people live in rural areas. Economic growth averaged 5.9% annually over the 2000-2009 period.

As a low lying downstream riparian country (70 percent of land area is 5 m or less above sea level) Bangladesh is also one of the countries most exposed to extreme climate events and to the impact of climate change, from both flooding and sea-water intrusion. 20-30 percent of the land area is flooded annually. Enhancing resilience is a major challenge not only for agriculture but for the substantial non-farm rural economy. In 2009 Bangladesh approved a Climate Change Strategy and Action Plan with an integrated approach and a particular focus on disaster preparedness.

Bangladesh’ agricultural strategy includes measures for technological innovation, diversification from rice into higher value livestock, fisheries and horticulture, and land and water management. Disaster management forms a key part of its strategy, with 6 million ha of agricultural land under some form of protection, a large program of coastal protection including structural and non-structural measures, flood warning systems and elevated ‘safe havens’ in many areas. A major challenge is to manage water sustainably. 56% of GHG emissions derive from agriculture and land-use, with livestock and paddy rice playing a major role.

Ongoing programs include a National Water Management Improvement Program, which is introducing a more integrated approach to flood management, and protection drainage and irrigation, restoring natural regimes where appropriate. A National Agricultural Technology Program is supporting innovation, crop diversification and demand driven extension and value-chain development. An Emergency cyclone recovery and restoration program would support enhanced crop, livestock and fisheries productivity in cyclone affected areas. A Social Investment Empowerment program supports broader livelihood and risk reduction measures using decentralized approaches. Bangladesh is participating in the GFRP (Global Food Crisis Response Program) and PPCR (Pilot Program for Climate Resilience) and in GAFSP (Global Agriculture and Food Security Program). Funding of US\$ 110 million under its PPCR, approved in November 2010 for US\$ 110 million, and integrated with larger programs, supports climate resilient agriculture and irrigation, strengthening of coastal embankments and afforestation, and climate resilient coastal infrastructure.

For Bangladesh disaster management, food security, social protection and climate resilience go together, accompanied by broader programs for socio-economic development and diversification.

Brazil: A diverse country and a food producer for the global market where improved land management is a key element in climate resilient, low carbon, environmentally sustainable and competitive growth.

With a land area of 8.5 million km², Brazil has highly diverse and favorable growing conditions for a range of commodities; agriculture accounts for only 7 percent of GDP but in 2009 Brazil accounted for 28% of world trade in agricultural commodities. Yet in 1970 it was a net food importer. Brazil's successful record on inclusive growth is well known; poverty levels have fallen from 20% of the population in 2004 to 7% in 2010. 15% of Brazil's population of 194 million lives in rural areas and per capita GNI is approximately US\$ 9300.

Deforestation and land- use changes associated with expansion of agriculture and livestock account for over 70 percent of GHG emissions in Brazil, which is globally the fifth largest GHG emitting country. 57 percent of the land area is forested and 24 percent is pasture land. Expected climate change impacts vary regionally, with increased water stress expected in the already drought-prone north-east and reductions in the areas suitable for cultivation of a number of key crops, including and especially soybean and coffee.

While Brazil's overall level of support to agriculture is low (under 6% compared with an OECD average of 26%), it has invested heavily in research in crops and farming systems adapted to its soils and climate through its National Research Organization EMBRAPA^{vi}, also focusing policy support and incentives on these measures. A substantial part of its research has focused on the less fragile, low fertility Cerrados areas, thereby reducing pressure on the more vulnerable Amazon forests. It has also created an enabling environment for value-chain enhancement. Agro-processing employs 18 million people and accounts for 28% of GDP.

Brazil is supporting a suite of policy measures to support the agricultural sector to enhance land and water management and enhance carbon sequestration in the agricultural landscape, while adopting improved technologies, business practices and marketing chain approaches. Programs are developed by and adapted to specific regions. Specific examples include rural competitiveness programs in Santa Catarina, Sao Paulo and Rio states, programs targeted at improved water management and market integration in the arid north-eastern provinces, and a program addressing locally adapted development in the Amazon state of Acre. Biofuels are also part of a low carbon growth approach. Brazil has a favorable climate for these and supports measures which focus their development largely in areas of abandoned pasture-land.

Brazil is committed to reducing deforestation in the Amazon by 80 percent by 2015. It has established ecological/economic zoning plans, and put in place a satellite monitoring system enabling prompt action against illegal activities. The Forest Code provides for the maintenance of vegetative cover on private rural property. The Brazil Development Bank,

^{vi} **Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA)** (Brazilian Enterprise for Agricultural Research) is a state-owned company affiliated with the Brazilian Ministry of Agriculture, which is devoted to pure and applied research on agriculture. EMBRAPA conducts agricultural research on many topics including animal agriculture, crops and integrated soil fertility management.

source of one-third of long term development lending, has restructured its lending guidelines on forests and agriculture including livestock to provide incentives for long term sustainability and ensure that project proponents have the necessary environmental permits.

Brazil's approaches are articulated in key policy documents such as the environment agenda within the National Plan (PPA), the Sustainable Amazon Plan (PAS) and the National Water Resources Plan, which aim to address environmental sustainability and climate change at the inter-sectoral level and within targeted sectors such as agricultural lands, forests, water and energy. These programs have been supported by the Bank through development policy lending. Improved irrigation and drought management form part of the resilience program and Brazil also has targeted social protection programs and agricultural insurance programs. Brazil is participating in one of the new climate investment funds, the FIP (Forest Investment Program) and in carbon trading through CDM in agriculture, for projects related to improved animal waste management and biomass electricity generation. It currently has no registered projects in afforestation or reforestation.

Brazil is now sharing its experience with other countries, including in Sub-Saharan Africa.

Burkina Faso: Community-based approaches to sustainable land management and agricultural productivity enhancement in a country facing climate stress and a rapidly growing population.

Agriculture accounts for 33 percent of GDP and 80 percent of people live in rural areas. A land-locked country with 15 million people and 44 percent of the population under the age of 15, Burkina is one of the most densely populated countries in the Sahel. Despite steady economic growth and political stability, Burkina is one of the poorer countries in Africa, with per capita GNI of US\$ 480 and 37% of the population facing food insecurity.

Always subject to variability, Burkina's climate is predicted to get hotter, with less predictable rainfall, over the coming decades, putting increasing stress on an already vulnerable population. Agriculture and land-use change (primarily from conversion of forest lands to agricultural lands) account for of 56% CO₂ emissions, which have risen by 30% in the last 10 years. Fuel-wood is the principal energy source and sustainable management of fuel-wood production is key to broader "climate-smart" land use.

Burkina's growth strategy emphasizes development of a broader and more sustainable resource base to support intensification and diversification of the economy, especially in rural areas, while supporting broader poverty reduction and food security measures. Two key pillars of agriculture and rural development are thus enhanced productivity, competitiveness and intensification, together with sustainable land and water management to ensure the long term basis for continued productivity increases. Burkina's strategy also builds on its strong track record in decentralized, participatory approaches to rural development.

With regard to the productivity agenda, the program includes support for growth pole development in Bagre in Tenkodogo region in southern Burkina, supporting value-chain and small and medium enterprise development as well as irrigation and supporting infrastructure development to enable more intensive production systems. A second pillar focuses on improving access to improved technologies for poor producers, through both matching grant and voucher for work schemes.

With regard to sustainable land and water management, Burkina has a strong tradition of participatory approaches to improved soil and water management, including water harvesting and agro-forestry through the “aménagement des terroirs” programs. As a participant in the Forest Investment Program Burkina seeks to focus on approaches which achieve benefits in resilience and productivity as well as improved carbon sequestration and reduced deforestation/forest degradation (REDD +).

Challenges include strengthening capacity at decentralized level, continuing to progress with securing simple, transparent land tenure regimes, and improving coordination between the different agencies responsible for agriculture, water management, forestry, environment and sustainable development.

China: Towards low carbon, climate resilient agriculture, land and water management while increasing productivity and intensification.

China is increasingly facing up to the challenge of managing its resources sustainably in a changing climate, while meeting objectives of food security and poverty reduction. It is a rapidly growing, urbanizing economy: 44% of people now live in urban areas compared with 27% in 1990. Agriculture contributes about 13 percent of GDP and includes about 250 million farm families, mostly with small-holdings of 1 hectare or less. Per capita GNI is estimated at US\$ 4,856. China is projected to suffer from increasing water stress and rising temperatures in several regions. The agricultural sector accounts for 15 percent of GHG emissions mostly from the livestock sector and from paddy rice, and has become the largest source of water contamination. Addressing the environmental footprint of agriculture is a major challenge for China.

China’s priorities for agriculture cover continued modernization through market development, technical innovation, intensification, food safety, regional development, improved land tenure security, disaster management and climate resilient low-carbon agriculture. The strategy involves moving away from quantitative targets. China is developing a vision for agriculture in 2030 as part of a broader green growth strategy; it includes further shifts in support measures from input support to support for watershed and sustainable management, research, insurance and climate risk management, use of weather based information, support for

improved, climate resilient varieties and a continued shift away from cereals towards higher value products.

Regarding climate risks, China's priority is to strengthen the resilience and reduce the emissions of the agricultural sector through technology enhancement, rural energy and land and water management. It has made progress in this regard in key national grain production areas (such as changing cropping patterns, irrigation and water saving technologies and support for more resilient varieties), in water stressed regions, in coastal regions and in ecologically fragile areas.

China, thanks to its longstanding reforestation and watershed management programs, is now a net "sequesterer" of carbon from land-use and forestry. Its Loess Plateau program restored degraded landscapes while increasing productivity. Its reforestation programs have helped stem watershed erosion and have adapted over the years. They now include support for a greater diversity of species, and more effective community management.

Programs supported by the Bank include the innovative Irrigated Agriculture Intensification Project which seeks to improve productivity of agricultural water management, and the Agricultural technology and Jilin food safety project, which supports value chain development and risk management, as well as a movement away from government being a direct actor to being service provider. China has a number of operations addressing agricultural pollution prevention and climate mitigation, including Biogas projects some of which have CDM support, and the Henan Yellow River Ecological livestock project. China is supporting improved management of its vast grasslands, supporting improved livestock productivity, better grazing and pasture management practices. This program is also benefiting from pilot carbon finance. The earlier Coastal Zone Management project established pollution monitoring systems and fisheries resource management. As part of a green growth agenda China is increasingly focusing on food safety and agricultural pollution issues. It is tackling land consolidation as the farming population gradually declines and agricultural labor costs increase.

A new Comprehensive Agricultural Development project is under preparation which would cover key grain provinces and invest in improved land and water productivity, crop yields, fertilizer management and rural energy efficiency and would scale up further the lessons learned in resilience and mitigation. The experience in China demonstrates the synergies between "climate-smart," broader environmentally sustainable agriculture, sector modernization and food security as it develops a long term vision for a "prosperous, green, harmonious society".

Ethiopia: Towards a green economy - increasing food productivity and re-greening the landscape while improving social safety nets and drought risk reduction measures.

Ethiopia, with a population of 85 million and a land area of 1.1 million km², has widely varying geography, agricultural ecosystems and climate. 83 percent of its population live in rural areas, and most are dependent on rain-fed agriculture and livestock for their living. With a per capita GNI of US\$ 350 it is one of the poorest countries in Africa. Despite the challenges, poverty rates have declined from 46% in 1999 to below 39% in 2005 (the date of the last comprehensive survey). Improving access to basic services and reducing poverty is a priority for Ethiopia.

Ethiopia is highly vulnerable to drought, which has caused great economic and social hardship; and climate models predict rising temperatures over the coming decades, likely to impose increasing stress on rainfed agriculture. Agriculture, forestry, land-use and land-use change account for 74% of GHG emissions. Fuel-wood is the predominant energy source and especially important in Ethiopia, where heating requirements are significant in highland areas in addition to cooking.

Ethiopia has developed a three pillar approach to addressing food security and productivity, resilience and low carbon growth, with implementation centered around its decentralized government structures. The *first pillar* has focused on social protection and risk reduction, the aim being to reduce by 5 million the number of people who are chronically food insecure, and to increase their resilience, while maintaining a safety net in times of crisis. Its Productive Social Safety Nets program is one of the largest in Africa (US\$ 4.4 billion over the 2005-2014 period) and supports cash for work, including for degraded land restoration and local infrastructure, as well as an a weather risk management system which uses agro-meteorological and social indicators to trigger contingent finance for social protection if a drought occurs. A complementary program has addressed the needs of pastoralists. This program also provides the basis for Ethiopia's response to the current drought in the Horn of Africa.

A *second pillar* is increasing agricultural productivity. A US\$ 280 million is ongoing which aims to increase productivity and market access, supporting farmer organization, value chains, small-scale irrigation and watershed management, as well as market infrastructure and feeder roads. Complementary programs are ongoing to increase access to irrigation.

The *third pillar* is sustainable land and water management. This is in part addressed through elements of the first two pillars, well as through a number of smaller scale initiatives. Ethiopia is participating in REDD and also planning to embark on a broader re-greening program, to enhance longer term landscape resilience, ecosystems functions and productivity as well as take advantage of climate mitigation opportunities, as part of a transition to a green economy. The nation aims at cutting carbon emissions in half through undertaking soil and forest development works, according to a recent statement by the Minister of Agriculture. Ethiopia is the first country in Africa to launch a green growth strategy. Ethiopia is participating in the GFRP as well as in the SREP (Strategic Renewable Energy Program under the Climate Investment Funds).

Ghana: Increasing productivity along the value chain for food, aquatic and forest products while addressing the challenges of climate variability and addressing deforestation and land degradation.

Ghana, with a population of 23 million and a land area of 230,000km², is the most rapidly growing economy in Africa. Per capita GNI was US\$ 1190 in 2009, and half of the population now lives in urban areas. The recent discovery of oil offers new opportunities as well as challenges. Agriculture accounts for 30% of GDP and Ghana is largely “food-secure”, though high poverty levels persist especially in the north of the country.

Ghana has sustained one of the highest deforestation rates in Africa, and adoption of improved land and water management practices more broadly has been limited. Agricultural growth in the past has come largely through area expansion and use of improved technologies is limited though there is a dynamic private sector. Ghana has a vibrant timber industry serving a growing domestic market, but improved harvesting and processing practices would reduce losses. Clarifying land rights remains a major challenge. Ghana has an important fisheries sector with difficult resource management challenges and a value added below potential. Ghana’s climate vulnerabilities relate largely to coastal erosion, and droughts and floods, especially in the north. Agriculture and land-use change account for about half of GHG emissions.

Ghana has prepared a number of strategic documents, and its agricultural strategy was prepared within the CAADP framework. Its key objectives are to support enhanced productivity, sustainable intensification and organized commercialization along the value chain, for agriculture, fisheries and forest products, while supporting improved land and water and broader natural resource management to reverse resource degradation. A particular focus in the north would include a ‘greening’ of the landscape, combined with broader improved watershed management and participatory irrigation development. There is scope also through these measures for the sector to contribute to a lower carbon growth agenda; Ghana is participating in REDD and the Forest Investment Program, with the African Development Bank coordinating program preparation together with the Government of Ghana.

Ghana’s vibrant private sector has a strong role to play. Government is committed to providing an enabling environment for agriculture and renewable natural resources to be a key driver of a diversified, modern economy into the future, even as the country takes advantage of the opportunities presented by the recent discovery of oil. It has developed a number of key strategies for agriculture and natural resource management which also address the challenges of inter-sectoral coordination.

Kenya: Climate-smart development in a challenging environment.

Kenya has one of the most diverse economies in Africa, with substantial foreign exchange earnings from agriculture and tourism, both heavily dependent on the natural environment. Total land area is 580,000 km². Per capita GNI is US\$ 760 and population 40 million, with growth rates of 2.7 % per annum. Agriculture contributes 27 percent of GDP but 75 percent of employment; 78 percent of people live in rural areas. Poverty rates declined from 52% in 1997 to 46% in 2006, according to household surveys. Economic growth in 2010 was 5%, rebounding from rates of only 2.6% in 2009. Steady growth has been challenged by local and global crises, and more recently by the drought in the Horn of Africa.

Geographically diverse, the north and east are arid and semi-arid while the densely populated central highlands have fertile soils and good rainfall. Kenya faces increasingly severe and frequent floods and droughts, exacerbated by land degradation. Yet it has developed regionally adapted approaches to addressing climate risks and creating an enabling environment for private sector development in diverse areas, including commodities such as tea and coffee, high value fruits and vegetables, and livestock.

Kenya's Agricultural Strategy, launched in 2010, has the vision of a "food-secure and prosperous nation", and includes pillars and policy measures to enhance productivity, support irrigation, diversification, food security, research, access to inputs, improved seeds, targeted and time-bound subsidies to the poorest, private sector investment, environmental sustainability and adaptation and mitigation including early warning systems. It aims to achieve an agricultural growth rate of 7 percent per year. The program has been developed within the CAADP (Comprehensive African Agriculture Development Program) framework.

Concerning specific programs, The Arid Lands Program, has been a 12 year program to support agro-pastoralists in the north and north-east manage risk through a mix of community driven technical and social interventions, including improved pasture and livestock management, innovative early warning systems and drought contingency funds. Lessons from this program are key in moving forward with the long term approaches that are being developed to address the current drought in the Horn of Africa together with short term humanitarian assistance and emergency social safety nets.

In Western and South-western Kenya community flood management, watershed management and natural resources programs all aim to improve landscape management, productivity and resiliency with strong community participation. With the help of the BioCarbon Fund Kenya is implementing the Agricultural Soil carbon project, where farmers who adopt sustainable land management practices to enhance productivity receive additional payments based on the carbon sequestered by these activities. The BioCarbon fund is also supporting reforestation

through the Kenya Green Belt Movement project. Thus, these projects capitalize on the synergies between soil carbon, productivity, and climate resilience.

Kenya has highly productive fertile soils in the central highlands which are producing a range of crops for the local and export market. The Agricultural Productivity and Agribusiness program supports private smallholders in technology enhancement and agribusiness and market development, and sustainable land management, building on existing gains in extension, research and small farmer empowerment. Kenya is participating in the Strategic Renewable Energy Program SREP, one of the programs supported under the Climate Investment Funds (in Kenya, biomass accounts for 70% of final energy demand and 90% of rural household energy). The investment program includes an element in support of improved cook-stoves and fuel wood plantations. Kenya participates in the REDD agenda.

Mexico: An agricultural sector program which addresses climate change as a major challenge, with a focus on adaptation.

Agriculture accounts for 4 percent of GDP but 15 percent of employment. Agricultural landscapes play a key role in watershed protection and broader ecosystems conservation, and include highly varied production systems. 23 percent of cropland is irrigated and the sector accounts for 77 percent of water use. 23% of Mexico's population of 107 million live in rural areas and per capita GNI is approximately US\$ 9,000. Land area is 1.96 million km².

Agriculture and land-use changes together account for about 21 percent of GHG emissions. 23 percent of land area is forested but deforestation has played a major role in GHG emissions over the last 20 years. Mexico is expected to experience increasing temperatures, reduced rainfall and increased incidence of extreme weather events over the coming decades, including increased incidence of forest fires and reductions in agricultural productivity.

Mexico's 2007-2012 Agricultural Sector and Water Program both focus on climate adaptation; they include support measures for crop rotation and fertilizer management, targeted research, seed reserves, conservation tillage, extreme weather events, wild land conservation, improved agricultural water management, flood and integrated water managements. Related mitigation support includes promotion of zero tillage, reduced use of fire, reforestation, and methane capture from livestock and more efficient use of energy in fisheries. Mexico has 23 CDM projects related to agriculture all addressing animal waste management. It also has its own Mexico Carbon Program.

The World Bank is supporting Mexico's program through a series of Development Policy Loans, including one on Adaptation to Climate Change in the Water Sector, and through a Sustainable Rural development project which also addresses agri-businesses, and community based rural development/natural resource management operations. Mexico is also participating in the FIP (Forest Investment Program). While grounded in REDD the FIP will

be prepared within the broader context of rural development, taking into account also the role that agriculture and livestock have played in deforestation. Local communities, which own a large proportion of Mexico's forests following widespread land reform programs, will be the principle participants and beneficiaries of the proposed FIP.

Morocco: Adapting to increasing water stresses while addressing social challenges and modernizing the sector.

. Morocco has a land area of 447,000 km² and a population of 32 million. Per capita GNI is US\$ 2,770 and 44% of people live in rural areas. Morocco is water stressed. Agriculture contributes 15% of GDP, about 45% of employment and 20% of exports. The sector characterized by its duality, with a commercially oriented irrigated sector and a less productive rainfed sector. Morocco has made great progress in reducing poverty in recent years; rural poverty levels, 25% in 2000, were 14% in 2007.

Irrigated land comprises 15 percent of cropped area, but over 50 percent of the value of production, and irrigation accounts for over 85 percent of water use. The rain-fed sector is dominated by low yielding cereal production which is highly vulnerable to fluctuations in rainfall, grown by small-holders, many of whom are aging. Morocco currently imports 50 percent of its cereal needs.. Morocco is predicted to become drier and hotter, placing increasing stresses on both rainfed and irrigated production. Agriculture accounts for about 27 percent of GHG emissions mostly from soil degradation.

Morocco's 2008 agricultural strategy Le Plan Maroc Vert (PMV, Morocco's Green Plan) envisages a sector overhaul in terms of cropping patterns, land tenure and taxation, including international trade liberalization, with two major pillars: support to rapid growth and competitiveness of private farmers in the modern, irrigated sector, and rural poverty reduction measures in the rainfed sector. Increased agricultural water productivity is major theme in this strategy and key to sector resilience. The PMV also envisages a major greening of the landscape through a variety of programs including conversion of wheat growing areas to olives and broader landscape restoration. This program could contribute to a low carbon growth strategy for Morocco. The PMV is increasing its focus on resilience, and there is potential for reducing emissions and increasing carbon storage

The World Bank is supporting the PMV through development policy lending, and with GEF support is addressing knowledge gaps and pilot adaptation measures; it is also supporting improved irrigation management through the Modernization of Irrigated agriculture in the Oum Er Rbia basin program. Morocco is strengthening decentralized, community driven approaches and these will play a key part in climate-smart agriculture and broader growth over the coming years.

Niger: Food Security, enhanced agricultural productivity and climate resilience are converging challenges in one of the world's most vulnerable countries.

Niger has a land area of 1.2 million km and a population of 15.3 million, with population growth rates of 3.3% per annum. A Sahelian country with highly variable rainfall and 84 percent of its population of 15 million lives in rural areas, largely dependent on land based activities for survival, including cropped agriculture and livestock-raising. Per capita GNI is approximately US\$ 340 and agriculture accounts for about 40% of GDP. Niger is committed to improving human development indicators, currently among the poorest in Africa; nearly 50% of the population suffers periodically from food insecurity and nearly one child in five dies before the age of five.

Agriculture, together with land-use change, accounts for nearly 90% of GHG emissions. However, resilience is the main challenge. The 2009-2010 drought exposed some areas to famine. Temperatures are projected to increase and the incidence of extreme weather events to become more frequent over the next decades. Only 3 percent of the rural population has access to electricity and overall GHG emissions are very low. Fuel-wood is the main source of energy. The 2008-2012 Poverty and Economic Growth strategy recognizes the key role of agriculture and the impact of climate on development and human welfare.

The government is addressing these challenges through a strategy which combines support for increased intensification on the most productive lands, commercialization of both crops and livestock products, improved land and water management to address soil fertility, erosion and run-off issues, and a social safety net program. Niger's Farmer Managed Forest Regeneration Program has also been instrumental in enhancing fertility on over 4 million hectares of agro-silvi-pastoral land use systems over the last 25 years, contributing to a "re-greening" of the Sahel. Decentralization, and giving farmers rights to trees, has been key to its success.

Government also recognizes the key role of addressing core development issues of health, education and access to basic services. Niger's Community Action Program (PAC) is key to these agendas. It supports local capacity building to deliver development at commune level, and includes social protection, local infrastructure, piloting soil conservation and afforestation measures. This approach is providing the institutional base for funding through both the PPCR (Pilot Program for Climate Resilience, and the GFRP (Global Food Crisis Response Program), in addition to substantial ongoing development partner and budget financing, and BioCarbon fund and GEF support. Niger's strategic program for climate resilience was approved in November 2010 for US\$ 110 million and focuses on scaling up support to sustainable land and water management under the PAC, improving weather and climate services, agricultural water management and improving social safety nets.

The ongoing Agro-Silvo-Pastoral Exports and Markets program will help develop improved risk management mechanisms and develop marketing chains. In Niger there are opportunities for “climate-smart” agricultural development, but for Niger to move towards climate resilience these programs need to be sustained over time, supplemented by effective emergency response measures and combined with broad economic diversification and socio-economic development support.

Uruguay: A livestock exporter vulnerable to climate change impacts which is taking measures to promote climate-smart agriculture through a range of sustainable land management approaches.

Uruguay is a major regional exporter of agricultural and livestock products, which account for about 10 percent of GDP and over 70 percent of exports though only 4 percent of employment. 85% of Uruguay’s land area is suitable for farming and livestock, one of the highest percentages in the world. 8% of Uruguay’s population of 3.3 million live in rural areas and per capita GNI is approximately US\$ 9,000.

Temperature, precipitation and incidence of extreme climate events are all projected to increase over the coming decades, with a negative effect on land productivity. Agriculture and land-use change account for over 50 percent of GHG emissions, of which methane from farm animals constitutes the great majority.

Uruguay is responding by: improving pasture-land and hence animal nutrition, supporting reduced tillage practices on crop-land together with improved crop breeding, and promoting afforestation, shelter and protection of native forests. Uruguay also has a number of subsidized climate-related crop insurance schemes in place. This combination of measures to support resilience and reduced emissions is already contributing to reduced CO₂ and CH₄.

Despite Uruguay’s relatively strong capacity and highly developed information base, it does not yet have any registered CDM (clean development mechanism) projects in agriculture, including afforestation or reforestation.

Uzbekistan: Improving resilience for a sector largely dependent on irrigation in a downstream country facing an increasingly water stressed environment.

Uzbekistan’s population is estimated at 28 million, per capita GNI at US\$ 2900 and 60% of the population live in rural areas. Economic growth rates overall are strong, averaging 8% in 2010. Despite favorable growth, Uzbekistan is concerned by growing income disparities and persistent poverty.

As a downstream country in an arid environment, 85 percent of cropped area is irrigated. Agriculture accounts for 23 percent of GDP, 34 percent of employment and 40 percent of exports and sector growth is robust. Livestock accounts of 40 percent of agricultural GDP. Cotton plays a key role in the agricultural economy and Uzbekistan is the world's second largest exporter of this commodity, but exports of fruits and vegetables are also considerable

Uzbekistan is likely to experience increasing temperatures and some increase in summer precipitation, but substantial decline in water flows from its two major rivers is expected together with increasing evapo-transpiration. The cropped sector is likely to suffer from water stress and the livestock sector from heat stress. The agricultural sector contributes only 12 percent of GHG emissions net; declines in swamp rice cultivation have reduced its contribution.

For decades Uzbekistan irrigation water consumption has exceeded natural river flows, contributing to the desiccation of the Aral Sea. It has not used irrigation water efficiently, and high use levels together with poor drainage have contributed to salinity problems and further exacerbated the drying of the Aral Sea.

Uzbekistan has identified a number of adaptation options for agriculture, including improved weather and climate monitoring, development of new adapted varieties, improved agronomic practices including minimum tillage, increased water efficiencies and catchment management involving all stakeholders, improved pasture and fodder and development of new livestock breeds. It is in the early stages of integrating these options into agricultural policies and practices at a farm level and of moving from a "top down" support delivery system to one that is demand driven and pluralistic. Its agricultural strategy objectives concern the maintenance of export revenues, food security and improvements in rural living standards. Uzbekistan has moved with land reform, creating an enabling environment for private farmer investment in land productivity.

There are ongoing programs in improved irrigation and drainage management and wetland rehabilitation, especially near the mouth of the Amu Darya river, in improved water management in the fertile Ferghana Valley, and in farm productivity and agri-business development, with a focus on improving the enabling environment for access to finance. These programs will improve resilience, especially if combined with further measures to liberalize the agricultural economy and enhance local participation in decision making.

Vietnam: Integrating climate and disaster risk management into a rapidly growing economy, through addressing productivity, diversification and sustainability in agriculture, water resources, fisheries and forestry.

Vietnam has land area of 331,000 km² and a population of 83 million, 70% of whom live in rural areas. Vietnam has sustained impressive economic growth rates of over 7% per annum over 2000-2008 period. It has succeeded in reducing poverty from 37% to 15% of the

population over the last 10 years, and improving access of the population to basic services. Per capita GNI is currently US\$ 1100. Agriculture accounts for 21% of GDP and 23% of exports.

Despite limited availability of arable land, Vietnam has succeeded in rapidly increasing agricultural production, especially of rice, and now accounts for over 20% of global rice exports. 34% of arable land is irrigated, allowing for intensive production systems. Aquaculture, much of it in brackish water, has expanded very rapidly, while Vietnam is producing an increasing quantity of higher value crops. It has also succeeded in reversing deforestation through a substantial re-greening program, though restoring natural forest ecosystems and addressing coastal mangrove degradation remain challenges. And 90% of Vietnam's poor live in rural areas.

With a long coastline and much of its productive land in the low-lying Mekong and Red River Delta systems, Vietnam is one of the countries most exposed to climate-related natural disasters, specifically floods and coastal storms. Climate models predict increasing temperature and precipitation, and increased risk of saline water intrusion and storm surges in low lying areas. Adaptation is the priority. Agriculture accounts for 36% of GHG emissions mostly from paddy rice and livestock.

Vietnam has developed strategies to integrate climate and disaster risk management into development planning, including in agriculture and broader land and water management. The challenge in the past has been development of enabling measures to facilitate implementation to scale. A *first theme* is modernization and diversification along the agricultural production, processing and marketing value chain, with a focus on higher value products and food safety, together with development of climate resilient farm systems and crop varieties. Agricultural water management is a *second theme*, with a focus on improving agricultural water productivity and addressing flood and salinity risks. Sustainable fisheries, aquaculture and coastal zone management is a *third area* of focus. A *fourth area* is broad disaster management and preparedness, including programs for improved weather and climate services, early warning systems, safe harbors for fishing boats, flood management and contingency financing.

Vietnam supports small-holder forest plantation management, and poverty reduction, and productivity and poverty reduction programs in the mountainous northern areas. Vietnam's low carbon growth potential in the agricultural sector includes reduced emissions from livestock and paddy, and capturing sequestration potential from reforestation programs. Vietnam participates in the REDD agenda.

Vietnam is also strengthening the broader enabling environment for improving agricultural productivity, including for climate-smart agriculture, through improving land administration systems, rural infrastructure and connectivity, improving market access and access to finance.

In summary, Vietnam has the strategies in place for climate-smart agriculture within a broader green growth context. Mainstreaming these strategies into development planning and budget processes, and providing enabling measures and capacity at central and local level to facilitate timely implementation, are the challenges that are currently being addressed.

Yemen: The challenge of balancing food security, the need for short term cash returns and “climate-smart” agriculture in a water stressed environment.

Yemen has a land area of 528,000 km² and a population of 24 million, growing at about 3% per annum. Agriculture comprises 15% of GDP and over half of employment, though only 7% of the land area is cultivable. Yemen has limited water resources and much of the land is desert. Per capita GNI is US\$ 1060 and 69% of people live in rural areas. 32% of the population is “food-insecure” and more than 90% are net food buyers. Although cereals account for 54% of cultivated area Yemen produces less than 20% of the wheat it consumes.

Yemen is expected to experience increasing temperatures and increasing variability in rainfall and hence incidence of both floods and droughts over the coming decades. Yemen is highly water stressed: renewable water resources are estimated at 1.5 billion m³ per year and annual withdrawals at nearly 2.5 billion m³. Irrigated agriculture accounts for 90 percent of withdrawals; groundwater resources are depleting especially rapidly, at 2 ½ times the rate of replenishment. Qat, a mild stimulant is the main cash crop, and accounts for 40 percent of water withdrawals; the area planted to it has tripled over the last 25 years. Yet analyses have indicated that increasing fuel prices (to increase the cost of groundwater pumping and reduce over-pumping) would likely increase poverty and reduce agricultural incomes in the short to medium term. Fisheries are an important sector and the second export after oil. Agriculture and forestry contribute 27% of GHG emissions but resilience is the priority.

Yemen’s agricultural and rural strategy aims at food security, with broad economic diversification and improvements in efficiency in agriculture and fisheries; climate risks are being incorporated into the 2010-2015 National Development Plan. A number of programs are ongoing to improve land and water management, including a groundwater and soil conservation program and a new Water Sector Support Project, as well as a program for rainfed agriculture and livestock and an accompanying GEF-supported agro-biodiversity and climate adaptation project.

Yemen is participating in both the GAFSP (Global agriculture and food security program) and the PPCR (Pilot program for climate resilience). The PPCR would focus on agricultural water management, watershed restoration, including water harvesting, soil-moisture conservation and improved rainfed practices, improved weather and climate services and coastal zone management. Preparation is well advanced. A broad agriculture and economic diversification approach, combined with targeting of social transfers and health and nutrition awareness, will be necessary as Yemen gradually moves towards managing its land and water more sustainably and faces increasing climate stresses. Progress on these long-term agendas is

4. Challenges and the Potential of Policy Support Measures

While there is encouraging progress, there are challenges in many areas; in adapting new approaches to different parts of countries and in scaling them up; in facilitating cross-country learning, south-south as well as north-south; in continuing innovation; and in mainstreaming “climate-friendly” approaches into broader policy support measures at local as well as national level. There are challenges also in overcoming initial barriers, including broader barriers such as land rights, lack of infrastructure, or trade regimes for accessing new markets. Land rights are a particularly difficult and sensitive issue in some countries, sometimes with overlapping “traditional” and “modern” systems and many competing interests.

There are also trade-offs between the short term costs and longer term productivity gains, or spatial trade-offs between investments in ecosystems upstream in a watershed bringing services downstream for a different area, sector or group of people. Overcoming these barriers requires the right mix of policy instruments to encourage long-term adoption. These are discussed in more detail in companion papers, but the country examples also show how the pattern of support can influence climate-smart agriculture. Clear, simple legal, fiscal and institutional frameworks which are adapted to country circumstances, have widespread support, are understood by citizens and are easy to enforce, are also important; often these frameworks are too complex and not easy to enforce.

More broadly, the agricultural sector has traditionally been underfunded in developing countries. In 2008, according to the World Development Report¹, agriculture represented on average 29 percent of GDP in agriculture-based economies, but public spending on agriculture accounted for only 4 percent of agricultural GDP. The corresponding figures were 16 percent and 11 percent for transforming economies and 10 percent and 12 percent for urbanized economies. African countries committed to increasing public expenditure on agriculture to 10% of national budgets under the 2003 Maputo Declaration. Progress has been uneven though some countries (for example, Ethiopia, Mali and Malawi) have more than met these commitments.^{vii} Furthermore, often the quality of spending may be low; support measures may not always be optimal compared with objectives. Support measures have often focused on input support (for machinery, energy subsidies for water, or fertilizer subsidies) rather than support measures for technical innovation or sustainable land and water management.

^{vii} There are also issues of definition; a recent document (Project Appraisal Document for the Agriculture Development Policy Loan for Ghana 2011) mentioned that estimates of the proportion could range from 3% to 9% of public budgets depending on the breadth of the definition. Including rural infrastructure increases percentages in many countries (including Ghana).

OECD agricultural subsidies are worth more than US\$ 260 billion per year, and have also traditionally been targeted at supporting intensive production through price supports and a variety of other protection measures. By removing the current levels of protection, it is estimated that industrial countries could induce annual welfare gains for developing countries of over five times the current flow of aid to agriculture, although the impacts would differ among countries (WDR 2008).

There is a great opportunity, in both developed and developing countries, to re-orient support programs away from distorting policies which support neither efficiency nor environmental sustainability, to measures which do not distort private farmer production patterns but which enhance key “underlying drivers” of sustainability and competitiveness. These include support for improved soil and water management, landscape restoration, infrastructure, access to weather and hydrological information, and weather-based risk, communications to improve market access, research and knowledge.

Within Africa the CAADP (Comprehensive African Agricultural Development Program) is a framework for accelerated agricultural development that has been adopted by African Union at the Heads of State level. The primary CAADP goal is agriculture-led development that eliminates hunger, reduces poverty and food insecurity, opening the way for export expansion. CAADP, which seeks to attain agricultural growth rates of 6 percent per year through 2015, comprises four pillars:

- Extending the area under **sustainable land management and reliable water control systems**;
- **Improving rural infrastructure** and trade related capacities for market accesses;
- Increasing **food supply**, reduce hunger, and improve responses to food emergencies
- Improving **agriculture research**, technology dissemination and adoption

There are cross cutting themes on knowledge and capacity building. CAADP pillars when originally developed did not explicitly address climate vulnerabilities or the scope for reduced carbon emissions growth from agriculture. However, in 2010, following a call by African leaders, the African Union and NEPAD prepared an African Agriculture and Climate Change Adaptation Mitigation framework which provides a strong basis for incorporating climate-smart agriculture in CAADPs.

On the practical side there is also much to build on from the Terrafrique platform for sustainable land and water management, supported by NEPAD (the New Partnership for Africa’s Development), also within the CAADP framework^{viii}. Terrafrique, in addition to

^{viii} Through the Terrafrique platform NEPAD, in coordination with FAO and the global network WOCAT (World Overview of Conservation Applications and Technologies) prepared a comprehensive document “Sustainable Land Management in Practice” summarizing experience and guidelines for sustainable land and water management in Africa (one key areas of climate-smart agriculture), including an estimate of the adaptation, mitigation and productivity benefits of identified interventions.

providing a platform for knowledge, has also financed with GEF assistance US\$ 150 million of investments in sustainable land management in Africa, integrated with broader agricultural and natural resources development programs and strategies.

Grounded in the African Union partnership principles of country ownership, transparency, accountability, responsibility, inclusiveness and aid effectiveness (particularly harmonized support and resource planning) NEPAD now seeks to build an investment platform which will catalyze harmonized resource planning and financing, strengthen knowledge sharing, and facilitate expert support to country design of climate-smart agricultural programs. The Platform will support countries' efforts to finance national agriculture and food security investment plans and build capacity. The Platform is a response to a call by African Heads of State and governments to strengthen resilience to climate change and deliver on the ground results.

At a meeting in Johannesburg in September 2011 African Ministers of Agriculture issued a communiqué re-affirming the importance of climate smart agriculture. In sustainably increasing agricultural productivity and meeting food security and poverty challenges, in building resilience to environmental pressures, in restoring landscapes, in adapting to climate change while reducing GHG emissions. The Communiqué further calls on African Countries to implement and mainstream climate change into the Comprehensive African Agricultural Development Programme (CAADP) and to invest in facilitating adaptation and climate-smart agriculture.

At the international level, the Communiqué announced its intention to call on the UNFCCC (COP 17) to establish an agriculture Program of Work that covers adaptation and mitigation, together with additional financial support to developing countries. Ministers also agreed to: call on COP 17 to design the Green Climate Fund in a way that recognizes adequate financing for agricultural adaptation and mitigation; urge synergies among national and regional organizations and with Ministries of Environment; and request the African Union (AU) Commission to consider establishing a technical working group to give direction and content to a program of work.

The European Union has modified its Common Agricultural Policy so that income support to farmers is contingent on their meeting good environmental and agricultural standards. The second pillar of its agricultural policy focuses on broad measures to improve competitiveness, manage the environment and the land and increase diversification. Specific agri-environment measures also provide support for sustainable land management and landscape restoration. These measures are similar to those summarized in the programs mentioned above, for example in the Brazil, China and Kenya cases, though adapted to different socio-economic and climatic conditions. More broadly, there is great scope to create the policy environment for investing more in watershed and landscape restoration, measures which conserve longer term productivity and resilience, while also sequestering above and

below ground carbon, thereby reducing emissions. There is also scope to facilitate recover of land-races, a key element in longer term resilience.^{ix}

The European Union will further revise its Agricultural Policy in 2013, in order to meet the food, natural resources and territorial challenges of the future². Its support measures will be aimed at a broad green growth agenda comprising three objectives: (i) viable food production, including income support and support for environmental measures aimed at sustainable land management and ecosystems conservation; (ii) sustainable management of natural resources and climate action, including support to innovation, to enhanced provision of public goods from the land, and to climate change mitigation and adaptation; and (iii) balanced territorial development, including support to diversification of the rural economy and heterogeneous farm structures. Broadly, the new policy gives increasing recognition to the role of farmers as guardians of the landscape. The EU Water Framework Directive also supports measures to reduce agricultural pollution of water bodies, especially through its Nitrate Directive, and the Natura 2000 Program addresses biodiversity and landscape conservation.

Many countries have under-invested in the key “public good” of weather and climate information. There is growing recognition of the importance of having such information available and easily accessible to a range of different users, including farmers and herders, foresters and fishermen; but there are important gaps in the collection, analysis and dissemination of basic data and services in many countries. In some countries there is poor coordination between hydrological and meteorological information services (though in others these are integrated) and there are also opportunities for greater sharing of information between countries.

5. Mobilizing Finance for a Transformational Change to Climate-Smart Agriculture

Work by a number of expert groups highlighting the key role that agriculture plays in growth and poverty reduction has helped to bring renewed focus to agriculture and related natural resource management over the last four years. The 2008 World Development Report on Agriculture, and the 2008 food price crisis, provided further impetus. The world is again experiencing increasing food price volatility, and most analysis recognizes that increasing weather and climate volatility has a role to play in this. A global Commission on Sustainable Agriculture and Climate Change will deliver its findings at Durban in December 2011, and will highlight the inter-connections between sustainable agricultural development, food security, energy and climate change^x.

^{ix} The Green Revolution of the last 40 years has been achieved in part by encouraging increased use of a limited number of high yielding crop and livestock varieties, which often have exacting requirements regarding water, fertilizer and disease control. There is increasing recognition that conserving a broad variety of breeds, adapted to different agro-climatic conditions, is key to long term resilience of food and supporting landscape systems.

^x The Commission has been established under the leadership of Sir John Beddington, lead scientist of the UK government, and includes experts from around the globe. Its work is supported by the CGIAR Climate Change, Agriculture and Food Security (CCAFS) program.

Recognizing the importance of agriculture in the growth and poverty reduction agenda, World Bank group commitments have increased substantially over the last 10 years³. They averaged US\$ 4.1 billion annually in the 2006-2008 period, compared with a “low” of less than US\$ 2.5 billion annually in the first years of the decade. They increased again sharply in 2009 to US\$ 7.3 billion, including US\$ 5.3 billion from IBRD/IDA, partly as a result of the 2008 food price crisis^{xi}. However, competing demands for resources contributed to a decline in lending to agriculture to US\$ 4.1 billion in 2010 and US\$ 3.6 billion in 2011. Lending levels, however, have been better maintained in South Asia and Africa, the regions with the largest proportion of people living in rural areas, and the largest proportion also suffering from food insecurity. In Africa, for example, new commitments were US\$ 1.2 billion in FY 2011, compared with an average of US\$ 700 million annually in 2006-8. And IFC has maintained its lending levels for agriculture over 2009-2011 at between US\$ 2-2.2 billion annually. Lending, furthermore, is addressing climate-smart agriculture and natural resource management in an increasing number of countries.

The Regional development banks and other multilateral and bilateral development partners are scaling up support to investments in agricultural productivity. The UN system including the World Food Program and the Food and Agriculture Organization, and IFAD are key partners in this regard. The Arab Funds, concerned with food security in their own countries, as well as addressing poverty reduction and growth in poorer countries, are increasingly investing in this area. A number of charitable foundations also provide support to investments in increasing agricultural productivity, livelihoods and enhancement of environmental sustainability. And private sector investment in agriculture is highly diverse and growing in a range of areas, from highly intensive horticultural production to large-scale bio-fuel and commodity production^{xii}.

There are a number of emerging funds aimed at tackling climate resilience, low carbon growth or food security issues; the challenges is to use these together with existing sources of private and public sector finance to achieve the goal of “climate-smart agriculture” integrating the objectives of agricultural productivity, food security and climate change. Some of these major programs are summarized below. They include the Climate Investment Funds, a series of funds specifically focused on climate change mitigation and adaptation, but often with a multi-sectoral perspective. Then there are also the Global Agriculture and Food Security Program and the Global Food Price Crisis Response Program, more specifically focused on agricultural issues. These are in addition to the Global Environment Facility, which includes windows to address climate change, land degradation and biodiversity, a number of pilot funds developed through the Carbon Finance Facility and the emerging funds to address REDD (reduced emissions from deforestation and forest

^{xi} The World Bank Group Financial Year runs from July to June. So lending numbers for 2009 would include commitments made from July 2008 to June 2009.

^{xii} The following paragraphs summarize some of the more recently established food security and climate-related funds. The list is not intended to be comprehensive; it focuses largely on funds where the multi-lateral development banks are more closely engaged.

degradation).. There are also a number of markets established through the Clean Development Mechanism (for carbon emissions trading) which are not discussed here.

Channeling multiple sources of donor financing through common programs can reduce fragmentation and recipient country transaction costs of aid, and improve alignment around country programs. Existing bilateral and multilateral funding cycles typically require several years advance programming by countries, are not easily amenable to restructuring of already allocated resources, and coordinating donor replenishment cycles is difficult.

The Global Agriculture and Food Security Program (GAFSP) is a multilateral financing mechanism (US \$925 million committed), which will allow the immediate targeting and delivery of additional funding to public and private entities to support national and regional strategic plans and scale-up assistance for agriculture and food security, on a coordinated basis, in poor countries. The plans are designed and implemented by developing country governments and their regional partners.

Depending on country and regional requests, GAFSP financing is aimed to provide for:

- **raising agricultural productivity** by supporting: a) adoption of high-yielding technologies; b) technology generation; c) water management; and d) land rights;
- **linking farmers to markets** by supporting: a) reduction in transaction costs; b) value addition; and c) mobilization of rural finance;
- **reducing risk and vulnerability** by supporting: a) price and weather risk management; b) strengthening food-related social protection for people who face chronic and transitory rural poverty; and c) improving nutrition of mothers and young children;
- **enhancing non-farm rural livelihoods** by supporting: a) investment climate improvements; and b) entrepreneurship promotion.
- **technical assistance, institution-building and capacity-building** by supporting: a) sector strategy development, investments and implementation; b) enhancing design, monitoring and evaluation; and c) knowledge development and dissemination.

Through these actions, expected impacts would be in improved incomes and **food security** of poor people in developing countries through more, better coordinated, country-led public and private sector investment in the agriculture and rural sectors; more predictable aid flows for countries by addressing financing gaps in ongoing assistance; and increased effectiveness of aid in agriculture and food security. By 2011 grants had been approved for Sierra Leone, Liberia, Togo, and Rwanda, Haiti, Mongolia, Cambodia, Bangladesh, Yemen, Nepal, Tajikistan and Ethiopia.^{xiii}

The GASFP framework document states that “GAFSP does not have a separate component on climate change adaptation and mitigation. Climate change cuts across all components of GAFSP. Raising agricultural productivity is needed to both offset the climate change yield losses that are projected in many developing countries, as well as meeting growing demand

^{xiii} Funding delivered to the GAFSP program has so far totaled about US\$ 580 million.

for food -- a double challenge. Better managing weather risk, diversifying household income, and improving market linkages to better match surplus and deficit regions will all be increasingly important. The components of GAFSP cover these aspects, as areas for increased investments. The intention is to not duplicate investments through specific climate investment funds". The document thus provides an enabling environment for complementary funding from other sources including the climate investment funds and REDD+.

The Global Food Crisis Response Program (GFRP) includes a facility encompassing several funding sources, with an authorized ceiling of \$2 billion.^{xiv} Its objectives are to:

- Reduce the negative impact of high and volatile food prices on the lives of the poor in a timely manner
- Support governments in the design of sustainable policies that mitigate the adverse impacts of high and volatile food prices on poverty
- Support broad-based growth in productivity and market participation in agriculture to ensure an adequate supply response as part of a sustained improvement in food supply
- Thus, interventions need to be rapid, include the poor and disadvantaged, and contribute to achieving sustainable longer-run food security. The program finances a mix of stand-alone technical assistance, development policy and investment operations, drawing upon country and international experience under four components:
 - food price policy and market stabilization;
 - social protection actions to ensure food access and minimize the nutritional impact of the crisis on the poor and vulnerable;
 - enhancing domestic food production and marketing response; and
 - implementation support, communications and monitoring and evaluation.

The program contributes to a reduction in the stress on environmental and social systems that arise from food shortages and lack of access to food (and that force many societal groups, including the most vulnerable, to degrade ecosystems of their supplies) due to its potentially wide range of efforts to improve access to and the availability of food in communities most at risk due to high food prices. So far over US\$ 1.2 billion has been committed to 35 countries, including several of the countries mentioned in this paper (Ethiopia, Bangladesh, Yemen, Kenya and Niger).

The Climate Investments Funds (total US\$ 6.3 billion) have been established to help developing countries move towards lower carbon growth paths on the one hand, and to integrate climate resilience in broader development programs on the other. Programs financed through these funds are designed and implemented by countries, with the assistance of Regional Development Banks, the IFC and the World Bank. Each has a separate governing body composed equally of members from developing and developed countries, and with observers from the private sector and civil society organizations. The aim is to integrate

^{xiv} This includes IDA assistance only. Additional funds have been made available by development partners including the EC, Russia, Spain, Canada and Korea.

finance provided by the CIFs into programs already under way or preparation, scaling up and bringing a resilience element to them.

The largest of these is the *Clean Technology Fund (US\$ 4.4 billion)*. Programs for US\$ 4.4 billion have been approved for thirteen countries, mostly middle income and large emitters. Despite the importance of agriculture and land-use change in GHG emissions (over 30 percent), however none of the CTF programs has included measures addressing agricultural emissions; the focus of all has been on energy efficiency, renewable energy and urban transport. However all have successfully blended CTF with other forms of finance, and the total value of CTF programs is over US\$ 25 billion.

The second largest is the *Pilot Program for Climate Resilience (US\$ 967 million)*, which aims to help countries transform to a climate resilient development path, consistent with poverty reduction and sustainable development goals. Thus adaptation is the key focus. Nine countries and two sub-regions (Bolivia, Yemen, Tajikistan, Niger, Zambia, Mozambique, Nepal, Bangladesh, Cambodia, the Caribbean and the South Pacific) were selected and strategic investment plans totaling US\$ 767 million had been approved by June 2010. All of the programs include agriculture, forests or water management as priorities (together with enhanced access to climate information, disaster management, coastal zone management in areas vulnerable to storms and sea-surge, and an improved approach to design and maintenance of infrastructure).

The Strategic Programs for Climate Resilience furthermore aim to blend funding from the PPCR with other development funding in order to take advantage of existing programs' implementation capacity and scale up existing or bring new climate resilience dimensions to these programs. For example in Niger the PPCR is improving the accessibility and timeliness of weather information to farmers and improving agricultural water management through adapting and scaling up ongoing programs of the African Development Bank; and a program supported by the World Bank brings a climate resilience dimension to a community action program by supporting community based investments in sustainable land management and strengthened social protection measures. Especially in countries dominated by agriculture it makes sense to blend development and public finance with the new climate and food security funds.

The Forest Investment Program (FIP) has a financing envelope of US\$ 602 million for eight countries (Mexico, Brazil, Peru, Ghana, Burkina, DR Congo, Nepal, Laos and Indonesia). FIP aims to help countries develop and finance programs which reduce emissions from deforestation and forest degradation, and helps them also put in place sound monitoring and measurement schemes. Transparency and improved governance, environmental and social sustainability and local participation are key elements. The FIP recognizes that agriculture, much of it "extensive" slash and burn agriculture by poor communities needing food, fuel and fodder for livestock, is a major driver of deforestation and degradation. Investment Programs will include measures address the livelihood and energy needs of people directly and indirectly dependent on forests. The FIP is intended also to provide lessons learnt in the

period leading up to full implementation of REDD (reduced emissions from deforestation and degradation) schemes in the post 2012 period (see below). To date the program for Democratic Republic of Congo has been approved, and that for Burkina approved subject to some revisions. The DRC program has a particular focus on reforestation and landscape restoration near urban areas, recognizing that these areas experience the most pressure.

REDD plus (Reduced Emissions from Deforestation and Forest Degradation and Sustainable Forest Management) In recognition of the role that deforestation and forest degradation play in GHG emissions, especially in developing countries, programs have been established to mitigate the impact of climate change through supporting countries in their efforts to address deforestation and forest degradation. The first stage in this has been support to national strategies for “REDD-readiness”. These include participatory approaches in strategy development, capacity building, establishment of monitoring, reporting and verification and national forest accounting systems. They include also development of national systems for determining baselines and reference emissions levels, transparent and equitable mechanisms for benefit sharing, safeguards and grievance mechanisms and clarification of land, forest and carbon tenure rights. A major challenge has been to establish systems which are simple yet robust. “REDD-readiness” programs such as the Forest Carbon Partnership Facility and the UN REDD scheme have been established to help countries prepare for this. Developed countries, with Norway playing a major role, have committed US\$ 3.3 billion to help implement REDD.

Since agriculture is the driver of deforestation in most developing countries, there is broad recognition that integrated action across REDD + and agriculture is necessary to achieve mitigation and food security outcomes.⁴ The FIP investment programs have been approved for DRC, for example, concentrate investments on deforestation "hot spots" located in the food and fuel-wood supply area of large urban centers, and also improve enabling conditions to address some of the underlying causes of deforestation. The Policy brief also underlines that sustainable agricultural intensification, management of the agricultural frontier and restoration of degraded landscapes are key to implementation of successful REDD + strategies as well as to climate-smart agriculture.

The Global Environment Facility: The GEF invests in a number of activities relevant to climate resilient agriculture through its operational programs on biodiversity, climate change, protection of international waters and land degradation. The most directly relevant is the land degradation program. Over the 2005-2010 period it has invested over US\$ 300 million for 87 projects, with the funding mostly blended with other operations. Support for the Terrafrique program in Africa has been a major example. **The Least Developed Countries Fund (LDCF)**, established under the UNFCCC is managed by the GEF. As of June 2010 US\$ 224 million had been mobilized for preparation and implementation of NAPAs (National adaptation plans of action). Most NAPAs name climate resilient agriculture and land and water management as key priorities.

A new program to fund investments in sustainable land and water management, according to priorities set by 12 African countries in West Africa and the Sahel, has been established with GEF support. The new programmatic approach will address desertification and food security in Africa, including through a US\$108 million regional program administered by the World Bank. Further commitments expected by the African Development Bank (AfDB), the International Fund for Agricultural Development (IFAD) and other partners for related programming as well as IDA may draw close to US\$3 billion. The program includes the Great Green Wall Initiative, comprising Burkina Faso, Chad, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan, Benin, Togo and Ghana. These countries all have arid and semi-arid landscapes, savannah and woodlands linked to the Sahel/Sahara region.

The objective of the Great Green Wall Initiative is to tackle desert advancement and soil degradation as well as to contribute to the integrated development of rural areas in the Sahel-Saharan region. Its goals are to expand investment in sustainable land and water management technologies in order to help communities adapt production systems to climate variability and change; improve land-use planning; and improve climate and water monitoring network improvements, institutional cooperation within and across countries, and evidence-based policy development. The program builds on the experience of investments under the Terrafrica Investment Platform, which has committed US\$ 150 million of GEF funding to support investments in sustainable land management throughout Africa, as part of the broader NEPAD-Terrafrica partnership.

The Green Climate Fund: The Cancun Agreements made as part of the conclusion of the UN Climate talks in December 2010 included a commitment to establish a Green Climate Fund as an institutional mechanism to deliver scaled up finance to address climate change. A transitional committee composed of 15 developed and 25 developing country participants is tasked with design of the Fund. The transitional committee has four work streams, examining (a) the scope, guiding principles and cross-cutting issues of the future Fund; (b) the governance and institutional arrangements; (iii) operational modalities; and (iv) monitoring and evaluation. Experience from the Climate Investment Funds (see above) will provide useful practical experiences in successes and challenges in implementing climate-smart development agendas which should facilitate rapid operationalization of the Green Climate Fund once its key design principles are agreed upon.

Weather related Risk management insurance instruments have been piloted in a number of countries. To be successful, however, they require reliable weather information and adequate systems of farmer registration. And where large numbers are affected by extreme weather events substantial funding is necessary. Mongolia has piloted these approaches for livestock, and Malawi for cropped agriculture. Systems are well established in OECD countries but there are risks of perverse incentives. In the poorest countries social protection approaches may be better adapted; the Ethiopia Productive Social Safety Nets has combined weather-based social protection instruments, cash for work and soil/water conservation approaches, aiming to lift rural populations out of dependence on food aid. More broadly

increased investment in upgrading hydro-meteorological systems and in adapting weather services to farmers 'needs is increasing recognized as a priority in climate smart agriculture. All country PPCRs include these activities as a major component.

Climate-Smart Agriculture: an Investment Platform. The African Union/NEPAD (New Partnership for Africa's Development), is seeking to build a platform for mainstreaming and scaling up support for integrating climate considerations into implementation of African countries' Comprehensive African Agricultural Development Plans (see also above).

A number of other funds have been established to support adaptation or improved forest management, and there is also a substantial volume of bilateral support to improved agriculture, land and water management in a climate constrained environment. The Congo Basin Fund, addressing sustainable forest management, is managed by the African Development Bank, which also supports, together with the African Union, Climdev, a regional program to improve the quality and accessibility of weather and climate information in Africa. **There is also growing support for broad green growth strategies,** of which climate-smart agriculture forms a key element. Korea has taken a lead in this area.

A major CGIAR research program on agriculture, food security and climate change (CCAFS) has been launched in collaboration with the Earth System Science Partnership. 15 CGIAR research centers as well as other thematic organizations will be collaborating under the leadership of CIAT (International Centre for Tropical Agriculture), The program, to be implemented over 10 years, aims to close critical gaps in knowledge of how to enhance food security, livelihood and environmental goals and understanding trade-offs in a changing climate, develop and evaluate options for adaptation, and facilitate assessment, tracking and adjustment of actions taken to address changes in climate.

Opportunities from Carbon finance and Carbon Policy: Carbon markets developed rapidly over the last 10 years, though, given the uncertainties in the global governance framework for climate change, prices are volatile. *However, despite the role of agriculture in GHG (over 30 percent), carbon payments related to agriculture have remained a very small part of the market.* Agricultural land management is not eligible under the Clean Development Mechanism (CDM). Even where methodologies for measuring reduced emissions or above-ground sequestration from afforestation are well established, projects, and the scale of financing, have been small. One reason is that there are many farmers and relatively small carbon payments per hectare per year (often below \$10/ha/year), resulting in high transaction costs and limited incentives for land-use change.

The BioCarbon Fund has provided very useful experience in project design and development of methodologies for assessing the carbon benefits from landscape restoration programs. US\$ 90 million was committed in the 2007-2010 period and a new financing program is nearing approval. The Kenya agricultural carbon project was supported under this program, as well as reforestation projects in Niger, Kenya and Ethiopia. Progress has also been made in measuring the carbon sequestered from growing trees (afforestation and reforestation), and

the work is well-advanced for the measurement of sequestration, or “avoided emissions” from improved forest management or reductions in forest degradation. The UNFCCC Conference of Parties recognizes the importance of reducing emissions and increasing sequestration from these sources and there was an agreement in Copenhagen in 2009, at least in principle, that they should be included in future carbon financing mechanisms.

It should be noted however that while methodologies or tools exist to measure soil carbon, even the Kenya Agricultural Carbon project is approved only for the voluntary market. *There would be great benefits in including reduced emissions from soil carbon sequestration in future carbon trading regimes.* The Kenya project has been ground-breaking in a number of ways. It has permitted development of a methodology for soil carbon accounting adapted to small-holder agriculture, thus reducing transaction costs. Measurement of the benefits also confirms that the principle benefits from adopting sustainable land and water management practices are increased productivity; potential additional payments from carbon sequestration, though useful, are modest compared with the productivity benefits. And it has confirmed that measures which increase carbon sequestration in the landscape also increase adaptive capacity (the triple win).

Substantial progress has been made in measuring livestock-related emissions which account for about half of all agriculture/land-related emissions. Emissions for livestock include carbon dioxide but also, and more importantly, methane (CH₄), as well as nitrous oxide (N₂O) and ammonia (NH₃). These sources of greenhouse gas emissions are already eligible for financing under current carbon market mechanisms. The challenge is to develop the programs and policy measures (see above) to help farmers in developing countries access financing “to scale”. Several upcoming agricultural technologies such as the system for Rice Intensification and Zero Tillage Agriculture also allow for improvements in productivity while reducing greenhouse gas emissions.

Progress is being made in developing and testing cost-effective, landscape-based approaches to assessing the carbon footprint of agricultural and rural development, though there are still present challenges. Particularly difficult has been agreement on a land-based approach to assess of soil carbon sequestration (which has both resilience (adaptation) and reduced emissions (mitigation) benefits), from improved land and water management practices. A robust system would most likely need to integrate both direct field or in-situ measurements and model-based approaches to leverage scientific understanding to measure soil carbon stocks and changes in a broader landscape. The FAO Ex-act carbon accounting tool has been piloted in a number of countries. Using information available from UNFCCC data bases, supplemented by country or sub-national data where these exist, it is proving to be a highly useful tool in assessing the carbon footprint of agricultural and rural development activities. It has also been shown to be quite robust when tested against field measurement techniques. Country stakeholders in several countries, including India, China, Russia, Brazil, Morocco and Niger, have also received training in applying the tool.

Encouragingly, models are being developed in which soil carbon measurement systems can be efficiently integrated into broader land surveillance systems for evidence-based management of land at project and national levels, simultaneously addressing food, feed, fuel, water, climate change and poverty problems. These tools also need to be simple and cost-effective. Such developments ensure that soil carbon offsets are measurable, reportable and verifiable – criteria necessary for soil carbon to be included in future carbon finance market mechanisms,

Finally, **with regard to carbon finance it is important to manage expectations.** Without a global agreement carbon markets will likely remain fragmented and prices low. Furthermore while carbon finance can bring down the cost of a project for a private investor (generally by 15-20 percent), it is unlikely by itself to make a project financially viable.

There are broader policy measures which could be used to support efficiency and environmental sustainability in production systems. Carbon taxes, if applied to both energy and land-use change, would provide strong incentives for increased intensification of crop production on a more limited land area, and would provide incentives also for protection of forests and grasslands. However, a carbon tax applied only to fossil fuel only, without accompanying regulations on land use change, could potentially provide an incentive for an increase in the clearing of forests and agricultural land for biofuels, as opposed to pasture or forest conservation^{xv}.

To address the challenge that developing countries face to access knowledge on the various sources of funding and to implement integrated programs, a knowledge platform is under preparation jointly by the UNDP and the World Bank. There is the potential to combine different sources of finance for the development of agricultural and rural economies, and to support climate resilience, low carbon and agricultural productivity/food security objectives together. Broader technical knowledge platforms are also being developed. In conclusion, however, the primary benefits from investing in climate-smart agriculture are sustainable economic growth and poverty reduction, and integration of this agenda in country strategies is sound development policy.

^{xv} This document does not attempt to compare different approaches, which are under study through other fora. The upcoming Science Conference in Wageningen in October 2011 will also provide an opportunity to share experience with different approaches.

Annex – Country Notes

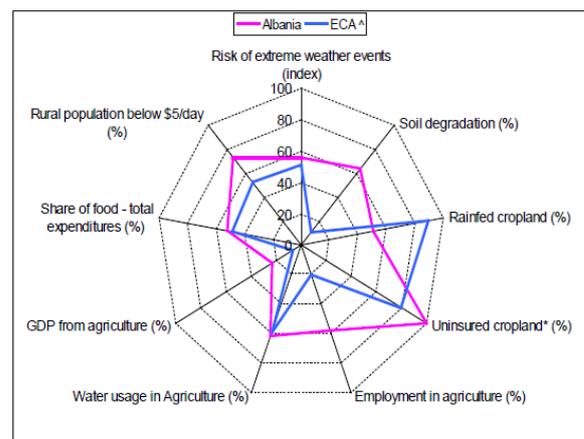
Albania Country Note: Managing Agriculture in a Mountainous Country highly exposed to Climate Risks and Change

Albania has a population of 3.2 million, with 55% of the population living in rural areas. Albania has had robust economic growth overall, and recovered quickly from the 2008-9 crises. Growth rates have averaged 7.5 % per annum in recent years and per capita GNI is US\$ 3,900.⁵ Poverty rates have also declined sharply, from 25% in 2002 to 12% in 2008. Population, which has declined over recent years, is expected to recover, with increases averaging 0.5% per annum over the 2010-2010 period.

Albania has a surface area of 28,000 km² with 77 percent of the country's territory on hilly or mountainous land.⁶ Given the terrain and change in relief from the mountains to the coast it is highly vulnerable to soil degradation, with powerful, highly erosive river flows. Its long, varied coastline has great natural beauty and tourist potential.

Agriculture and its Role in the Economy

Agriculture, including forestry and fisheries, still accounts for 20 percent of GDP, and over 50% of employment.⁷ 75 percent of the total land area is used for agriculture, including crops, pastures, and forests.⁸ The flatter, coastal areas are dominated by crop production, while forestry and pasture predominate in the mountainous areas in the east of the country.



Note: Employment in agriculture (% of total employment)*; Rainfed cropping (% of cropland)*; Water usage in agriculture (% of total annual freshwater extraction)*; Uninsured cropland (Estimate); Soil degradation (% of total land)**; Risk of extreme weather events (additional 1:20 year events 2070-2100 Vs. 1961-1990)***; Share of food – % of total expenditures ****; GDP from Agriculture*; Rural population below \$5/day****; Sources: *World Development Indicators 2008; ** FAO AGL 2005; *** Baettig, M. et al., 2007. **** ECA Databank. ^ECA statistics come from transitions and developing economies of Eastern Europe and Central Asia, where available

Furthermore Albania's rivers provide over 90 percent of electricity, though this percentage is decreasing as rainfall becomes less predictable (see below) and demand increases.

Livestock (including the value of products grown and fed to livestock) accounts for 56 percent of the total value of production, fruits 14 percent, and crops 30 percent. Of these, the value of vegetables is more than twice that of cereals, which are grown on drier and less fertile land.

From 2000 to 2007 the value of agricultural products increased from €890 million to 1118 million, while that of agro-industry increased from €11 million to E 388 million. Albania's net food imports have grown through the decade as incomes have grown, and totaled €450 million in 2007.

Albania's comparative advantage is likely to lie in seasonal fruits, vegetables and livestock products. Its forests and pastures also play a key role in landscape and watershed conservation, as well as in provision of fodder and fuel. The contribution of cereals, grown for subsistence and historically for self sufficiency, is likely to continue to decline.⁹ Broader landscape conservation will be increasingly important in the context of rural tourism development and nature conservation, and is eligible for EU accession funding.

Climate Change Projections

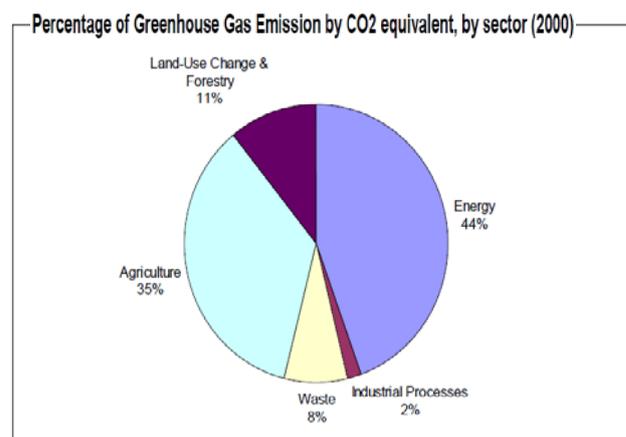
The mean temperatures in the mountainous zone range from 4-12°C, while in the coastal plain, they range between 12-18°C. Annual mean precipitation in the lower rainfall band running east-west across the central and southern areas of the country is 600-1000mm. In the mountainous region in the north, precipitation averages up to 3000mm.

Historical data indicate that Albania has become warmer and drier, and projections for the period from 2030-2049 compared to 1980-99 indicate that Albania will be exposed to¹⁰:

- A 2°C increase in mean annual temperature for winter and summer
- A decline in mean precipitation of 8 percent
- A decline in annual water availability for crops (runoff) by 28 percent
- An increase in the number of consecutive dry days and decrease in the number of frost days
- An increase in the Heat wave Duration Index of 20 days.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions

35 percent of greenhouse gas emissions by CO₂ equivalent come from agriculture and another 11 percent from land-use change and forestry. Agriculture accounts for 77 percent and 91 percent of Albania's methane and nitrous oxide emissions respectively.¹¹



Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

With potential adverse changes in temperature, precipitation, and the frequency of extreme events, existing inequalities between rich and poor populations and vulnerable communities within Albania may be exacerbated and place a strain on institutions, food supply and rural growth. Across the country there will be a significant variation in vulnerability, with areas presently under marginal rain-fed production having less adaptive capacity and becoming increasingly riskier compared with more productive areas and irrigated agricultural land.

Average annual rainfall and runoff is expected to decline, river flows will decrease and place pressure on water resources, increasing conflicts between agriculture and other water uses. The impact of changing river flows on hydro-electric power in particular and energy availability more broadly has led to increasing consensus on the need for an integrated approach to water resources management. Combined with increased temperatures, and drought risk, the threat to crop yields is clear, especially for summer crops. Changing climatic conditions may lead to problems associated with an array of agronomic issues including changes in soil drainage patterns leading to salinity, damage to soil structure reducing land productivity, and exposure to new pests and diseases that challenge existing plant and animal genetics and management.

Changes in temperature, precipitation, and water scarcity will affect cropping conditions as well as the livestock sector in terms of animal health, nutrition, husbandry, and livestock-related infrastructure. Changing climatic conditions will adversely affect fodder and forage production and rangeland biomass, which could lead to volatile feed prices, increased competition for community grazing lands, and increased water scarcity. Given these constraints, there could be shifts in production from intensive to less intensive livestock systems and an increased risk of losses for small-scale producers, who comprise the majority of the rural population in Albania.

Projections of climate change impacts on crop yields vary but on average the results from the different models are negative. The impact on crops is mixed: projections suggest improved yields for wheat (if pest damage does not increase) and irrigated alfalfa, reduced yields for grapes and olives, and mixed impacts on other crops.

There is the opportunity to develop agricultural systems that are resilient and highly adaptable to the range of conditions that may present themselves. Programs to support continued “regreening” and landscape restoration, efficient use of water during dry seasons, improved irrigation and drainage management, will all contribute to enhanced resilience and productivity.

Government Strategies for Agriculture, Food Security and Climate Resilience

The Inter-Sectoral Rural Development Strategy of Albania (2007-2013) outlines the priorities for rural development policy in the medium term. The strategy was prepared by the Ministry of Agriculture, Food and Consumer Protection and focuses on strengthening agriculture, agro-

food chain and rural communities through enhancing competitiveness of the sector via structural reforms. A World bank study, Albania Strategic Policies for a more Competitive Agriculture Sector 2007 outlines policy options and strategic challenges that face the agricultural sector and provides a basis for future analysis that incorporates climate change exposure.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

As in many other countries programs are ongoing which contribute to “climate-smart agriculture” even if this was not the stated intention. More recently Albania has explicitly included reducing vulnerability to climate change as a strategic priority in its new Country Partnership with the Bank, (2011 to 2014). It is improving its disaster preparedness, irrigation and water management, territorial development, infrastructure and energy and environmental management programs with this objective.

The Disaster Risk Mitigation and Adaptation Project (2008-2012) is a US\$ 10 million program which aims to strengthen institutional capacities to reduce Albania’s vulnerability to the natural and manmade hazards, limit human, economic, and financial losses due to these disasters. One component of the project specifically will work to improve the availability of hydro meteorological information to Albania’s key weather dependent sectors, as well as on development of early warning systems. Albania is also addressing disaster risk and water resources management more broadly in the context of climate variability and change.

The Natural Resources Development Project (2005-2011) has a budget of US \$15 million and aimed to establish or maintain sustainable, community-based natural resource management, including reforestation and pasture restoration, in about 218 communes in upland and mountainous erosion-prone lands. This successful program has enhanced productivity and incomes from sustainable resource management, reduced soil degradation, improved water management, conservation of biodiversity, and strengthened public sector management of these resources. The project also includes co financing from the Biocarbon fund, with payments for sequestration from reforestation made to local communities, funding from GEF through the land degradation window, and Swedish government co financing. Pastures and forests in this area are key sources of fodder for livestock and their sound management is thus key to rural livelihoods and to livestock productivity.

The Europe and Central Asia Regional Program on Reducing Vulnerability to Climate Change in Agricultural Systems has been a three year program of analytical and advisory activities to help impacts of climate change on the agricultural sector in four countries, including Albania. Work was carried out with key stakeholders to develop practical recommendations on the actions these countries can take to increase the resiliency of their agricultural sectors in the face of climate change. The overall objective of the program is to enhance the ability of countries in the Europe and Central Asian region to mainstream climate adaption into agricultural policies, programs and investments.

Analysis and economic modeling was undertaken to assess both the climate change impacts and potential adaptation measures for a range of farming, livestock and production systems across three agro-ecological zones. This was combined with a series of consultative workshops and regional knowledge exchange. Adaptation options were agreed upon, including improved irrigation, drainage and water resource management, development of improved livestock and crop varieties and landscape restoration.

A recently closed Agricultural Services Program aimed to create an environment conducive for rural income growth by addressing key constraints faced by Albania's emerging small-holder farmers in agricultural production, trade, and the functioning of land markets. It supported revitalization of the seed industry, land title registration, market rehabilitation and technological improvements, focusing on horticulture and livestock.

Improved irrigation and water resource management have also played a key role in Albania's rural development strategy. Specifically the recent water resources project has addressed dam safety, irrigation and drainage restoration, river bed restoration and strengthening of water users associations to help reduce vulnerability to weather related risks and support production of high value crops. A planned new Water Resources and Irrigation project aims to build on these lessons, addressing upstream efficiency and safety of irrigation reservoirs, but also improving water distribution efficiency and consolidating recent reforms in irrigation management and cost recovery.

Albania's "climate-smart agricultural" strategy is likely to focusing on reducing vulnerability on the one hand (through watershed management, dam safety, irrigation, drainage and flood management, improved climate information and eventually weather based risk instruments) and increasing incomes and resilience on the other, through creating an enabling environment for production and processing to enhance value added of competitive products, mostly vegetables, fruits and livestock products. The EU accession process also provides opportunities in both of these areas.

Bangladesh Country Note: Meeting Food Security Goals in Densely populated Country highly vulnerable to Natural Disasters

Bangladesh is a delta country located between the Himalayas to the north and the Bay of Bengal to the south, has a population of over 160 million, and per capita GNI of US\$ 580.¹² 72% of the population lives in rural areas. It is one of the most climate vulnerable countries in the world, due to its location, the frequency of extreme climate events and its high population density. Most of the country is low-lying land, with floodplains occupying 80 percent of the country. This makes it susceptible to annual inundation - normally nearly 70 percent of the country gets flooded during heavy monsoons.¹³ . Despite these challenges Bangladesh has succeeded in significantly substantially improving social indicators over recent decades; poverty levels, 57% in 1990, were 32% in 2010 and the mortality rate of children under five has declined from 148 to 52 over the period. Economic growth has averaged 5.9% per annum over the 2000-2009 period. Population growth is gradually declining, and predicted to average 1.4% per annum over the 2010-2015 period.

Agriculture and its Role in the Economy

Agriculture accounts for 20 percent of GDP and employs about 63 percent of the total labor force.¹⁴ Growth has averaged 3.3% per year over the 2000-2009 period, and agriculture comprises 10% of exports while food accounts for 22% of imports.. Bangladesh is one of the most “land-scarce” countries in the world, with only 0.05 hectares of arable land per person.

Out of the total land area of 14 million hectares, about 8 million ha is arable but double-cropping is widespread. Rice, the main crop and staple food of the country, is produced in about 70 percent of total cropped area. About one percent of total agricultural land is lost every year to non- agricultural use. About 60 percent of total cropped area has access to irrigation of which ground and surface water account for 83 percent and 17 percent respectively.

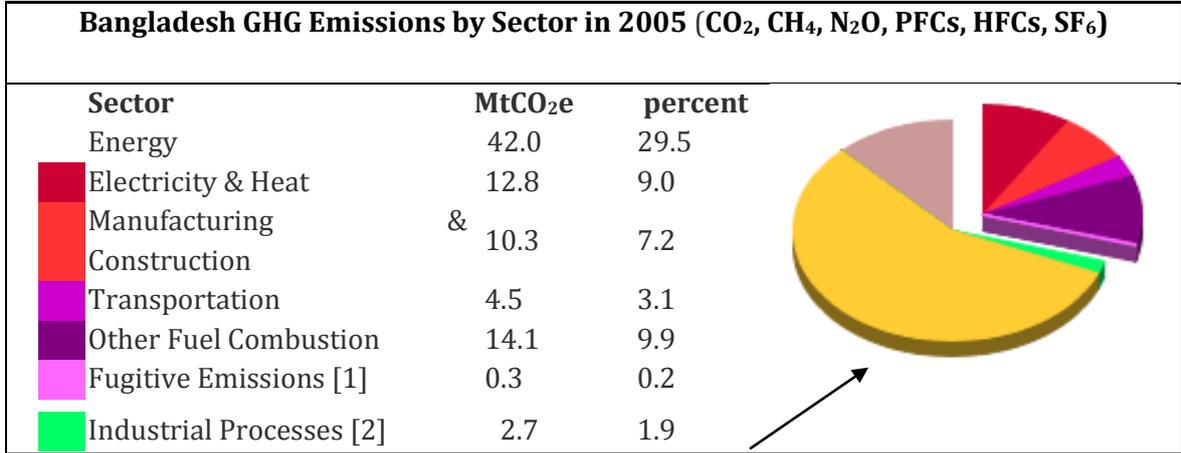
Climate Change Projections

Climate change is likely to increase the frequency and severity of the extreme weather events that Bangladesh already faces.

- i. *Increased flooding, both in terms of extent and frequency, associated with sea level rise, greater monsoon precipitation and increased glacial melt:* Most of Bangladesh lies in the delta of 3 of the largest rivers in the world, and two thirds of the country is less than 5 meters above sea level. The country is susceptible to flooding from the rivers, sea level rise as well as tidal flooding during storms. In most years, 30-70 percent of the country is affected by floods. Every 4-5 years, there is a major flood that inundates 60 percent of the country and casuses losses of life, substantial damage to infrastructure, housing, agriculture and livelihoods (Agarwala et al. 2003). *Increased salinity intrusion:* The sea level rise also casues saline intrusion up coastal rivers and into ground aquifers, which reduce the availability of fresh water. One key study projects that sea level rise in Bangladesh will affect 15-17 million people and submerge 12-16 percent of the total land area by 2100 (Agarwala et al. 2003). Another, using three different scenarios of future sea level rise, estimates that the total area that perenially floods could increase by 6 percent, 10 percent or 20 percent.¹⁵
- ii. *Increased vulnerability to cyclone and storm surges:* Bangladesh is the most vulnerable country in the world to tropical cyclones. The storm surges tend to be higher than in neighbouring countries because the Bay of Bengal narrows towards the north, where Bangladesh is located.
- iii. *Increased moisture stress during dry periods leading to increased drought:* droughts in Bangladesh are seasonal and commonly affect the northwestern region, which generally has lower rainfall than the rest of the country, which is expected to increase due to climate change.
- iv. *Greater temperature extremes*

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions

Agriculture and land-use change account for 56% of GHG emissions, with emissions from paddy rice and livestock accounting for the majority. Emissions from paddy rice cultivation are estimated at 20 million tons of CO2 equivalent annually (ICRAF). Less than 12% of the land area is classified as forest land and deforestation rates are low at 0.018 per cent per year.



Agriculture	80.2	56.4
Land-Use Change & Forestry	--	--
Waste	17.4	12.2
Total	142.2	

Source WRI

Main Threats and Opportunities Posed by Climate Variability and Change to Agriculture and Food Security

Bangladesh's population has lived with extreme weather events for centuries and developed adaptation strategies including the well known floating gardens. A recent publication details the impacts of climate change on food security in Bangladesh.¹⁶ With 70% of the country less than 4 to 5 meters above sea-level, sea-level rises of only, sea level rises of 25 centimetres, conservative projections for 2050, would have major implications. These sea-level rises will threaten valuable coastal agricultural land, particularly in low-lying areas, including the biodiversity in some of the most fragile environments, such as sunder bans and tropical forests. The center and north of the country, on the other hand, are likely to experience more prolonged dry spells.

Mainstreaming Climate Considerations into Development Planning

Bangladesh has played a leadership role in international fora on climate change-related issues.. It has also emphasized that the specific interventions within the country have to be within the framework of ensuring the security of food, water, energy and livelihoods. The government strategy is to integrate climate change challenges and opportunities into the overall development plan and programs involving all sectors and processes for economic and social development.

The recent Bangladesh Poverty Reduction Strategy Paper includes a supporting strategy on mainstreaming and strengthening climate change adaptation across various sectors including improved crop production practices, watershed management, and particularly in the coastal zone it emphasizes increasing afforestation, building cyclone shelters and embankments, improving salinity control measures, enhancing public awareness, climate research, and data collection.

GOB also issued its **Bangladesh Climate Change Strategy and Action Plan (BCCSAP)** in 2009. This comprehensive strategy has six thematic areas: (a) food security, social protection and health; (b) comprehensive disaster management; (c) infrastructure development; (d) research and knowledge management; (e) mitigation and low-carbon development; and (f) capacity building and institutional strengthening. The program builds on the NAPA prepared in 2005. In 2010 Bangladesh established a national Climate Resilience Fund, with an initial contribution of US\$ 110 million and supported by British, Swedish, EU, and Danish contributions and the aim of supporting implementation of the Action Plan, focusing on helping vulnerable communities adapt to great climate uncertainty and changing agricultural conditions. Bangladesh is also participating in the Pilot Program for Climate Resilience (see below).

Given the vulnerability to frequent natural disasters, government has also made significant progress in policies and investments for reducing disaster risks. It has drafted the **National Plan for Disaster Management (NPDM)** in 2008 for addressing disaster risk reduction and climate change adaptation comprehensively. Overall, the impact of disasters on people's lives and livelihoods has decreased substantially since the 1970s, as a result of improved macro-economic management, increased resilience of the poor and significant progress in disaster management. Substantial public investment in protective infrastructure (e.g. cyclone shelters, embankments) and early warning and preparedness systems have played a critical role in minimizing these impacts¹⁷.

Agriculture and Water Management Initiatives

Bangladesh's agriculture and food strategy (Food Policy 2008-2015) includes measures for technological innovation, diversification from rice into higher value livestock, fisheries and horticulture, and land and water management as well as social protection and gender targeted measures. Disaster management also forms a key part of its strategy, with 6 million ha of agricultural land under some form of protection from floods. It is participating in the GAFSP (Global Agricultural and Food Security Program) for which it received a grant of US\$ 50 million in 2010.

Bangladesh has initiated a number of agricultural programs to address climate risks, including the development and distribution of drought and saline resistant rice varieties to enhance year round production. Scientists at the Bangladesh Rice Research Institute (BRRI) have developed salinity-tolerant rice varieties, including BRRI Dhan 47 for coastal areas of the country where crop lands are susceptible to sea water intrusion. High yielding, submergence tolerant and short-duration (110-120 days) rice varieties are making a huge difference in boosting food security. BRRI is also developing drought-tolerant varieties of rice for release in the near future.

Regarding productivity, the government of Bangladesh is implementing two major national programs to increase agricultural yield. The Bank, with co-financing from IFAD, (IDA US\$ 62.6 million and IFAD US\$ 19.4 million), is supporting the Government in the implementation of National Agriculture Technology Project (NATP), which was launched in May this year. The NATP is the first five year phase of a 15 year Adaptable Program Loan Program to support the generation, dissemination and adoption of agriculture technology in crop, livestock and fisheries sub-sectors. The overall objective of the NATP is to support the government's strategy to improve agricultural productivity and farm income by revitalizing the national agricultural technology. The National Water Management Improvement Program (WMIP) supports flood control, drainage and irrigation through physical rehabilitation and institutional reforms of the two main national water resource agencies. Agricultural and water management approaches adapted to increasing climate uncertainty and funded through national programs, include floating gardens in areas subject to flooding (locally called "baira"), crop-aquaculture systems, and soil moisture conservation, promotion of drought

resilient legumes and crop varieties and rainwater harvesting in drier areas. Local researchers and extension agents are working on these approaches.

The Second Social Investment Program Empowerment and Livelihood Project (2010- 2016) has a budget of US\$ 120 million.. It aims to increase competitiveness and sustain growth; to improve access to service delivery and social safety nets for the poor; to increase agricultural growth to improve food security; and to implement effective climate and disaster risk management measures to reduce vulnerability... The community development component will empower the most vulnerable households and community institutions, and fund village investments incorporating risk reduction plans. The institutional development promotion component will promote inter-village development to consolidate livelihood investments, promote business, establish market and informational linkages for community organizations, and facilitate job creation. The capacity development component will strengthen the capacity of the implementing agency and other partners to deliver services and build linkages with the local governments and public and private sector agencies; and support interventions in Community Driven Development, climate risk management and community adaptation, environmental sustainability and livelihood development.

Government has ongoing an Emergency Cyclone Recovery and Restoration Project (ECRRP) (approximately US\$ 109 million) which would include provisions for improving sustainable agriculture production in cyclone affected areas in the medium-to-long term, to enhance food security. The project includes support for agriculture recovery through sustainable crop, livestock and fisheries production and productivity enhancement in the cyclone affected areas.

The government of Bangladesh has received budget-support under its fast-track Global Food Response Program (GFRP) facility, to assist the government's measures to maintain macroeconomic stability, ensure food security in the immediate short-run, and help those affected by rising food prices. The Food Crisis Development Support Credit Project provides a US\$ 130 million budget support to ensure that food grain, particularly rice, is available to the poor at subsidized prices, scale up existing safety net programs and ensure timely availability of inputs.

With regard to climate resilience, In November 2010 Bangladesh's Strategic Program for Climate Resilience under the PPCR was approved for US\$ 110 million. The program, integrated under larger programs, focuses on twelve coastal districts of Bangladesh which are most vulnerable to climate change. PPCR activities support climate resilient agriculture and irrigation, strengthening of coastal embankments and afforestation, and climate resilient coastal infrastructure. Activities include climate-proofing embankments to withstand cyclone and tidal surges; improving water management structures for drainage, reduced flooding and water logging, and enhancing agricultural and fish productivity; improving connectivity, access to water supply and electricity within the polders areas;; strengthening early weather forecasting and warning systems; Livelihood diversification through adaptive agriculture; and public health intervention and social protection measures.

With regard to reduced emissions, given the high levels of methane emissions from rice cultivation in Bangladesh, the System of Rice Intensification (SRI) methods have been tested in Bangladesh since 2000. SRI was developed as a set of practices that change the management of plants, soil, water and nutrients used in growing irrigated rice. SRI methods, by promoting growth of more productive and robust plants give higher yield, require less seed and less water, require fewer external inputs, and, do not require the purchase of specialized seeds, since most rice varieties give higher yields with these methods. The resistance of SRI rice plants to lodging caused by wind and/or rain, given their larger root systems and stronger stalks, can be quite dramatic, and the use of SRI methods can reduce agronomic and economic risks. The Bangladesh Rice Research Institute (BRRI) and Bangladesh Rural Advancement Committee (BRAC) have documented yield increases using this methodology and have initiated their own trials. At present, there is a national SRI working group and steering committee continuing to pilot and the approach is being disseminated more broadly.

Brazil Country Note: A Diverse Country and Global Food Producer where Improved Land Management and Forest Conservation are Key Elements in Climate-smart, Competitive Growth

Introduction

Brazil, with a surface area of 8.5 million km² and a population of 194 million, has highly diverse and favorable growing conditions for a range of commodities. With 66 million ha considered suitable for arable and permanent crops (7% of the surface area) it has 2.5 hectares of farmland per person and is “land and water abundant”. Brazil has the largest area of tropical rainforest of any country; 57% of the land area is forested and 24% is pasture land. Brazil’s successful record on inclusive growth is well known; poverty levels have fallen from 20% of the population in 2004 to 7% in 2010. 15% of the population lives in rural areas and per capita GNI is approximately US\$ 9300. Brazil is increasingly a global player on the climate-change agenda. Deforestation and land-use changes associated with the expansion of agriculture and livestock account for over 70% of GHG emissions in Brazil, which is globally, the fifth largest GHG emitting country. The Brazilian authorities are aware that they face great challenges in combining the benefits of agricultural development, environmental protection and sustainable development.

Structure of Agriculture and Role in the Economy

Agriculture comprises 7% of GDP but 38% of exports, nearly US\$ 60 billion annually, or 28% of world trade in agricultural products. Agriculture GDP growth has averaged 3.7% over the 2000-2009 period, a little higher than GDP growth overall (3.6% per annum). In 2009 Brazil was the largest global exporter of sugar, ethanol, beef, poultry meat, coffee, orange juice, and tobacco, and accounted for nearly 40% of the world’s soybean and chicken exports. The agro-processing industry employs over 18 million people, nearly 38% of the work-force, with agriculture comprising 28% of GDP.

Yet in 1970 Brazil was a net food importer. As regards agriculture, Brazil has a low overall level of state support for agriculture (5.7% compared with an OECD average of 26%). But it has focused on support measures which enhance the value of its natural capital and provide an enabling environment for sustainable private sector investment. A major focus has been public investment in agricultural research by Brazil's national research organization EMBRAPA, with accompanying investments in soil fertility enhancement, land and water management systems, and crop and livestock breeding for varieties adapted to Brazil's climate and ecosystems. Over half Brazil's grains are now grown using minimum tillage, an approach which conserves water and organic matter in the soil. These investments have been complemented at the state level by measures to enhance competitiveness and environmental sustainability through support for improved value added chains and producer organizations for family farms, food safety enhancement measures, rural infrastructure development, and support to improved water, environmental and biodiversity management. There have been also been investments in innovation, technology and investing in natural capital.

Forests cover 57% of Brazil's territory. In addition to the role they play in biodiversity and climate regulation, they are the basis for timber, furniture firewood and charcoal production as well as for a range of non-timber products. They also play a key role in regulation of the waters of the Amazon River. Over past decades about 18% of the Amazon forests have been lost, due to large-scale cattle-ranching and unsustainable agricultural and logging practices. In the two decades up to 2000 forest loss averaged 0.4% per year. The Atlantic rainforests have been more seriously degraded, by coastal development as well as other factors. Because of extent of the Amazon rainforests, their loss has had a global impact as regards GHG emissions. The Brazilian authorities recognize their importance and over the last decade have instituted a series of measures to address the situation.

Brazil is a country rich in water but with an uneven distribution across the country. The north-east is water-scarce. Only 4.4% of the total cultivated area is equipped for irrigation. Flood irrigation for rice paddies accounts for 42% of the irrigated agricultural area. Furrows or other gravity methods accounts for 6%, mobile sprinkler for 22%, mechanized sprinkling 23%, local irrigation 6% (drip or micro-sprinkling systems). The main water source for irrigation is surface water (95% of total). Approximately 15,000 ha are affected by salinity, mostly in the north-east.

Climate Change Projections and Impacts on Agriculture

Projections indicate that the temperature will increase by 2 to 5.4°C according to the A2 (more pessimistic) scenario and by 1.4 to 3.8°C according to the B2 (more optimistic) scenario. As regards precipitation, South-eastern Brazil is likely to have increasing aridity, and increased flood intensity and severity, while under the more pessimistic projections rainfall in the arid north-east could decrease 15-20% by 2100. Over the 2000-2007 period losses to the Brazilian economy from floods and droughts totaled US\$ 5.4 billion.

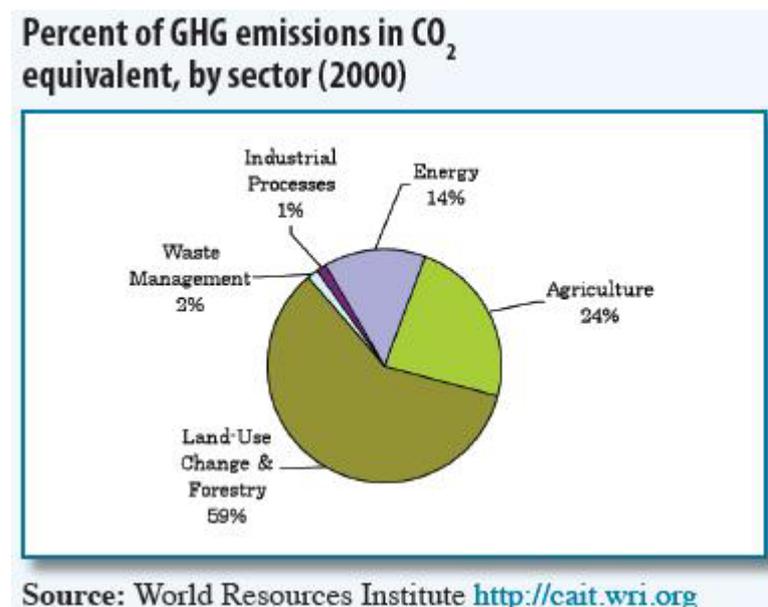
Studies indicate that reductions in the area suitable for rice and cotton are likely. One early study estimated reductions in the area suitable for coffee as 18% by 2050, with greater

reductions for soybean. The government's agricultural research agency (EMBRAPA) has conducted simulations with data from the IPCC to predict the impact of climate change on five crops: soybeans, maize, coffee, rice and beans. The results of scenarios with temperature increases of 1.3 to 5.8°C and 5, 10 and 15 percent decreases in rainfall revealed the need for some geographical reorganization of the country's agricultural production. In the coming decades, grain crops may be increasingly difficult to grow in Southern Brazil, while perennials like coffee will tend to prefer zones with more moderate temperatures, implying that the centre of production could shift southwards. Excessive heat in the southern hemisphere summer will likely push production of crops like rice, beans, maize and soy towards Brazil's central-west.

Agriculture and Land-use Change Contribution to GHG Emissions

Brazil is the 5th largest emitter of greenhouse gases in the world, and agriculture, including land use change and forestry, accounts for 75% of total GHG emissions. Land use change and forestry accounted for 75% of total CO₂ emissions and livestock accounted for 77% of all methane (CH₄) emissions.

Brazil's emissions per capita were estimated at 1.8 tons in 2004, lower than the Latin American average of 2.6 tons per capita and much lower than average global emissions of 4.6 tons per capita. One of the main problems that the country faces is deforestation of the rainforest to clear space primarily for pasture-land, accounting for about 60% of all deforestation activities. As of 2009 65 million hectares of forest, corresponding to twice the State of São Paulo, had been removed to create pastureland of low productivity, a third of which has been abandoned.



The emission reduction potential of the agricultural sector (including land use change and forestry) is very significant. Brazil currently has 30 CDM projects in the agricultural sector (targeting only methane emission reductions and biomass generation), while there are no

registered CDM projects in the country under the “afforestation and reforestation” category. However significant work is ongoing on REDD and Brazil has already made impressive progress in this regard even in the absence of CDM mechanisms (see also below)

Government Strategies for Agriculture and Climate Change

Brazil submitted a first National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2004. The Communication established the First National GHG Inventory and gave a description of the programs and policies currently active in the country containing a climate change component. It included programs for integration of climate change in future medium term and long term planning, in terms of environmental legislation, measures against deforestation and research programs on climate change topics. Brazil established a National Panel on Climate Change in 2009. The Ministry of Environment has overall responsibility for coordination of climate change policies. A webpage with climate change information for Brazil was created within the Ministry to facilitate the integration of all specialists and institutions: www.mct.gov.br/clima.

A second National Communication was issued in October 2010. It provided an updated inventory, and laid down a strategy for 2020, which included a voluntary target of reducing GHG emissions by 34-36% by 2020. Brazil has reduced deforestation rates by 70% since 2003, avoiding emissions of 2.9 billion tons of CO₂ equivalent, according to the communication. Initiatives include new plans to fight deforestation in the Amazon and Cerrado, reforms to reduce the GHG footprint of the energy, agriculture and steelmaking sectors; and establishment of a National Fund on Climate Change, using profits from the oil supply chain industry. The Fund, with an initial budget of US\$ 226 million will support activities aimed at combating desertification and adaptation to climate change. It will also support education initiatives and training projects, REDD, technology, public policy formulation, support to sustainable productive chains, and payment for environmental services as well as research.

Brazil’s strategies include a strong focus on science, research and knowledge. The Center for Weather Forecasting and Climate Studies within the National Institute for Spatial Research focuses on climate change research, including impacts on agriculture and forestry, and regional. EMBRAPA has a weather and agriculture monitoring unit which produces climate change maps showing the cultivation suitability of a certain crop depending on increases in temperature or precipitation or various types of soils. It also produces publications on climate change and its impact on agriculture.

Given its federal structure and diversity, Brazil also has a particular interest in international cooperation at the sub-national level. The state of Amapa, Amazonas, Mato Grosso and Para have joined the US states of California, Wisconsin and Illinois and the Indonesian Provinces of Aceh and Papua in signing a Memorandum of Understanding that provides the foundation for future cooperation on a number of issues related to climate policy, financing, technology exchange and research.

Brazil has emerged as a world leader in the climate change agenda over the past 10 years.

Agricultural and Natural Resource Strategies

With regard to cropped agriculture and livestock, The Agriculture and Livestock Plan is published annually. It includes a climate risk zoning plan that helps define the planting calendar for the 30 most common crops in more than 5,000 Brazilian municipalities; this helps producers know what, when and where to plant based on simulation of cumulative water balance. Some states, including the State of Sao Paula, have also enacted climate change laws.

For the field crops and livestock sub-sectors, Brazil has done much to implement climate-smart agricultural policies, though the work is on-going. Use of conservation tillage for soybean and other field crops is widespread, and there is support for a range of integrated fertility management practices. In some areas there has been progress in developing mixed farming systems integrating livestock and field crops, a practice which combined with stream bed protection can re-use animal waste as manure and enhance long term sustainable land and water use. Legumes in pasture-land, improved feeding practices and enhanced productivity also play key roles. Brazil is a major producer of ethanol from sugar-cane, grown in humid, tropical landscapes. Unlike production of biofuels from some other crops, the production process “from field to tank” is a highly efficient, more “climate-friendly” alternative for petrol (gasoline).

The Agribusiness Sustainable Production Program finances the restoration of degraded pastureland. Financial resources are applied toward the adoption of sustainable agricultural practices such as that of agro-silvi-pastoral systems or soil management practices in rural areas.

Recognizing the key role of private investment and finance, The Brazilian authorities have mandated the cessation of bank lending to agricultural producers who do not have the necessary environmental permits. The major Brazil Development Bank (BDNES), the source of over one-third of long term development financing in Brazil, has restructured its programs on forests and agriculture to provide incentives for long term management, and has revised key sectoral lending guidelines. These include support for planted forests and for rehabilitation of degraded areas. BDNES is a key source of over one-third of long term financing for Brazil’s economic development.

With regard to forest management, Brazil has implemented a series of measures to address sustainable management of the Amazon; enforcement and monitoring was difficult in the early years. In 2003 it launched the Plan to Prevent and Combat Deforestation in the Amazon, involving 14 different ministries, and putting in place a participatory process for development of a comprehensive Sustainable Amazon Plan, which has now been enacted. The program includes establishment of ecological/economic zoning plans. Programs are also under way for the (severely degraded) Atlantic Rainforests.

Forest fire management is also a critical element. A number of initiatives are under way, some with the assistance of the EU and Netherlands government; they include support for “agriculture without burning”; crushing of the secondary vegetation that is normally burned in order to clear the space for cropland or pasture. There is also support for commercial forest plantations.

Monitoring and enforcement plays a key role; a satellite monitoring system has been put in place which can locate deforestation areas every 7 to 10 days rather than annually as previously. This has enabled prompt action against illegal activities. Deforestation in the Amazon was 0.27% in 2007 compared with 0.66% in 2003.

The Forest Code provides for the maintenance of vegetative cover on private rural property, and the Public Forest Management Law supports establishment of sustainable forest management concessions based on regional best practices, including provisions which favor local communities, and reduce fees for certified operations.

The Brazilian government has created the Amazon Fund as a channel for receiving compensation for reducing GHG from deforestation without having to rely of market-based mechanisms. The Fund is managed by BNDES, and will be capitalized by donations conditioned to reductions in deforestation. It will provide grants addressing sustainable forest, biodiversity and protected area management, zoning and land regularization, monitoring and enforcement, and rehabilitation of degraded areas.

With regard to water resources, Brazil is implementing a National Water Resources Management Plan, which supports enhanced water management institutions, water quality monitoring, water allocation and water charging mechanisms and payment for environmental services initiatives in key watersheds. A major focus has been on improved water resource management, including irrigation management, in the drought-prone north-east. The programs are integrating climate forecasting into planning mechanisms.

At the regional scale, the Framework Program for Sustainable Management of Water Resources of the Plata River Basin aims at assisting the governments of Argentina, Bolivia, Brazil, Paraguay and Uruguay in the integrated management of water resources in the Plata River Basin in relation with climate change effects. The Plata River Basin encompasses the Brazilian Pantanal (swampland) ecosystem. Some of the components of this program are: i) implementation of a hydro-climatic forecasting system of the Plata Basin and adaptation to the hydrologic effects of variability and climate change, ii) monitoring of water quality, iii) integrated management of underground water resources, iv) control of soil degradation and v) identification of opportunities for sustainable development.

The Ministry of Environment has also enacted a number of institutional reforms, including establishment and adequate staffing of the National Biodiversity Management Institute and the Brazilian Forest Service. A rural environment cadastre is also under way.

Social protection is an important element of integrated approaches to climate resilient development, in Brazil as in poorer countries. About 60% of Brazil's poor and 70% of rural poor live in the semi-arid Northeast. Rural institutions are generally weak and face financial constraints. Initiatives include the well known Bolsa Familia program, the zero hunger program targeted at poor rural regions and providing micro-credit, markets for produce and drinking water; and the national program for strengthening family agriculture implemented by Banco do Brasil to finance farming and non-farming activities (tourism, crafts, fishery, and other agribusiness activities) that directly employ farmers and their families.

Agricultural insurance schemes are mostly for multi-hazard insurance (although some index based insurance has been introduced) as well as some transport risk for the case of sugar (multi-hazard insurance contracts include not only climate risks, but also potential losses due to plant disease, fire, etc.). Climate related risk instruments are limited in scope. There are two programs for managing climate risks, both requiring public support. These include credit guarantee and catastrophic loss programs. There are also pilot private programs for warehouse receipts.

The World Bank has assisted Brazil, through a series of programs adapted to particular regions on the one hand, and through development policy lending to assist with implementation of "systemic" reforms on the other.

With regard to investment lending, the operations in the north-east have focused on poverty reduction, improved access to services, business development and economic diversification. There are programs ongoing and under preparation in Bahia, Ceara, Paraiba and Pernambuco. In these drought-prone areas programs include specific support for climate-smart agricultural innovations, improved water and irrigation management, drought management and poverty reduction. Bank lending averages US\$ 100 million per program but the contribution of the Brazilian authorities is substantial in all cases. In the centre and south the focus is on rural competitiveness, with improved land and water management, access to markets and value-chain enhancement (including in some cases an assessment of operations' carbon footprint using tools developed by FAO). There are programs in Santa Catarina, Sao Paulo, and Rio de Janeiro states. In Acre in the western Amazon the Social and Economic Inclusion and Sustainable Development project (US\$ 120 million) improves access to services for both rural and urban populations. The agricultural and rural elements include support for extension, production chain development and sustainable forest management. It also includes a particular focus on working with indigenous communities.

There are also a number of operations targeted at protected area management and biodiversity (in the Cerrado, the Rio Grande do Sul and the Amazon), pilot initiatives such as improved approaches to using charcoal for pig-iron production, and reforestation initiatives using native species.

A recently completed Development Policy Loan on Environment and Natural Resource Management was recently completed. The objective of this US\$ 1.3 billion budget support

operation was to facilitate improvement of environmental management and further integrate principles of sustainability into natural resource management including forests, as well as to address climate change concerns. It included measures for improved environmental management by both the private sector and the public sector. Provisions included (i improving environmental licensing procedures and strengthening institutions; (ii increasing the number of CDM projects partly financed by BDNES to 20 million tons of CO2 equivalent; and improved monitoring of BDNES projects for consistency with the new Environmental and Social Institutional Policy; (iii expansion of sustainable management of private and public forests from 27,000km² to 50,000km²; reduction in Amazon deforestation for the period 2008-2010 to 20% below the 2005-2007 period; and increased support for natural resource management from the Amazon and Atlantic Forest Funds; (iv improved water quality monitoring on 90,000 km² of main rivers; pollution load reductions; energy efficiency gains; and national water quality evaluation programs.

Brazil is also participating in the Forest Investment Program under the Climate Investment Funds. The program is still under development.

Carbon Finance The global share of agricultural and land-use projects benefiting from finance under CDM is only 6% of all transactions. Latin America, as a region, currently holds the largest share of registered agricultural projects globally, 61%. As of 2009 Brazil had 28% of all registered agricultural projects globally and 47% of those registered in LAC. And 21% of registered CDM projects in Brazil were for the agricultural sector. All the registered agricultural projects address either biomass electricity generation or GHG reductions from improved animal waste management systems in confined animal feeding. Currently, there were no registered CDM projects in Brazil under the “afforestation and reforestation” category.

The Biocarbon Fund, implemented through the World Bank, has supported pilot REDD and agricultural soil carbon projects through the voluntary market. These have included development of some new methodologies. One of the most interesting pilot operations has been in Brazil through the Plantar pig iron project referred to above. The objective is avoid a fuel switch from charcoal to fossil fuels for pig iron production by providing additional finance for use of certified fuel-wood plantations for production of “climate-neutral” coke, and for restoration of native forests on pasture land. About 1.5 million tons of carbon equivalents would be purchased through 2012.

Burkina Faso Country Note: Community-based approaches to sustainable land management and agricultural productivity enhancement in a country facing climate stress and a rapidly growing population

Introduction

Burkina Faso is a land-locked country in West Africa with an area of 274,000 km². Its population is estimated at 15 million, with a growth rate of 3.1% per annum. Young people under the age of 15 account for 44% of the population, and Burkina is one of the most densely populated countries in the Sahel. Economic growth averaged about 5% per annum in the 2003-2008 period; growth collapsed in 2009 due to external shocks, including severe floods, the energy and global financial crises and fluctuating commodity prices, but recovered in 2010 in part due to high cotton and gold prices. Despite steady growth and political stability, Burkina Faso, with a per capita GNI of US\$ 480¹⁸, still experiences poverty rates of 44 percent. The under-five child mortality rate is 191 per thousand and 37% of the population suffer from food insecurity.

The newly-released Strategy for Accelerated Growth and Durable Development (SCADD) has an ambitious goal of a 10 percent economic growth per annum over the five upcoming years to address the poverty issue. The aim is to address economic vulnerability and develop a broader and more durable resource base through intensification and diversification of the economy, especially in rural areas.

Structure of Agriculture and Role in the Economy

Agriculture, forestry and fisheries comprise 33% of GDP, and 80% of people live in rural areas¹⁹. The main source of growth in agricultural production has been from area expansion; over the 1990-2010 period arable land area expanded from 12.9 million ha to 23 million ha, while forest area declined from 25 million ha to 20.9 million ha²⁰. Burkina's staple crops are millet, sorghum, maize, cowpeas and rice, and the principle export crops are cotton, groundnuts, karate (Shea nuts) and sesame. Burkina is Africa's largest producer of cotton and is a leader in West Africa of biotechnology. Livestock and fisheries also make a substantial

contribution to agricultural value-added. Enhanced productivity, sustainable intensification, and agricultural diversification present opportunities for Burkinabe agriculture.

Climate Variability and Change: Challenges and Opportunities

The climate is characterized as Sudano-Sahelian, with a long dry season (7 to 9 months) and a short summer rainy season (3 to five months). Average annual rainfall varies from 350 mms in the north to 1200 mms in the extreme south. Three major rivers, the Niger, the Volta and the Comoe, flow through Burkina Faso.

The climate has always been subject to variability. Experience over the last 25 years, however, indicates an increasing incidence in the frequency and severity of drought. This pattern is likely to be exacerbated in the future; models predict a likely increase in average temperatures 0.8 degrees Celsius by 2025 and 1.8 degrees Celsius by 2050. The data on rainfall illustrate a steady southern movement of isohyets over the last 80 years: in other words, the proportion of Burkina Faso's area which receives sufficient rainfall for reliable rain-fed agriculture is declining.²¹

At the same time Burkina has the potential to increase its irrigated agricultural area, which currently comprises only 0.5% of agricultural land area. With only 850 m³ per capita of fresh water available from internal renewable freshwater resources Burkina is not water abundant, but its water resources could be further developed and it has access to regional water resources. It also has the opportunity to increase resilience in rainfed agriculture through supporting sustainable land and water management practices, sustainable intensification and increase of trees in the production landscape, activities which would also contribute to climate change mitigation while enhancing long-term productivity.

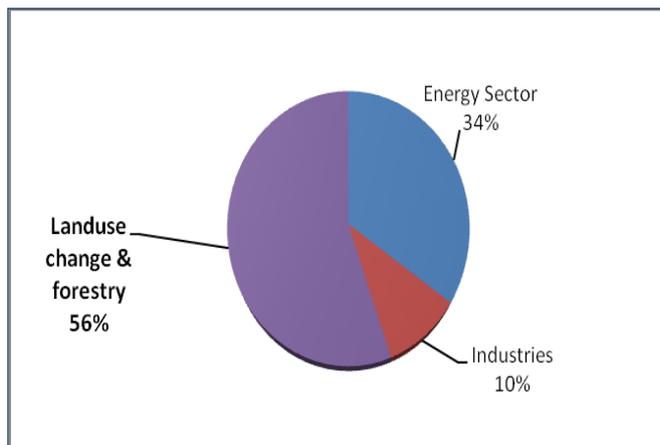
Despite its relatively high population density Burkina Faso also hosts the largest population of wildlife in West Africa; these already provide the basis for employment from tourism, and conservation of the ecosystems on which they depend is important for the country.

Agriculture, Land-use Change and GHG Emissions

Land-use change and forestry comprise 65 % of CO₂ emissions in Burkina Faso. Reported GHG emissions from livestock and agriculture are also substantial^{xvi}. GHG emissions are estimated to have increased by 30% since 1999, largely due to expansion in agricultural area. The Forest Investment Program for Burkina Faso highlights the potential for synergies between adaptation and mitigation.²²

Burkina Faso CO₂ emissions in 2006, by sector*

^{xvi} The figures provided by the National Institute for Statistics and Demography for 2009 are 396,000 tons of CH₄ from enteric fermentation and 25,000 tons of N₂O from agriculture. If these are converted to CO₂ equivalents, then GHG emissions from these sources, according to the figures, would account for over 80% of total GHG emissions.



Source: National Institute of Statistics and Demography, 2009.

*This figure includes only CO₂ emissions as reported. The data do not convert emissions from agriculture (mainly N₂O) and livestock (mainly CH₄) into CO₂ equivalents.

Government Strategies for Agriculture, Food Security, Climate Resilience and Mitigation

The priority for Burkina Faso is enhanced food security, productivity, diversification and competitiveness, while improving management of land, water and forests and woodlands to maintain underlying productivity and resilience. Burkina is emphasizing support for many of the underlying “drivers” of sustainable productivity increases, including improving rural land governance, road access and education as well as irrigation. In 2008 it signed a five year compact for US\$ 480 million with the US Millennium Challenge Corporation which focused on these areas. Decentralization is also key: its Community based Rural Development plan (An ongoing program of over US\$ 100 million) aims to build local government capacity and strengthen participatory approaches and local accountability in development planning and implementation. Burkina has a strong tradition of locally led development. It is also committed to the African Union-NEPAD CAADP process and has prepared a Country Agricultural Investment Program.

Enhanced Productivity, Diversification and Competitiveness for agricultural products, regarded as the cornerstone of economic growth and employment generation as well as poverty reduction. Two examples illustrate complementary approaches.

The objective of the US\$ 155 million Bagre growth Pole project in Southern Burkina Faso aims to increase economic activity in this region, resulting in an increase in private investment, employment and agricultural production. The project includes (i) support to the business environment, including clarification of land tenure and access rights, and regulations for environmental and social impact assessment; (ii) support to irrigation infrastructure development, to fisheries conservation and processing, to livestock herding as well as improvements in roads, social services and electricity access; and (iii) technical support for small and medium enterprise development, also helping small holders to improve their capacity to be able to respond to markets and increase their competitiveness.

The US\$ 40 million Agricultural Productivity and Food Security project, on the other hand, has a direct focus on the poor. It aims improve capacity of poor producers to increase agricultural production and increase food availability in markets. The first component aims to improve food production. It finances: (i) matching grants for the adoption of high performing agricultural technological packages to qualified households and communities, and ' voucher for work ' program contributions for the poorest households; and (ii) development of community assets in support of food production and marketing as planned and organized by village development councils (with payment of labor through a ' voucher for work ' program). The second component aims to improve the availability of food products, strengthening the capacities of stakeholders to manage the variability of food supplies. It finances: (i) matching grants to producer groups for reducing post-harvest losses; and (ii) support to marketing of food products, including development of a warehouse receipts system to enhance access to credit. The third component of the project is institutional development and capacity building. It supports: (i) building capacities of service providers; (ii) strengthening agricultural input supply delivery systems; (iii) strengthening the capacity of producer organizations and; (iv) management and monitoring and evaluation (M & E) of project activities

Improving management of land, water and forests and woodlands to maintain underlying productivity and resilience is the second pillar. In this regard Burkina Faso has a strong tradition of success in participatory approaches to sustainable land management²³, stressing the need to promote mixed farming, the use of organic manure, other agricultural inputs and water and soil conservation techniques including soil restoration and fertilization with the Zäï technique (involving digging pits filled with organic matter to improve water retention), stone cordons, and organic manure. There is a strong emphasis on the role of decentralized initiatives and organizations. Village Land Management Commissions (CVGTs) encourage tree planting and forest conservation as part of a strategy to regenerate soil fertility. More recently these programs have been supported through the Terrafrique initiative.

The “Gestion des Terroirs” approach used in the National Land Management Programme (PNGT) involves community-based land management that creates awareness of environmental degradation and conservation issues, development of new guidelines, training and support for adoption of sustainable land management and income generating activities. The Program has supported over 12,000 sub-projects, and evaluation studies have been highly positive; concerns about land tenure security are mentioned as a barrier to larger scale adoption.

Burkina has the opportunity of successfully combining the resilience, mitigation and productivity agendas through scaling up support to agro-forestry in the production landscape, and improved woodland management more broadly. The success of *Faidherbia Albida* (an acacia species) in “greening agriculture” in the Sahel and Southern Africa is well known. Burkina is a pilot country under the Forest Investment Program, one of the Climate Investment Funds. The objective of its FIP is to improve sustainable management of woodland resources for a green socio-economic development, reducing deforestation and

forest degradation, increasing carbon sequestration capacity, and improving the livelihoods of people dependent on forests and woodlands. Given the importance of woody biomass as an energy source in Burkina, the program also supports improved fuel wood management throughout the value chain. Burkina is also developing a broader REDD strategy.

In conclusion, Burkina Faso has a strong track record in community based approaches to rural development and sustainable land management. Bringing these agendas together with the agricultural productivity and competitiveness agenda will help ensure the success of a “climate-smart” approach to agricultural development and poverty reduction.

China Country Note: Low Carbon, Climate Resilient Agriculture while Increasing Productivity and Intensification: Towards Green Growth

China is a rapidly growing, urbanizing economy. 44% of its population of 1.33 billion now lives in urban areas, compared with 27% in 1990. Per capita GNI was estimated at US\$ 3650 in 2009, with annual growth rates of 9%. China’s has achieved dramatic reductions in poverty and improvements in social indicators over the last 30 years; life expectancy is now 73 years.^{xvii}

Agriculture contributes about 13 percent to China’s GDP. Average annual agricultural GDP growth over the last ten years has been around 6 percent, which is high by international standards but below growth rates in other sectors in China. The sector is dominated by small-holder farming, with 250 million farm families on land-holdings averaging less than 1 hectare. About 150 million farmers have incomes below the Bank’s poverty line and remain dependent on agriculture for the most part of their livelihood.²⁴ China is thus “land-scarce” and also faces water scarcity in the arid north-west. Major achievements have been made over the past two decades in improving agricultural productivity through increasing crop yields, developing irrigation infrastructure, introducing new technologies, diversifying into higher value crops, integrating domestic markets, and increasing international competitiveness and food exports.

Despite these successes and despite large-scale rural to urban migration, strong agriculture growth needs to be maintained to help raise rural incomes and bridge the rural-urban income gap. This will require linking small farmers to domestic and global markets through technology improvements, value chain integration, standardization of agricultural products, foods safety, plant and animal health improvements, tenure security, better environmental management, institutional development and other measures. In addition, climate change adaptation, the reduction of GHG emissions from agriculture, and the management of the environmental footprint of agriculture pose major challenges.

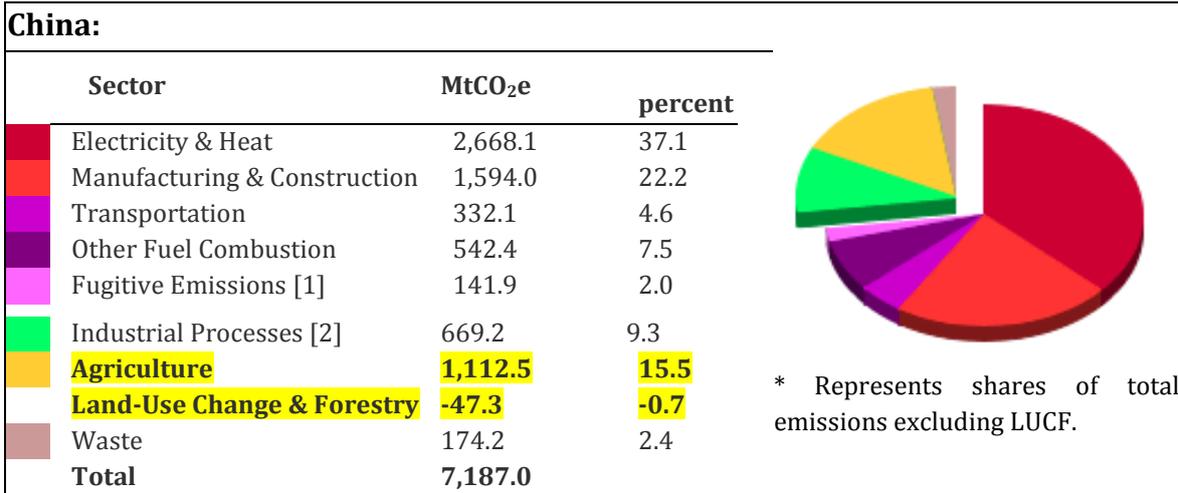
^{xvii} According to international poverty indicators (WDI) based on the number of people with less than US\$ 1.25 per day, poverty levels fell from 28% in 2002 to 16% in 2005 and have continued to fall. According to recent Chinese figures poverty incidence is now only 3%.

Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

Climate change is expected to affect agricultural production, agricultural prices and trade and grain self-sufficiency. Studies for major grain producing regions project an increase in temperature, greater variability in precipitation, prolonged seasonal droughts, and increased water stress due to decreasing water availability and increasing demand. Water scarcity is predicted to lead to water reallocation and more efficiency measures as well as changes in cropping patterns. Producer and market responses are likely to partly offset the impacts of climate change on crop production. Trade could also help China mitigate the impacts of climate change. However, trade accounts for only a small share of China’s total grain demand and overall impact of increased trade on grain self-sufficiency is expected to be small. The effects of climate change on farmers will vary with rain-fed areas likely to be more vulnerable than irrigated areas.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions

Non-point source pollution from agriculture has become the biggest source of water contamination and is a major source of air pollution and contributor to GHG emissions in China. Improper use of fertilizers as well as improper production and use of pesticides in combination with the fast developing livestock and aquaculture sectors are the causes for the high levels of pollution. There is great potential to reduce GHG emissions from agriculture, which are estimated to account for about 15 percent of China’ total GHG emissions (CO₂ equivalent). Within agriculture, 55 percent of emissions come from nitrous oxide, and 45 percent come from methane. How to address the environmental footprint of agriculture, how to ensure ecological and environmental sustainability of agriculture production systems and how to move towards low-carbon agriculture are all major challenges for the future.



Source: World Resources Institute (<http://cait.wri.org>)

Government Strategies for Agriculture, Food Security and Climate Resilience

China’s priorities for the agriculture sector cover the continued modernization of the sector through market development, technical innovation and intensification, food safety,

coordinated regional development along comparative advantages, more efficient allocation of agricultural production land and ensuring land tenure security, disaster management and adaptation to climate change, and low-carbon agriculture. The Government's comprehensive sustainable agriculture development strategy promotes shifting of away from simple quantitative production targets to more balanced and efficient production, while maintaining the overall objective of food security. It promotes environmentally-friendly and resource-conserving agriculture, the expansion of irrigated lands, and a transitional from household-based production to more organized agricultural production along sophisticated value-chains and market integration. China has largely met its requirements for food security. As incomes rise consumption patterns are changing, and the contribution of fisheries and livestock to agricultural value added has more than doubled since 1980, from 20% to 45% of agricultural value added. Fruits, vegetables and dairy products all show very robust growth. China is also a major global producer of aquatic products.

Within its strategy, the Government is pursuing a climate change strategy that seeks to strengthen the resilience of agriculture to climate change and, at the same time, reduce the emission of greenhouse gases from agriculture. The Government has made progress in introducing climate adaptation and mitigation technologies in key national grain production areas (such as changing cropping patterns, increasing investment in irrigation infrastructure, using water saving technologies and planting new crop varieties to increase resilience to climatic shocks), regions under stress from water shortages, and ecologically fragile areas, such as ecological rehabilitation and development and coastal areas.

Efforts have also been made to increase public investment in climate change research. To combat low fertilizer use efficiency in China, the government in recent years has begun promoting technology aimed at calibrating fertilizer dosages according to the characteristics of soil. In addition, conservation tillage has been considered as a potential way to create carbon sinks. Extending intermittent irrigation and adopting new seed varieties for paddy fields are also strategies that have been supported and promoted as part of the effort to reduce GHG emissions. China has also pursued for nearly two decades a wide-reaching program of landscape restoration and reforestation, which has adapted over time and has helped to restore productivity to degraded areas.

Programs to Support Climate-Smart Agriculture and Natural Resource Management: Successes and Challenges

The Bank is supporting China's agriculture sector in a number of key areas: In its *Agriculture Technology Project* and *Jilin Food Safety Project*, innovations are being introduced to assist in the integration of smallholders into markets and promote a reorientation of government in agriculture away from being a direct actor towards a service provider. These include value chain development, technology innovation and transfer, farmer associations, new forms of agribusiness financing, risk and benefit sharing partnerships between smallholders and private sector, and extension service delivery and monitoring in form of public-private partnerships, development of good agricultural practices (standards) to improve quality and safety of

products (matching grants schemes) and infrastructure and support for risk-based food safety monitoring.

As part of its Irrigated Agriculture Intensification Project (IAIL3), the Bank is supporting a number of innovative demonstration and learning interventions with GEF grant financing, including a Climate Change, Water Security and Agricultural Development in the 3H Region Study, the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project that complements the ongoing IAIL3 lending operation that is taking climate change models down to the micro level and using these models to design better irrigation and water saving interventions at the project level; and the GEF-financed Sustainable Land Management and Adaptation Component under the Sustainable Development in Poor Rural Areas Project. The 3 H program aims to address “total water productivity” in agricultural water management, producing more crop per unit of evapo-transpiration as well as simply “more crop per drop” through integrating careful, adapted water management and monitoring of crop characteristics and requirements.

A new Comprehensive Agriculture Development Project has been proposed by Government for Bank support in the coming years. This project would cover key grain production provinces and include large-scale investments in various agricultural sub-sectors to improve land and water productivity, crop yields, fertilizer applications, and rural energy use efficiencies. The project offers an important opportunity to up-scale the experiences and lessons from the ongoing climate change adaptation and mitigation pilots.

On the mitigation side, the Bank is implementing a number of Clean Development Mechanism (CDM) projects, including the Hubei Eco-Farming Biogas Project, Shandong Provincial Biogas Program, and Xinjiang Aksu Pig Farm Biogas Project. There is a diverse portfolio in the field of agriculture pollution prevention, including the Eco-Farming and Henan Yellow River Ecological Livestock Projects (both IBRD), and the Shanghai Non-Point Source Agricultural Pollution Project (GEF). Elements of agriculture pollution control are also supported under the *IAIL3*, and the *Jilin Food Safety and Agriculture Technology Projects*. Issues being addressed include the management of animal waste, promotion of biogas use, non-point source pollution reduction, good agricultural practices, monitoring ambient environmental conditions that affect food quality, heavy metal contamination of soils, animal disease outbreaks, and organic production. The earlier *Coastal Zone Management Project* established monitoring systems for pollution into coastal waters and fish populations to sustainably manage these resources. There are also a number of environmental projects that tackle agriculture run-off into river and lake systems. Finally the Bank is maintaining its largest POPs program in China.

China’s programs of landscape restoration are well known. In the Last two decades it has successfully implemented one of the world’s largest erosion control programs and returned the Loess Plateau to sustainable agricultural production. The program supported recovery of grasslands, trees and shrubs on previously cultivated sloping lands, terracing, irrigation on low lands and fencing of previously free-ranging livestock. Perennial vegetation cover

doubled to 34%, the area became self-sufficient in grain production, but production also changed to focus on higher value products. The program itself benefited 2.5 million people, but as many as 20 million people may have benefited from similar programs throughout China.

China has also succeeded in reversing deforestation. and is now a “net sequesterer of carbon” from forests. Forest cover has increased from 120 million ha in 1980 to 180 million ha in 2010. This achievement is the more remarkable since China is “fertile land and forest-scarce”, with an average of only 0.14 ha of forest land per capita. The restoration of forest cover in China is the result of policies that had as their initial objective the restoration of environmental balance and the securing of raw material supplies. There were substantial investments in tree planting across the country.

Since the mid-1990s, large areas of natural forest have been withdrawn from commercial logging. China is the world’s largest importer of logs and sawn wood, but local timber production is now expanding. Two-thirds of requirements are met from domestic production and projections indicate that over the next 20 years China will be increasingly self-sufficient. China has transferred forest land from public sector control to farm families and community groups. Program of payments for environmental services from forests and for the conversion of agricultural land to forest cover are ongoing. Increasing attention is paid to species mix, with 75% of species planted being indigenous to China. There have been reforms in the ownership use rights, many involving provisions to offer individual households a large degree of economic autonomy and forest management independence, with households and farmers’ groups receiving certificates of use rights.

China recognizes the key role also those forests play in watershed protection, control of desertification and air pollution, carbon sequestration and habitat conservation, and complements these institutional reforms by regionally adapted support to farmer and community investment in natural capital. The most recent of these is the Integrated Forest Development Program in China for soil and water conservation and restoration of degraded lands, under implementation since 2010 with US\$ 100 million loan participation from the World Bank.

The project aims to increase vegetative cover in environmentally degraded areas in five provinces, and to improve forest management. Components include establishment of multi-functional forests to create windbreaks and sand breaks, soil and water conservation forests and farmland shelter belts; improvements in resiliency of existing plantations, and institutional support and monitoring.

Opportunities Ahead

China has largely met its food security requirements. Over coming decades, while continuing to address rural poverty and agricultural productivity, production systems will increasingly change to meet the needs of a wealthier urban population, while rural landscapes will be

managed to maintain environmental services as well as to meet food needs^{xviii}. Climate variability and change poses additional challenges.

Ethiopia Country Note: Towards a Green Economy - Increasing Food Productivity and Re-greening the landscape while improving Social Safety Nets and Drought Risk Reduction Measures

Introduction

Ethiopia, with a population of 85 million and a land area of 1.1 million km², has widely varying geography, agricultural ecosystems and climate. 83 percent of its population live in rural areas, and most are dependent on rain-fed agriculture for their living. With a per capita GNI of US\$ 350 it is one of the poorest countries in Africa. Its 2010-2015 Growth and Transformation Plan is aimed at broad-based and sustainable development, with a focus on pro-poor growth. It is already making progress in this regard: the poverty head-count is 39% compared with 55% in 1999. The Plan has the ambitious goal of achieving economic growth of 11% per year, doubling agricultural production, and achieving almost universal access to primary education, safe water supplies and electricity by 2015.

Structure of Agriculture and Role in the Economy

Agriculture accounts for 45 % of GDP and almost 90% of exports, led by coffee (60%) followed by hides and skins (12%), but increasingly complemented by a variety of high value horticultural products. Coffee, grown very largely by small-holders, is the primary agricultural export. Ethiopia also has the largest livestock population in Africa and exports a range of livestock products. Livestock is a significant portion of agricultural GDP and plays an important role in broader agricultural livelihoods. With a population density of 88 persons per km², 0.17 hectares of arable land per person, and only 12% of land area classified as forest land, Ethiopia is relatively “land-scarce”. Small-holder farming predominates. The main staples vary according to rainfall and altitude and include cold tolerant teff and barley, wheat, maize and drought-tolerant sorghum as well as plantains/bananas, which together account for three-quarters of arable land and two-thirds of crop production. Other products include oil seeds and pulses, fruits, vegetables and flowers, natural gums, honey and a range of livestock and dairy products.

Climate Variability and Change: Challenges and Opportunities

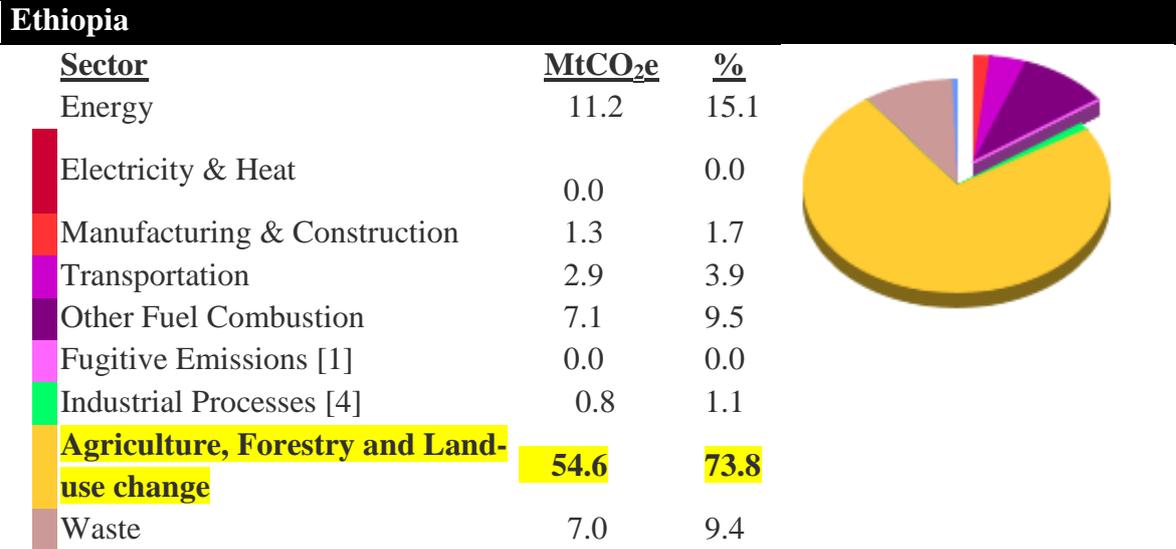
^{xviii} A recent paper, still in draft, addresses the challenges of China in 2030: “towards a green economy” and describes China’s agricultural and rural transformation as moving “from food to farm to field”; the role of agriculture evolves from providing food and cheap labor, to providing for a decent living for farmers while meeting urban food requirements, to providing environmental and landscape services in addition to food.

Ethiopian agriculture is highly exposed to climate variability, and in particular to drought and related heat stress. There are close correlations between changes in rainfall, agricultural productivity, GDP and broader human well-being. Droughts in the early 1970s and 1980s caused large-scale loss of life. Ethiopian policy makers have developed programs to mitigate the impact of droughts, including early warning systems and social safety nets. These programs focus on geographical areas most exposed to unpredictable rainfall. The drought programs are being increasingly complemented by longer run programs to address productivity and sustainable land and water management (see below).

Global circulation models predict an increase in temperature of 1.7 to 2.1 degrees Celsius by 2050. The predictions regarding rainfall are much less consistent; but increasing unpredictability, together with more frequent and intense patterns of extreme weather, is likely to be the trend.²⁵ The combination of higher temperatures and more unpredictable rains has negative implications for the length and reliability of the growing season. Parts of Ethiopia have abundant surface water resources, but so far irrigated agriculture is not well developed.

Agriculture, Forestry and Land-use Change: Contribution to GHG Emissions

The chart below provides a breakdown of the sources of Ethiopia’s greenhouse gas emissions. Agriculture, land-use change and forestry account for 74 percent of CO2 equivalent. The sector has potential to take advantage of mitigation opportunities through adopting improved land, water, agriculture and agro-forestry management practices to sequester carbon in and above the ground and to reduce emissions per unit of production. There is also very substantial scope to “re-green” the landscape through reforestation and broader watershed restoration measures which will also contribute to longer term resilience, fertility, and restoration of ecosystems functions and biodiversity. Given Ethiopia’s large livestock population, emissions from agriculture will remain substantial, but the mitigation potential is also considerable; there are opportunities for better grazing practices, livestock breeding manure management and for biogas.



International Bunkers	0.5	0.6
Total	74.0	

Source: World Resources Institute, Climate Analysis Indicators Tool (CAIT); Based on 2005 estimates.

Strategies for Agriculture, Food Security, Climate Resilience and Mitigation

The government is strongly committed to continued agricultural growth and has a three-pillar approach - food security and drought resilience, agricultural productivity, and sustainable land and water management. Between 13 and 17 percent of government expenditure has been channeled towards agriculture and rural development (including natural resource management) in recent years—far more than the average for sub-Saharan African countries. While almost half of this expenditure supports chronically food insecure households (see below) there is now increased commitment to raise national food production by investing in areas with high agricultural potential. There is commitment also to achieve longer term green growth through focusing on improved land and water management and increasing tree-cover to achieve a greener agriculture. Ethiopia is, furthermore, supporting a number of enabling measures, including support for land registration to clarify land tenure, improved rural infrastructure for enhanced connectivity, and education and social services.

The first challenge has been to address the needs of the relatively large portion of the population which has been chronically food insecure. Much development partner support has been channeled to this area, through the Ethiopia’s Productive Safety Nets Program (PSNP), the largest social protection program in Sub-Saharan Africa outside South Africa. The program, implemented over the 2005-2014 period in three phases, is financed by a range of development partners and totals over US\$ 4.4 billion over the period²⁶. The objective of the program is to support a transition away from an emergency appeal system to a more predictable safety net to tackle chronic and seasonal hunger, in the process improving food security for at least 5 million chronically food insecure people. The program started in four regions but has now spread to nine. It includes careful targeting and cash-for-work programs, and is administered through local structures. Works programs supported include environmental regeneration, which has led to recoveries in the water table and vegetation cover, increasing carrying capacity for livestock, as well as small-scale irrigation, water supplies, rural roads and farmer training.

The program has evolved over time and now includes an approach to managing weather risks called LEAP. (Livelihoods - Early Assessment - Protection). It combines early assessment, early warning, contingency planning and capacity building with contingent finance. It estimates funding needs in the event of a weather shock, using ground and satellite rainfall data to calculate weather-based indices for the whole of Ethiopia, even where there are no weather stations. The agro-meteorological information is integrated with livelihoods and vulnerability data at local and regional levels. These indices are used to trigger contingent finance to scale up the PSNP if needed, enabling a shift from managing disasters to managing

risk. LEAP is currently being refined to integrate a flood index and a climate change and seasonal forecast component. The program has also provided the basis for allocation of emergency funds under the GFRP (US\$ 275 million) in 2010, as well as emergency funding under the current drought.

An Internal Evaluation group (IEG) review²⁷ confirms that the program has been effective, pragmatic and flexible. An earlier review by IFFPRI²⁸ indicated that households with access to both the productive social safety nets program and to packages of agricultural support were more likely to be food-secure, to borrow for productive purposes, use improved agricultural technologies, and operate nonfarm business activities.

A complementary approach has been through Pastoral Community Development Programs, focused on Ethiopia's pastoral and agro-pastoral regions. These have aimed at (i) increasing the resilience of Ethiopian pastoralists to external shocks; and (ii) improving the livelihoods of beneficiary communities, contributing to poverty alleviation in Ethiopia. The second component is the pastoral risk management. The program has included an support for an improved pastoral early warning system through a participatory approach as well as the establishment of an early response fund, as well as strategic disaster preparedness and mitigation investment planning.

The second challenge has been to increase agricultural productivity and value chains, to enhance growth and diversify rural livelihoods. Many areas have potential for productivity growth, and there are opportunities to add value to produce both on-farm and along the value chain in activities such as oilseeds, pulses, fruits, vegetables, coffee, milk and meat.^{xix} Exposure to climate risk is an impediment to long term investment. Increasing agricultural water availability and reversing environmental degradation also increases growth potential through increasing soil fertility, moisture holding capacity and resilience, reducing livestock and crop losses during dry spells.

The objective of the Agricultural Growth Program, initiated in four regions²⁹ in 2010 for a cost of US\$ 281 million and supported by a range of development partners, is to increase agricultural productivity and market access for key crop and livestock products, with increased participation of women and youth. The project is supporting agricultural production and commercialization, through (i) strengthening the capacity of farmer organizations and their service providers to scale up best practices and adopt improved technologies in production and processing, soil fertility, improved seed and animal health, and enhancing marketing and processing of selected commodities by engaging the private sector; (ii) strengthening small-scale rural infrastructure to improve productivity, and to further develop

^{xix} About 25 percent of rural households earn some income from non-farm enterprises. Rural wage employment (in commercial agriculture and in non-agricultural enterprises) is negligible. See World Bank, "Ethiopia, Diversifying the Rural Economy: An Assessment of the Investment Climate for Small and Informal Enterprises," October 6, 2009. Productivity potential studies include assessments of "commodity belts" by the Ethiopian Institute of Agricultural Research (EIAR); an analysis of potential growth areas by the International Food Policy Research Institute (IFPRI) and Ethiopian Development Research Institute (EDRI); analyses of growth corridors and value chains for different commodities.

and increase the efficiency of key value chains through improved access to markets; supporting small-scale irrigation, soil and water conservation and water harvesting, ponds and pumps, together with capacity building in water management, watershed development, planting of multi-purpose trees, groundwater recharge and gully erosion control as well as market infrastructure and feeder roads; and (iii) program monitoring and evaluation. Ethiopia has also received funding for agricultural development through the GAFSP (US\$ 51 million).

An objective of the program is to reduce farmers' exposure to unfavorable environmental conditions and associated risks, by supporting investments in sustainable land and water management. These will strengthen resilience to livestock and crop losses during dry spells and enable smallholders to take advantage of new opportunities.

The Ethiopian authorities, with the assistance of development partners, are also investing in increasing access to irrigation through a number of programs.

Sustainable land and water management. Sustainable land and water management is a key element of the productivity agenda (see above) but can also contribute to reduced carbon growth. Ethiopia is also investing in broader landscape restoration, including agro-forestry, through under its broader Strategic Framework for Sustainable Land Management. The aim of the programme is to increase agricultural production and reduce land degradation, for example, through the use of terracing and physical structures to arrest erosion, and through reforestation and the use of organic fertilizers (compost). Programs under this framework are supported by a number of development partners. For example the Sustainable Land Management Project, supported by the GTZ, GEF and the World Bank, taking a watershed approach, aims to cover a total area of about 250,000 ha, benefiting about 400,000 people.

The Humbo Assisted Natural Regeneration Project follows a Farmer-Managed Natural Forest Regeneration approach to reforest 3,000 ha of degraded land, encouraging new growth from tree stumps previously felled but still living. The regeneration project has resulted in increased production of wood and tree products, such as honey and fruit as well as fuel wood, which contribute to household budgets. Improved land management has also stimulated grass growth, providing fodder for livestock, an additional source of income, and the regeneration of the native forest is expected to provide an important habitat for many local species and reduce soil erosion and flooding. The protected areas of forest now act as a 'carbon sink,' absorbing and storing greenhouse gases from the atmosphere to help mitigate climate change. The project thus contributes to the "triple win" of climate-smart agriculture. It is the first land-use/forest project in Africa to be registered with the United Nations Framework Convention on Climate Change (UNFCCC). It is supported by World Vision and the Biocarbon fund.

Ethiopia is now committed to a major landscape re-greening program and is the first country in Africa to have declared its commitment to a green growth strategy, of which landscape restoration forms a major element.

Conclusion

Ethiopia is fully committed to addressing the challenge of meeting food security and productivity needs, addressing resilience and taking advantage of mitigation opportunities in agriculture and natural resource management. There remain opportunities further to scale up the work especially in landscape restoration and “greening”, as well as in enhancing agricultural productivity and resilience.

Ghana: Increasing productivity along the value chain for food, aquatic and forest products while addressing the challenges of climate variability and addressing deforestation and land degradation

Introduction

Ghana has a population of 23 million and an area of 230,000 km². Agriculture comprises 30% of GDP. Ghana is rapidly urbanizing, and about half of the population now lives in urban areas compared with 36% in 1990. Ghana has achieved solid economic growth through much of the decade, together with impressive reductions in poverty. Overall levels fell from 52% to 29% between 1990 and 2006. Spatial disparities remain a concern, however, with rural poverty rates in Northern Ghana remaining high at over 65%. Per capita GNI was estimated at US\$ 1190 in 2009, but economic growth has accelerated following the discovery of oil, and annual growth in 2010 was over 13%, the most rapid rate of any country in Africa. With stable government and a favorable environment for private sector investment^{xx}, Ghana is well advanced in the transition to a middle income economy.

Structure of Agriculture and Role in the Economy

Agricultural GDP grew at an average of 6% per annum over the 2007-2010 period. Agriculture accounted for 72% of exports in 2009, led by cocoa, but with significant contributions also from timber and fisheries. Arable land constitutes about 20% of total land area and permanent crop land 10%. Ghana has experienced rapid deforestation over the last decades, caused largely by expansions in agricultural land area but also by poor logging practices. Forests now account for 22% of land area and closed canopy forests 7.5%³⁰. Irrigation accounts for only 0.5% of cropland area. Unsustainable land-use practices carry a heavy economic cost in Ghana; studies estimate that soil erosion costs about 2% of GDP and forest degradation about 5%.³¹

Ghana is reasonably “food secure” at the national level, with adequate or surplus production of most of the basic staple roots (cassava, yam, and cocoyam), cereals (maize, millet and sorghum) and plantains, though in certain northern regions a significant proportion of the

^{xx} Ghana rated fifth among African countries in the 2010 Doing Business Survey

population remains “food insecure”. Ghana imports significant quantities only of rice, which, once regarded as a luxury, is increasingly seen as a staple food, as well as poultry products. Growth has largely been due to area expansion rather than to productivity increases and use of improved seed and technologies remains low, Adoption of sustainable land and water management practices also remains low and, especially in the north, agriculture is vulnerable to drought and flood (see also below). While there is a vibrant private sector there is need for a more systematic approach towards integration into commercial value chains. With the right policies and support measures Ghana has the potential to meet rising domestic demand for higher value products.

Fisheries and aquaculture are important in Ghana, accounting for at least 4.5% of GDP and over 50% of animal protein consumption, and with 10% of the population dependent on the sector for their living. In part because of a focus on supporting increased fishing effort as opposed to increased value added and loss reduction, together with insufficient emphasis on resource management, profitability and incomes have declined in coastal and marine fisheries in recent years and the sector is not achieving its potential. Aquaculture especially from Lake Volta is a growing share (now 50%) of fish catch but there is also scope for improving value added and sustainability.

Despite a long tradition as a timber producer and processor, Ghana has experienced among the highest deforestation rates of any country in Africa in recent decades (1.89% per annum over the 2000-2010 period)³². This has been in part because of agricultural expansion, in part also because of growing domestic demand for timber products and policies which have favored over-capacity in lower-quality processing, and in part also because of land tenure systems which do not provide the right incentives for forest conservation. Furthermore there has been focus in the past on sustainability in the export sector, while sustainable management in the domestic and regional markets has received less attention³³.

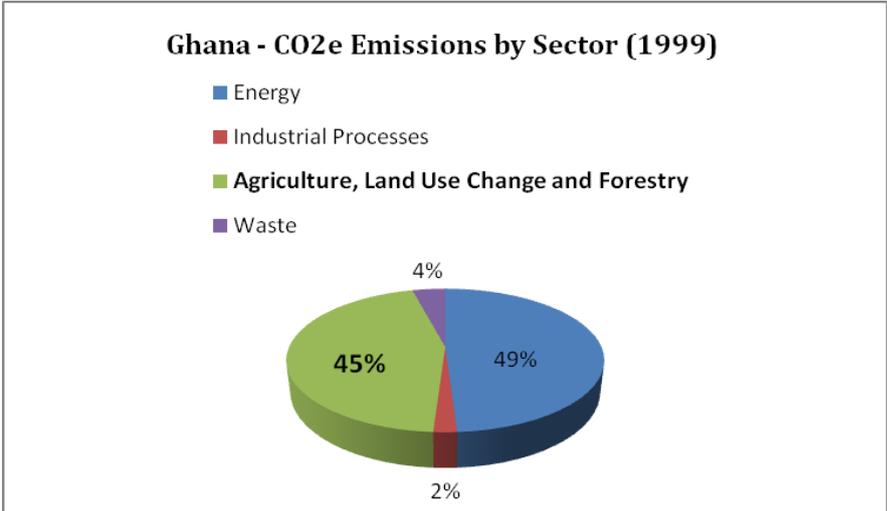
Climate Variability and Change and Impact on Agriculture

Ghana is vulnerable to climate variability and change both because of the importance of its agricultural sector, and because of its long coastline, which is home to approximately one-quarter of the population. In common with most other countries there is much more certainty regarding projected changes in temperature than in precipitation, and the impacts vary by region. Ghana was the subject of a study, the Economics of Adaptation to Climate Change³⁴ which used a global modeling approach to estimate welfare losses under different scenarios. The study concluded that temperatures are likely to rise by 2.2-2.4 degrees centigrade over the next 40 years, with the highest increases in the already warmer northern savannah areas, and more and longer periods of extreme heat. Projections regarding rainfall and stream-flows vary widely but greater unpredictability in rainfall events is likely, leading to more frequent floods and droughts. Changes in temperature and currents are also likely in marine ecosystems, leading to changes in the “upwelling” patterns which influence fisheries abundance. Average welfare losses of 5-10% are predicted, and agricultural households would likely be most affected.

The study recommends an increased focus on drought and flood resilient farming and livestock systems including investments and policy support measures in R&D and extension and development of new crop and livestock varieties, in water storage capacity to manage seasonal and annual variability, in irrigation, land tenure improvements, agricultural value added and broader economic diversification, as well as improvements in rural infrastructure. It also recommends sustainable management of coastal wetlands, coastal flood protection, fisheries protection and broader review of coastal developments. Work undertaken in the context of the AU-NEPAD Terrafrica Sustainable Land Management initiative also emphasizes the need for investments in sustainable land and water management and broader landscape restoration.

Contribution of Agriculture, Forestry and Land-use Change to GHG Emissions

Updated information on the structure and trends of GHG emissions in Ghana is not available. Agriculture, land-use change and forestry contribute an estimated 49% of Ghana’s GHG emissions according to its communication to the UNFCCC in 1999. In part because of underlying favorable growing conditions and the past history of forest and land degradation, Ghana has considerable potential to reduce GHG emissions through addressing REDD (reduced emissions from deforestation and forest degradation) . Ghana has been selected to participate in The Forest Investment Program (FIP), one of the programs set up under the Climate investment Fund. The FIP expert committee³⁵ charged with country selection estimated mitigation potential from REDD at 141 million tons of CO2 over the 2010-2030 period, and emphasized that lessons from Ghana could be useful for other humid West African countries.



Source: <http://unfccc.int/resource/docs/natc/ghanc1.pdf>

Government Strategies for Agriculture, Food Security, Climate Resilience and Low Carbon Growth

Ghana has prepared a range of strategic documents which detail its approach to agricultural development, sustainable land and water management, forests and climate-smart natural resource development more broadly. These include the Ghana Shared Growth and

Development Agenda 2010-2014, and the Medium Term Agricultural Investment Plan (METASIP) which has been developed fully within the CAADP framework. Full implementation of METASIP is currently challenged by a funding gap of approximately US\$ 150 million annually. METASIP includes six core programs, several of which are relevant to the “climate-smart agriculture” agenda. These include (i) food security and emergency preparedness, including productivity enhancement, livelihood diversification, storage and distribution, early warning systems and emergency preparedness, irrigation and water management and mechanization; (ii) increased growth in farmer incomes covering value chain development, fisheries as well as agriculture, and rural infrastructure development; (iii) competitiveness and market integration; (iv) sustainable management of land and environment including promotion of SLM; (v) development and uptake of science and technology; and (vi) institutional coordination.

Other key related strategies include the Agriculture Sustainable Land Management Strategy and Action Plan (2009-2015), the Food and Agriculture Accelerated Development Policy, the National Land Policy, an Irrigation Policy (2010) an Integrated Water Resources and Flood management plan (under development) and a REDD Readiness strategy (also under development). Ghana has also begun to address improved forest management through supporting certification and voluntary partnership agreements to address FLEG (forest law enforcement and governance). Ghana addressed integration of climate considerations into agriculture and related strategic documents through a series of development policy operations implemented over the 2008-2010 period. It is also addressing the specific concerns of Northern Ghana through strengthening the capacity of the Savanna Accelerated Development Authority. Recognizing the link between biodiversity conservation and long term sustainability, Ghana also has strategies in this area.

Ghana is receiving international support for a range of relevant programs, with a focus on the productivity and commercialization agenda. These include a US\$ 212 m program addressing commercialization, irrigation, rural infrastructure and land tenure through the Millennium Challenge Corporation Program, and a new series of development policy operations to support METASIP implementation. The first (a credit of US\$ 57 million approved in 2011) addresses improvements in agricultural technology, market access, irrigation, fisheries management and sector management. Related investment operations are under way and planned in commercial agriculture and agricultural productivity. Ghana’s vibrant private sector has a strong role to play in climate-smart agriculture, through a range of activities through the value chain, and including sustainable tree-crop management.

Regarding the broader enabling environment, Ghana is also seeking to modernize its land tenure and administration system, and to upgrade rural roads and improve access.

Ghana has developed a Country Investment Framework for Sustainable Land Management, and there have been a number of pilot initiatives addressing the problem. The problem in the past has tended to be addressed in a fragmented way. Ghana has now established a

Sustainable Land Management Committee which aims to tackle the issue in an integrated way. The program has been developed through the NEPAD-Terrafrica partnership.

Recognizing the challenges of Northern Ghana, a strategy³⁶ has been developed with a vision of a “forested north” where “food crops and vegetables are inter-cropped with economic trees that are resilient to weather changes, sustain a stable environment and create a permanent stake in land for poor people”. These initiatives would be combined with flood and watershed management programs. A GEF financed operation (US\$ 7.8 million) aims to support implementation of this strategy in targeted watersheds,³⁷ with the specific objectives of improving sustainable land and water management to control degradation, maintaining biodiversity and strengthening spatial planning. This initiative helps also provide the technical experience for scaling up under programmatic approaches supported through agriculture and environment budget support operations (development policy lending).

Ghana is also developing a comprehensive program of irrigation and water resource management, and plans to improve its weather and climate services and disaster preparedness programs.

Given the specific challenges of fisheries and aquaculture, Ghana, aims to improve fisheries through a US\$ 50 million (approved 2011) credit under the West Africa Fisheries program. The objective is to support the sustainable management of Ghana’s fish and aquatic resources by: (i) strengthening the country’s capacity to govern and manage the fisheries sustainably; (ii) reducing illegal fishing; (iii) increasing the value and profitability generated by the fish resources and the proportion of that value captured by the country; and (iv) developing aquaculture.

Regarding forests, Ghana has developed a coordinated approach through the Natural Resources and Environmental Governance program. There has been great progress in achieving transparency and sound management in the export sector. There is scope for afforestation of degraded lands as well as improved management, with the participation of local communities, of remaining forests. There is also scope for a value-chain approach to improve value added and reduce waste along the production, processing and marketing chain for timber products produced for domestic and regional markets. The “forested north” vision also provides scope for integrating trees into the production landscape. Ghana is preparing its REDD strategy and Forest Investment Program which will build on past experiences. As with agriculture, the private sector has a strong role to play.

Kenya Country Note: Agriculture, Food Security and Climate Change

Agriculture and its Role in the Economy

Kenya has a total area of 570,000 sq. km. Only 5 million hectares are classified as arable or permanent crop land, and Kenya is relatively “land-scarce (0.2 ha of arable land per person). The land stretches from the sea level in the east to 5,200m above sea level at the peak of Mt. Kenya, with the altitude changing gradually from the coastal belt and plains to the highlands. Kenya’s per capita GNI is US\$ 760 and its population is estimated at 40 million, with growth rates of about 2.7% per annum. Poverty reduction remains a challenge in Kenya, with poverty incidence declining from 52% in 1997 to 46% in 2006, according to household surveys. Economic growth in 2010 was 5%, rebounding from rates of only 2.6% in 2009. Steady growth has been challenged in recent years not only by global crises but also by post-election violence in 2008, and more recently by the drought in the Horn of Africa.

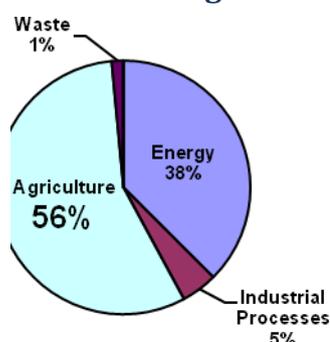
Kenya has one of the most diversified economies in East Africa, with relatively advanced agricultural and industrial sectors, a vibrant private sector and substantial foreign exchange earnings from agricultural exports and tourism contributing approximately 27 percent of the GDP and 57% of merchandise exports. Kenya’s geographical variety contributes to its diversified agricultural economy. Its main agricultural cash crops include tea, coffee, horticultural products, pyrethrum, pineapple, sisal, tobacco and cotton. Food crops include maize, beans, cane sugar, wheat, rice, bananas, cassava, potatoes, sorghum, and millet. 78 percent of the Kenyan population live in the rural areas and include commercially oriented small-holders, out growers and employees on plantations, pastoralists and subsistence farmers. Kenya has a long tradition of integrating multi-purpose trees in production landscapes, especially in the more fertile central and western highlands.

Climate Change Projections

A study by the Stockholm Environment Institute along with DFID³⁸ has considered projections of future climate change from a suite of downscaled global models for Kenya, such as:

- **Temperature.** The projections indicate future increases in mean annual temperature (average monthly temperatures) of broadly 1 to 3.5 °C over the range of models by the 2050s (2046 -2065). There will also be increases in sea level.
- **Rainfall.** The changes in precipitation are more uncertain. All the climate models show that rainfall regimes will change but these vary with season and region. Most models project rainfall will increase on average, though some models project rainfall reductions in some months for some areas.
- **Extreme events.** The information on extreme events (floods and droughts) is much more variable and future projections vary widely. Many models indicate an intensification of heavy rainfall in the wet seasons, particularly in some regions and thus greater flood risks. Droughts are likely to continue but the projections are more varied - some models project an intensification of these events, particularly in some regions, though other models indicate reductions in severity.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions



GHG emissions by sector (without LUCF) for 1994

Information on GHG emissions from land-based sources is not good in Kenya. Figures dating from 1994 do not include land use and land use change, and indicate that agriculture comprises 56% of GHG emissions.

Government Strategies for Agriculture, Food Security and Climate Resilience

Kenya's long term development has been guided by a long term strategy for transforming Kenya into a newly industrializing, middle income country providing a high quality of life for all its citizens by 2030. Within this over-arching framework the goals are to increase incomes in agriculture, livestock and fisheries even as the industrial and service sectors expand by focusing on value-added, competitiveness, commercialization and modernization. Specific strategies would include transforming key supporting institutions, increasing productivity, enhancing value chains and branding, improving land tenure and broader land use, developing irrigable areas for both crops and livestock, especially in arid lands and improving market access for smallholders. For livestock there would be a focus on disease control and improved processing to meet international marketing standards.

Medium term agricultural policy in Kenya revolves around the main goals of increasing productivity and income growth, especially for smallholders; enhanced food security and equity, emphasis on irrigation to introduce stability in agricultural output, commercialization and intensification of production especially among small scale farmers; appropriate and participatory policy formulation and environmental sustainability. The key areas of policy concern, therefore, include:

- Increasing agricultural productivity and incomes, especially for small-holder farmers (through inputs, credit, markets and trade policies at international, regional and national levels, expansion and intensification of irrigation, and strengthening institutions for service delivery).
- Emphasis on irrigation to reduce over-reliance on rain-fed agriculture in the face of limited high potential agricultural land.
- Encouraging diversification into non-traditional agricultural commodities and value addition to reduce vulnerability.
- Enhancing the food security and a reduction in the number of those suffering from hunger and hence the achievement of MDGs.
- Encouraging private-sector-led development of the sector.
- Ensuring environmental sustainability.
- Adaptation and mitigation (through early warning systems, conservation agriculture, soil and water conservation, drought tolerant crops, and water storage systems, among others)

In July 2010, Kenya officially launched its **Agricultural Sector Development Strategy (ASDS) 2012**, a strategy to guide further development of the country's agricultural sector in line with the **Comprehensive African Agricultural Development Program (CAADP)**. The ASDS was launched to replace the **Strategy for Revitalizing Agriculture (SRA)** and has the overall objective of increasing productivity and through an increase in agricultural growth of 7 percent per year over the next 5 years. The Agricultural Development Strategy was jointly developed by ten ministries and aims at improving on the living standards of Kenyans under the vision "a food-secure and prosperous nation" by positioning the agricultural sector strategically as a key driver for sustained economic growth.

The government has made efforts to promote increased agricultural productivity through reforms and support to research; reforms and support to extension; investment in agricultural development programs; management of water tours; and expansion of irrigated agriculture. Similarly, efforts to increase access to inputs (seeds, breeds, fertilizer and agro-chemical) have been made through a national seeds supply system; increasing adoption of improved seed; targeted seed subsidy to smallholder farmers; increasing adoption of improved traditional crops; managing fertilizer prices; target fertilizer subsidy; and increasing access to animal breeds.

There are several other government policies and strategies to note, such as, the **Food Security and Nutrition Policy**, which is now finalized and under implementation and the **National Climate Change Response Strategy (NCCRS)**, which has been developed and launched.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

Kenya faces increasingly severe and frequent floods and droughts, exacerbated by land degradation. Yet it has developed regionally adapted approaches to addressing climate risks. The World Bank supports several projects that in different ways contribute to increasing Kenya's capacity to adapt to the impacts of climate variability and change. These projects focus on various sectors, such as agriculture, environment, and natural resource management. Some of the climate-related activities foster synergies between mitigation and adaptation, in particular the carbon finance operations. Experience from these programs should help Kenya, in the longer run, take advantage of carbon finance in its landscape restoration programs. Kenya is now beginning to move towards tackling protection of its mountain "water towers" through landscape restoration there.

The recently closed Arid Lands Management program was a 12 year initiative totaling US\$ 120 million of IDA assistance helping agro-pastoralists in the north and north-east manage risk posed by drought and other factors through a mix of community driven technical and social interventions, including innovative early warning systems and drought contingency funds, and strengthening and institutionalizing natural resources and drought management systems. The program also attempts to create alternative livelihood opportunities so that the population in these areas, who otherwise largely depend on livestock, is not so vulnerable when the rains fail. This has helped reduce the vulnerability of the population in an area that experiences frequent, acute food insecurity related to drought. The program has benefited 2 million people in 28 districts.

A follow-on program is being developed whose objectives, similarly, are the increase the resilience and productivity of pastoral and agro-pastoral systems in semi-arid and arid areas. Key performance indicators for this US\$ 100 million IDA program, with additional funding from GoK, Danida, DIFID and the EU, would include: : (i) change in household assets in participating communities, normalized by drought severity index; (ii) community projects rated satisfactory by participating communities; (iii) resources leveraged from other sources due to harmonized process of community and district planning; (iv) decreased proportion of people in each district assessed needing free food aid, normalized by severity of drought; and (v) improved child nutritional status over time, normalized by severity of drought. The program would support planning and implementation processes, enhanced drought management, including establishment of a Drought Management Authority with authority to implement early warning systems, drought assessments, contingency planning and funding and rapid response systems with local communities, and local development including support for community based water management, irrigation, livestock development, agriculture and natural resource management. ,

The urgency of effective, substantial scale drought management programs has been highlighted by the current drought in the Horn of Africa, which had affected 12.4 million people by September 2011, including 3.7 million in Kenya. The WFP and a range of

humanitarian organizations have played a lead role in the response, and both Kenya and Ethiopia have hosted a large number of refugees from badly affected areas in Somalia.

In the light of the Horn of Africa drought and its trans-boundary impacts, the planned Kenyan drought management program referred to above may well be implemented together with a regional Drought Resilience and Livestock Recovery Program, for which a provisional IDA allocation of US\$ 234 million has been made. The Kenyan government also planned a summit on the drought, and the GFDDR provided US\$ 7 million for emergency response approaches.

In Western and South-western Kenya regionally adapted flood management, watershed management and natural resources programs all aim to improve landscape management, productivity and resiliency with strong community participation:

A US\$ 70 Natural Resource Management program is helping Kenyans better manage water and forest resources, and improve the livelihoods of surrounding communities. Communities organized in Water Resource User Associations and Community Forest Associations benefit from funding to improve catchment management and efficient water use. As an alternative to forestry, communities also receive support for asset building and income generating micro-projects which encourage the sustainable use of the natural resources. The aim is to reach 1,000 communities benefiting 2 million people. The project is targeting communities in the critical Upper Tana catchment and key ecosystems in the Nzoia and Yala river basins, linking with the Western Kenya project. It is also strengthening key national institutions to manage water and forest resources in a sustainable and participatory way. Most of the programs activities contribute to increased climate resilience through capacity building and sound management of natural resources.

The US\$ 86 million Western Kenya Community Driven Development and Flood Mitigation Project: The US\$86 million project aims to create new opportunities for the local communities in Western Kenya to engage in wealth creating livelihood activities and reduce their vulnerability to flooding. The project supports an early warning system for flood mitigation as well as improved floodplain management for major rivers in Western Kenya. Although Western Kenya is rich in natural resources, the local communities remain poor and vulnerable to flooding, disease and natural resource degradation. The project aims to provide technical support and funding for demand-driven, income generating micro projects in 600 communities, including 200 projects earmarked for youth groups in Western Kenya Province, Siaya and Bondo. There is also funding for the fight against malaria. There have been some challenges with implementation but the goals remain sound.

Kenya has also benefits from a number of pilot, knowledge focused initiatives. The GEF funded Western Kenya Integrated Ecosystem Management Project sought to improve the productivity and sustainability of land-use systems in selected watersheds in the Nzoia, Yala, and Nyando River basins through adoption of an integrated ecosystem management approach. It supports on- and off-farm conservation strategies and develops capacity in local communities and institutions to identify, formulate, and implement integrated ecosystem

management activities (including both on-and off-farm land-use planning), capturing local and global environmental benefits. It provided useful lessons for scaling up in a variety of programs including the Lake Victoria Environmental Management program.

With the help of the Biocarbon Fund Kenya is piloting soil carbon sequestration based on the adoption of sustainable agricultural land management practices by smallholder farmers as well as in reforestation through the Kenya Green Belt Movement project. The Kenya Agricultural Carbon Project supports carbon sequestration through the adoption of sustainable agricultural land management practices in Western Kenya. While increased productivity and improved climate-resilience of agricultural systems are the main drivers for the adoption of these practices, payments for GHG mitigation are an additional incentive. A key component of this project is the development and application of innovative methodological approaches for measuring the amount of carbon sequestered in the soil through different agricultural land management practices. The project has developed a robust and cost effective carbon accounting methodology outlining how to quantify these emission reductions.

There are also a number of programs aimed at improving agricultural productivity, a key element in climate-smart agriculture strategies.

The US\$ 82 million Agricultural Productivity and Agribusiness program development aims to increase agricultural productivity and incomes of participating smallholder farmers, by improving agricultural technology systems, empowering stakeholders, and promoting the development of agribusiness. The program supports research, demand drive extension services and market development. Its agricultural productivity and sustainable land management component aim to help producers adopt environmentally-sound land management practices without sacrificing their economic welfare, mitigating land degradation and achieving greater productivity of crops, trees, and livestock. It also assists agricultural producers to adopt alternative livelihood options where non-degrading production methods are not feasible to reduce the pressure on natural resources.

Integrating land and water management remains a challenge. Kenya is concerned to protect its major mountain “water towers” to regulate water resources for cities and farmlands, but there are land pressures. It also intends to manage wildlife corridors to protect its important nature-based tourism industry. The government intends also to address land use and land tenures issues as part of a long term development strategy.

Mexico Country Note: An Agricultural Sector Program which Addresses Climate Change as a Major Challenge

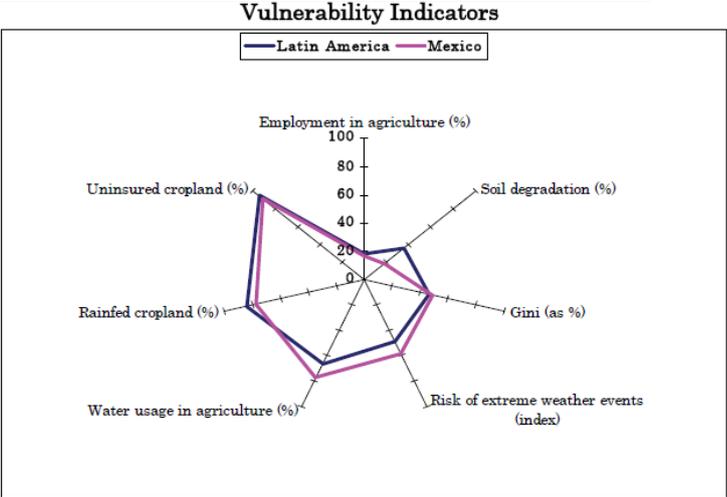
Agriculture accounts for 4 percent of Mexico’s GDP and 15 percent of employment. Agriculture and land-use changes account for about 21 percent of GHG emissions. 23 percent of land area is forested but deforestation has played a major role in GHG emissions over the last 20 years.

Small agricultural producers are particularly vulnerable to climatic changes, as they depend on rainfed agriculture, and have limited financial resources to spread risk. Mexico’s per capita GNI is US\$ 8,900, and 23% of its population of 107 million lives in rural areas.

Agriculture and its Role in the Economy

Although agriculture only accounts for 4.3% of GDP, landscapes play a key role in watershed protection and broader ecosystems conservation, and include highly varied production systems.

Implementation of NAFTA has opened Mexico's agricultural sector and fruit and vegetable exports in particular, have increased dramatically in recent years. Agriculture contributes 9% of exports, which include a variety of horticultural products. 23% of Mexico’s arable land is irrigated, and agriculture accounts for 77% of water withdrawals. More than half of the value



Note: Employment in agriculture (% of total employment)*; Rainfed cropland (% of total cropland)*; Gini*; Water usage in agriculture (% of total annual freshwater withdrawals)*; Uninsured cropland (% of total cultivated land area)*; Soil degradation (% of total land)**; Risk of extreme weather events (index; annual average 1997-2006)****
Sources: *World Development Indicators 2007, 2000-2007 average; **IADB, IICA, 2002/2003 figures; ***FAO AGL 2005; ****Germanwatch

of the total agricultural production of Mexico (54 percent) is generated in 8 States, and many of Mexico's horticultural products are highly competitive on regional markets.

Top revenue-producing crops include corn, tomatoes, sugar cane, dry beans, and avocados. Mexico also generates significant revenue from the production of beef, poultry, pork, and dairy products.

It is estimated that half of Mexico's producers are subsistence farmers, many of whom are not a part of the formal economy, and over 60% of whom produce corn or beans, with the majority of these farmers cultivating five hectares or less. However the number of Mexican farmers is steadily decreasing as they seek greater economic opportunities from off-farm employment and remittances from family members working away are an important source of income for the rural population.

Forests account for only 1.8% of GDP and Mexico is a net importer of forest products. However forests play an important role in watershed and biodiversity conservation; only one-third of forest area is managed primarily for sustainable commercial timber production. Following legislative reforms in the 1980s responsibilities, and formal titles, for two-thirds of forest land in Mexico has been transferred to local communities, and Mexico's forest strategy has focused on strengthening community capacity (both indigenous communities and land reform communities (ejidos)) in sustainable management. Although there have been many challenges and deficiencies in Mexico's CFEs, they have the potential to deliver significant economic and social benefits and have advantages for environmental stewardship.

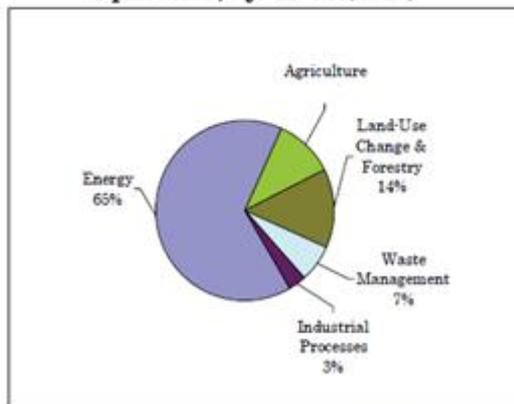
Climate Change Projections

According to the Third National Communication the following climatic changes with relevance to the agricultural sector can be expected in Mexico:

- increases in temperature - by 2020 projected temperature increases in the winter are between 0 and 2.5 C and in the summer are in the range of 0.9 and 2.2 C.³⁹ It is probable that by the year 2050 the climate in Mexico will become warmer by 2 to 4 C.
- reduction in precipitation - the rainfall will decrease by up to 15 percent in the Central part and by less than 5 percent in the area of the Gulf of Mexico, mainly between January and May; by 2020 projected precipitation fluctuations will be in the range of -7 to +12 percent (December-February) and -8 to +12 percent (June-August).⁴⁰
- increased frequency and intensity of extreme weather events - the number of severe storms and the intensity of periods of severe drought will also increase; the sea water temperature will increase between 1 and 2 C leading to stronger and more intense tropical hurricanes in the Caribbean Sea, the Gulf of Mexico and the Mexican portion of the Pacific Ocean, with an increase of 6 percent in wind intensity and an increase in precipitation of 16 percent within a radius of 100km from the center of the hurricane; the cold fronts may become less frequent.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions

Percent of GHG emissions in CO₂ equivalent, by sector (2000)



Source: World Resources Institute <http://cait.wri.org>

13 percent of the land area in Mexico is used for arable agriculture, 55 percent for grazing and 23 percent for forestry.

According to the Strategy (ENACC, 2007), **agriculture** accounts for 7 percent of total GHG emissions in the country and forests and land-use change account for 14 percent, a total of 21 percent of emissions.

The scale of **deforestation** in Mexico in the last 15 years has been large with 47.8 thousand sq km of forests lost from 1990 to 2005, with an average annual deforestation rate of 0.5 percent during this period.⁴¹ For each hectare of forest lost in Mexico during this period, between 20 and 170 tons of carbon were emitted into the atmosphere, depending on the type of forest.⁴²

Livestock are an important source of methane (CH₄) emissions. Of the total methane emissions from livestock in Mexico for the period 1990-2002, 89 percent came from beef and beef-dairy production, 10 percent from dairy cattle and 1 percent from other livestock.⁴³ These emissions represent 88 percent of total livestock related emissions, the remaining 12 percent being nitrous oxide (N₂O).

Mexico has made 3 updates to its National GHG Inventory⁴⁴, covering the period between 1990 and 2002 and a user-friendly, searchable database is available to the public.⁴⁵ In per capita terms, in 2005 Mexico was the 2nd largest emitter of CO₂ in LAC (at 3.70 t CO₂/capita). Though the level of GHG emissions has grown as the economy develops, the carbon intensity of the Mexican economy has decreased by 5 percent since 1993. MEDEC⁴⁶, a study on low carbon growth potential, concluded that GHG emissions could potentially be reduced by 42% by 2030 over 2011 levels, with the transport, agricultural and forestry sectors having the greatest potentials.

Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

During the past two decades, over 80 percent of the total economic losses from weather-related disasters occurred in the agricultural sector.⁴⁷ The drought of 1997-1998, for example, produced a record number of forest fires; a period of drought during the 1990's resulted in many water-related conflicts in the North of the country; delays in the rains in 2005 resulted in the reduction of agricultural production by 13 percent.⁴⁸

Changes are expected for both forests and grasslands due to drier and warmer conditions. It is anticipated that climate change will result in an increase in scale and frequency of fires because climatic conditions will favor initiation and propagation of forest fires, replacement of tropical forests by savannas in Central and Southern Mexico along with replacement of

semi-arid by arid vegetation in most of Central and Northern Mexico and extinction of species found in tropical forests. A reduction in agricultural production is expected and a significant reduction in livestock production can also be produced if temperate pastures are adversely affected by droughts caused by higher temperatures.⁴⁹

The most important agricultural crop cultivated by area in Mexico is maize (it occupies 50 percent of total cultivated area). The crop is highly susceptible to climate variability, in particular droughts. The climate scenarios for 2020 for Mexico predict a moderate reduction in the land suitable for maize cultivation of 4.2 percent. A further effect will be a reduction of pastureland (6 percent loss by 2020 and 13.2 percent by 2050 relative to 2002 base year) used for livestock in the Northern and Central part of the country due to increased drought and land deterioration and an increase of plagues associated with environmental changes.⁵⁰

There are opportunities in the form of **adaptation measures** that could result in positive social outcomes include improved management of water availability and a shift to drought resistant crops. In addition, adaptation should ensure that communities' traditional knowledge and capacity in managing climatic changes is recognized and further strengthened. Coping strategies of poor farmers to weather variations in Mexico have included:

- diversification (short-term reactions range from selling livestock, seeking off-farm employment and informal loan options, replanting and switching to shorter-cycle crops; in the long-term, switching to subsistence maize is a prevalent strategy) - non-farm income (55 percent of rural incomes in Mexico⁵¹) and in particular non-farm wages e.g. from working in public projects, in tourism or other industries are the most profitable form of livelihood diversification;
- migration to urban areas or the USA - Mexico is the largest remittance-receiving country in the region, with over \$23 billion in 2006 (money originates from the US). Highest concentrations of recipients are in Central Mexico, in the regions of Guanajuato, Jalisco, Michoacán, San Luis Potosí, and Zacatecas⁵²;
- storage of rainwater for additional irrigation.

Government Strategies for Agriculture, Food Security and Climate Resilience

To date, Mexico is the only developing (non-Annex I) country to have submitted three National Communications to the UNFCCC⁵³, demonstrating a strong commitment to the international climate change agenda. The communications lay out the actions that the government has already taken and the analytical basis for its policy response to climate change and its commitment to take future actions within an official international framework.

Agriculture Sector Initiatives

The **Agricultural Sector Program 2007-2012** defines climate change as a strategic national and international problem which demands immediate action. The Program reconfirms the importance of ongoing programs targeting reconversion and rotation of crops, efficient use of

fertilizers, conservation tillage, and special attention programs to farmers affected by extreme weather events. In addition, it promotes other methods, such as generating incentives to expand sustainable use and conservation of natural resources and wild lands. Mitigation activities include eliminating the use of fire, promoting zero tillage, reforestation, retrofitting livestock facilities to capture and use of methane and more efficiency in the use of energy in fisheries. The main initiatives to strengthen capacity to adapt to climate change include targeted research, gene banks and expansion of seed reserves, corridors and conservation areas.

The **National Water Program 2007-2012** (Programa Nacional Hidrico) is developed with focus on climate change policies. Among the proposed adaptation measures in the water sector are fomenting the efficient use of water in the agricultural sector, diminishing the risks of floods, promoting the technical, administrative and financial development of the water sector and the promoting integrated and sustainable water management.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

The Clean Development Mechanism (CDM) and the Mexican Carbon Program (PMC)

As of January 2009, there are 110 registered projects in Mexico, representing 28 percent of all registered projects in LAC. Mexico also holds 8.12 percent of the global share of projects. Of the registered CDM projects in Mexico, 23 are classified as being related to agriculture (or 21 percent of all registered CDM projects in the country). All the registered agricultural projects address GHG reductions from improved animal waste management systems in confined animal feeding operations in different regions of the country.

The Mexican Carbon Program (PMC) was established in 2005 to coordinate scientific activities related to the carbon cycle in Mexico, assisting in the design of public policy aimed at tackling and adapting to climate change. Among the participants in the Program are 27 governmental, non-governmental and academic institutions, including some from the agricultural sector.

An Adaptation to Climate Change in the Water Sector Development Policy Loan (DPL) for US\$450 million was approved in 2010. Mexico has emerged as a global climate change leader and is moving quickly to prepare mitigation and adaptation policies to tackle the most pressing issues that affect the country's main economic sectors and the DPL will support government priorities established in the climate change adaptation and water sector agenda.

Water used for agriculture represents around 77 percent of estimated total national water abstraction, which totals 78.9km³ for the country as a whole. Of the 6.5 million hectares with irrigation facilities in Mexico, about 67 percent are irrigated with surface water (40.5 km³), and the remaining hectares are served by groundwater pumping (20.1 km³). In light of the importance of the agriculture sector in total water use, demand management and efficiency improvements in irrigation are key drivers of federal programs.

The main objective of the operation is to support the government's efforts aimed at strengthening the institutional framework and monitoring capacity in integrated water resources management as well as mainstreaming adaptation to climate change in water programs. The operation DPL supports adaptation to climate change in the water sector, including the allocation of institutional and financial resources and strengthening of monitoring and evaluation capacity. Government would support irrigation systems that reduce water usage (e.g., high- or low pressure systems, or demand-based irrigation) and low water consumption agriculture (including macro-metering of surface and groundwater).

A second Climate Change Development Policy Loan for US \$501.25 million aims to support mainstreaming climate change considerations in three areas:

- an improved analytical basis for policy responses through the submission of a third national communication to the United Nations (UN) framework convention on climate change;
- the approval of the national climate change strategy by the government's inter-secretarial commission on climate change and its announcement by the President; and
- the integration of climate change considerations in sector programs.

This operation builds on the Bank's engagement in the energy and natural resources sectors, and ongoing support on the climate change activities in Mexico, particularly on: (a) support for adaptation; (b) policy development and institution building; (c) first-of-a-kind mitigation projects and programs; and (d) identification and promotion of short-term and long-term mitigation options.

In the context of the long-term development challenges posed by climate change, the DPL's contributions are:

- reinforcement of a results framework for voluntary emission reductions and focus on vulnerability reduction through adaptation action plans;
- improved institutional capacity, including coordination and knowledge base, to undertake key actions.

Within rural areas a number of investment operations are also ongoing. The Sustainable Rural Development Project (2009-2013) for US\$ 168 million promotes the adoption of environmentally sustainable technologies in agri-businesses. The environment objective is to contribute to the goals of the National Strategy on Climate Change by reducing GHG (CO₂) emissions through the adoption of emission-reduction technologies and the support to the implementation of the President's Special Program for Climate Change (PECC), with special reference to the improved environmental sustainability of small and medium-scale agri-business. The program promote investments in environmentally sustainable technologies in agri-businesses operating at the various stages of the production chain of agricultural products, provides investment and production support services to beneficiaries, and training to integrate technologies promoted through the project in their farms and agri-businesses. It also strengthens supports relevant institutions' climate change policy development.

REDD+ and the Forest Investment Program: The Government of Mexico is well advanced in a REDD+ strategy. The intention is to integrate REDD into Mexican policy instruments, with the close involvement of local communities and within a broader vision of rural development. The strategy will build on ongoing programs, including for payment for environmental services programs, administered by CONAFOR (the Mexican Forestry Commission). Among other development partners, the French Government has committed 185 million Euros to help Mexico combat climate change, with REDD as a focal area. Similarly, recognizing that many of the drivers of deforestation come from outside the forest sector (including from agriculture and livestock), the FIP is being developed within a broader rural and spatial development context. Local communities will play the key role in forest management and conservation. The FIP will also be integrated into broader development policy operations.

Morocco Country Note: Adapting to Increasing Water Stresses while addressing Social Challenges and Modernizing the Sector

Agriculture and its Role in the Economy

Morocco has a land area of 447,000 km² and a population of 32 million. Per capita GNI is US\$ 2,770 and 44% of people live in rural areas. Agriculture contributes 15% of GDP, about 45% of employment and 20% of exports. The sector characterized by its duality, with a commercially oriented irrigated sector and a less productive rainfed sector. Morocco has made great progress in reducing poverty in recent years; rural poverty levels, 25% in 2000, were 14% in 2007.

Irrigated agriculture contributes 50 percent of the country's agricultural added value, and up to 75 percent in drought years. Principle crops include tomatoes, citrus (oranges, tangerines, and mandarins), and other fruits and vegetables (peaches, strawberries, melons). Livestock and dairy products are also important. Exports of the agri-food sector are supported at political level through Morocco's Advanced Association Status with the EU and bilateral agricultural trade liberalization. However, water resources constraint the development of irrigated agriculture.. Agriculture, which currently accounts for 87 percent of water use, is competing for water with urban and industrial demands. In irrigated agriculture, more efficient irrigation techniques can help sustain production while conserving water resources.

Rainfed agriculture, which accounts for 85% of agricultural land, is highly vulnerable to drought,, and dominated by small-holdings.. Wheat yields average under 2 ton/ha, and in dryer years have been as little half a ton/ha.⁵⁴ The effect of rainfall fluctuation on agricultural production explains 75 percent of the year-to-year variability in yields. More than 45% of the heads of farming families are over 55 years old with limited education and access to modern technologies is limited. Many rural families operate on a semi-subsistence basis and are also supported by remittances by family members who have moved away.

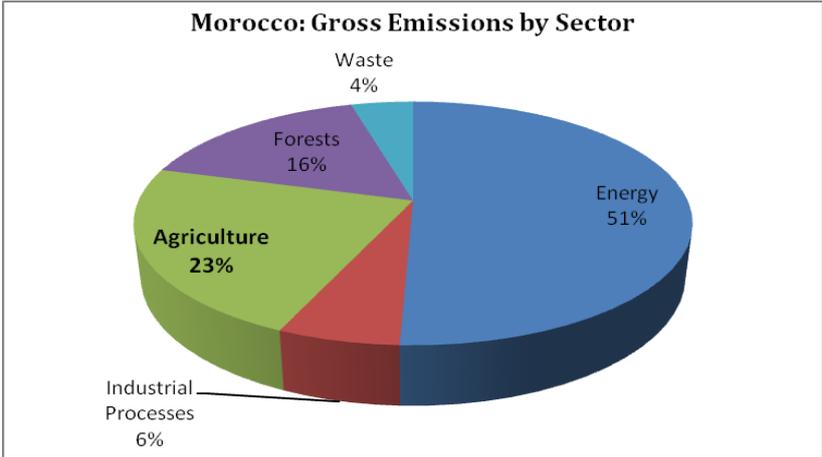
Climate Change Projections

Morocco has already experienced changes in both temperature and precipitation over the last five decades. Since the 1960s, annual mean temperatures have increased by 0.16 °C per decade, and there has been a significant decrease in the number of cold days. Despite the rainfall variability typical of the region, there are signs that precipitation is decreasing. At national level, spring rainfall has declined by over 40 percent, and the maximum dry-spell

length has increased by 15 days. Monthly rainfall totals for the Oum er Rbia and Tensift river basins in the Atlas Mountains have declined.

Climate change projections are characterized by a certain degree of uncertainty, but Morocco will become drier and hotter. Compared to other areas of the World, North Africa - including Morocco - is characterized by a high agreement among different scenarios. Based on an ensemble of 22 GCMs from the most recent IPCC Fourth Assessment Report mean annual temperature is expected to increase 4°C in inland areas and 2°C in coastal areas of Morocco by the end of the century. Over the same period, winter precipitation is expected to decrease by 20 to 40 percent. Drought years will become disproportionately more severe. Downscaling at river basin level suggests that different areas of Morocco will be affected with different intensity by climate change, with the marginal areas being those which are going to suffer the most.

Besides experiencing the negative effects of climate change, the agriculture and forestry sectors contribute to Morocco’s GHG emissions, accounting for 36 percent of the national emissions or a total of 32 kilotons.⁵⁵



Source: First National Communication, UNFCCC, 2001 (<http://unfccc.int/resource/docs/natc/mornrc1e.pdf>)

Main Threats Posed by Climate Change to Agriculture and Food Security

Climate change will affect both rain-fed and irrigated agriculture in Morocco. The warmer climate will increase evapotranspiration. This could produce yield gains in irrigated vegetable, fruit, and fodder crops, if additional water is made available to cover the increasing irrigation demand. However, water volumes in storage facilities will probably decline, due to lower precipitation and more than proportional reduction in runoff. Lower precipitation and increased variability will affect rainfed crops such as wheat, barley, and olives. However, the quantification of possible yield reduction remains an open question.

Climate change in Morocco could raise concerns about food security.. Morocco currently depends on imports for about 50 percent of its cereal needs. Increasing domestic production would have significant opportunities costs, since the scarce land, water, and labor resources

currently employed in cereal production would have a higher pay-off if allocated to other activities. Climate change will intensify the tension between the competing objectives of maximizing returns to land and water and reducing dependency to food imports. Recent modeling done by the World Bank shows that Morocco would be capable of achieving 85 percent self-sufficiency with present yields, by diverting land from high value crops to cereal production. With a 30 percent increase in cereal yields, Morocco could achieve cereal self-sufficiency in the present, and with 40 percent increase, achieve self-sufficiency until 2022.⁵⁶ An alternative would be to invest more in high value crops for international trade, shifting the focus from being self-sufficient to be self-secure.

Government Strategies for Agriculture, Food Security and Climate Resilience

In 2008, Morocco launched its new national agricultural strategy, the *Plan Maroc Vert* (PMV). The PMV seeks to make agriculture the driving force for economic growth. The PMV aims to double agriculture's value added within a decade through a comprehensive overhauling of the sector's structure in terms of cropping patterns, value added and productivity, land tenure, and agricultural taxation. The PMV disaggregates sector goals into two pillars. Pillar I promotes high growth in the irrigated, competitive sector of high-value exports, opening the sector further to international trade. Pillar II aims to reduce rural poverty and increase efficiency in the low productivity rain-fed sector. The PMV promotes public-private sector partnerships and value-chain development and seeks to address duality in the sector.

Many of the elements of the PMV are consistent with climate smart agricultural strategies. The PMV supports programs to enhance irrigation efficiency, including the conversion of 555,000 ha of surface irrigation to drip irrigation. It supports research into climate resilient crop varieties. It envisages modernization of fruit and vegetable wholesale marketing, animal health and slaughterhouses, key elements in the value chain and sustainable intensification. It also plans for a landscape re-greening, including conversion of low-potential land currently used for cereals to trees, including olive trees and other species adapted to local climate conditions.

Programs to Support Climate-Smart Agriculture:

The World Bank is supporting the PMV through a Policy Development Loan (DPL) series, of which the first loan for US\$ 205 million was disbursed in 2011. The objectives are to: 1) improve the efficiency of domestic markets; 2) improve the socio-economic impacts of investments directed to small farmers; 3) improve agricultural services; and 4) improve the use and the management of irrigation water and the planning of irrigation infrastructures. The program supports improvements in the management of wholesale fruit and vegetable markets and modernization and privatization of slaughterhouses. It increases the effectiveness, local ownership and governance of small-holder project assistance. It supports competitive research and extension systems, and establishment of effective HASSP (hazard analysis and critical control) systems for food and animal safety and control, including in shipping and trade. It supports more effective water management through improved on-farm management, water

abstraction licensing regimes, consistent upstream water delivery systems, monitoring and cost recovery.

An accompanying investment operation of US\$ 30 million (including US\$ 5 million GEF) implements and pilots specific measures for climate resilience under PMV, aiming to provide replicable experience. The focus is on climate adaptation in five pilot regions, and it focuses on local institutional strengthening in climate adaptation, training, and support to adaptation measures including improved rainwater harvesting, crop production and sustainable land and water management. This program also complements a rainfed agriculture program.

There is also support for improved water management at the river basin level. The US\$ 115 million program for Modernization of Irrigated Agriculture in the Oum Er Rbia Basin aims at increasing the productivity and to promoting more sustainable use of irrigation water in the river basin. The Oum Er Rbia river supplies water to half of Morocco's large scale irrigated areas, accounting for 60 percent the country's sugar beet, 40 percent of olives and 40 percent of the milk as well as horticultural products. The development objective is for participating farmers in the Oum Er Rbia basin to increase the productivity and to promote more sustainable use of irrigation water to overcome current and future water deficits. The program aims to improve irrigation services and support replacement of canals by pressurized drip irrigation system, providing irrigation on demand in accordance with a predetermined annual quota. The program supports improved water regulation, distribution and monitoring, as well as development of water contracts with farmers. . It supports public-private partnerships for improved production of high value crops and use of the irrigation systems, and market information services. And it supports program implementation, monitoring and evaluation.

Niger Country Note: Food Security, Enhanced Agricultural Productivity and Climate Resilience are converging Challenges in one of the World's most Vulnerable Countries

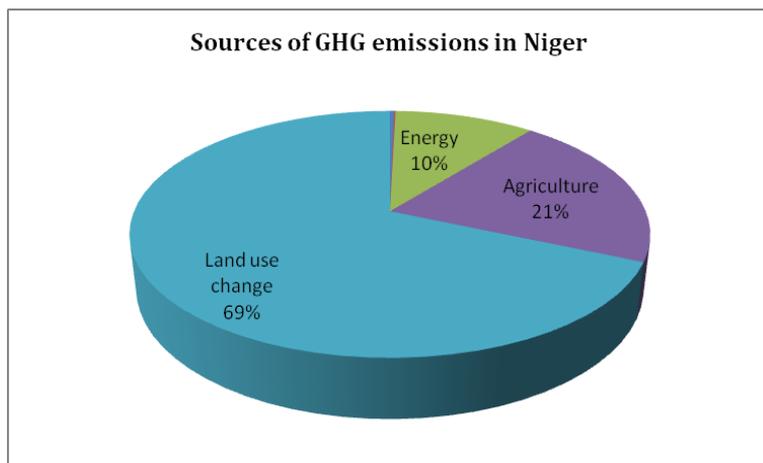
The Role of Agriculture and Key Vulnerabilities

Niger is a Sahelian country with a land area of 1.27 million km². Rainfall averages less than 150 mms over 77 percent of the land area. Rainfall averages 300 -600 mms over 10 percent of the country and more than 600 mms over 1 percent. Irrigated agriculture is practiced along the river Niger in the south-west of the country, and in the Chad Basin in the south-east, and there are substantial groundwater reserves. The rainy season is generally short and intense, lasting from June to September. Average maximum and minimum temperatures have shown an upward trend over the last 20 years, while rainfall has shown increasing annual variability, with an increase in the frequency of dry years since 1970. 84 percent of the population is dependent for livelihoods on agriculture, livestock, forestry or fisheries and these climate-vulnerable sectors comprise 46 percent of GDP.

Niger's population is currently estimated at 15.3 million, with an annual growth rate of 3.3 percent. Per capita GNP is estimated at US\$ 320, and the Human Development Index places Niger at the bottom of 182 countries analyzed. 50 percent of the population suffers periodically from food insecurity, and the 2009-2010 drought has brought famine to many areas in the east and south of the country in recent months. Although Niger has a system in place for emergencies, delivery of food relief continues to face challenges.

Niger's agricultural production is highly dependent on rainfed production (cereals and legumes), on livestock for meat and milk, with a limited number of cash crops (e.g. onions, cowpeas and hides and skins). The livestock sector comprises over 13 percent of GDP. Production systems are extensive with limited access to modern technology or post harvest conservation systems: only 1.4 percent of cultivated land is currently irrigated, and less than 5 percent receives any fertilizer. Crops are highly vulnerable also to pests, particularly to locust outbreaks. On average cereal production meets 96 percent of requirements but there are wide annual fluctuations in production. Fallow periods and farm size are being reduced as population increases. Fewer than 10 percent of households nation-wide have access to electricity (35 in rural areas) and 96 percent of households use wood and charcoal for cooking, placing additional pressure on the natural resource base.

Overall GHG emissions are low in Niger, only 0.1 tons per capita, 10 percent of the average for Sub-Saharan Africa, but nearly 90% percent of the total GHG emissions can be attributed to land-use change including land degradation and deforestation, and agriculture.



Source: PCN, 2001: Première communication nationale du Niger. Conseil national de l'environnement pour un développement durable (CNEDD), république du Niger (<http://unfccc.int>)

Government Strategies for Agriculture, Food Security and Climate Resilience

The Government of Niger's overall development strategy for the 2008-2012 period is outlined in its Accelerated Poverty Reduction Strategy Paper (APRSP) and related Rural Development Strategy (RDS). The APRSP emphasizes the constraints to growth and poverty reduction outlined above. Its development strategy is focused around four pillars:

- (i) intensification of agriculture and stock-breeding;
- (ii) diversification of sources of economic growth;
- (iii) control of population growth; and
- (iv) effective social programs.

The strategies support programs which improve land and water management, enhance livestock productivity, support irrigated agriculture, access to improved technologies, finance and markets, and protect natural resources. Niger has promoted decentralization and deconcentration in order to adapt service delivery to local requirements, and many decision making processes now take place at the commune level.

Niger prepared a NAPA (National Action Plan for Adaptation) using a highly participatory process which re-enforced previous analytical work on climate risks and trends and their impact on the agriculture, forestry and livestock sectors. Adaptation measures proposed were complementary to those in the APRSP, reinforcing the importance of "climate-smart development."

Niger is one of the countries selected to participate in the Pilot Program for Climate Resilience (PPCR)^{xxi} Its Strategic Program for Climate Resilience builds on existing programs and is focused on three main pillars: (i) integration of resilience into planning

^{xxi} The PPCR is one of the Climate Investment Funds being rolled out in a number of countries. The PPCR aims to support programs which integrate climate risks and resilience into development planning, together with other activities. The PPCR is being implemented in nine countries and two sub-regions, with a total funding envelope of about US\$ 930 million. For Niger the program is country led, and supported by AfDB, IDA and IFC together with other development partners.

processes including improved weather forecasting and information, especially at local level (ii) investment support to increased resilience including improved land and water management, enhanced agricultural productivity and intensification, crop insurance and warehouse receipts systems and social protection (iii) knowledge and coordination.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

Niger is thus a country where agricultural productivity, food security and climate change are at the heart of development; the following paragraphs outline some programs under way.

Niger supports productivity enhancement through supporting intensification, and through enhancing access to technology, value chains and financial services as a first pillar of its agricultural strategy. The ongoing Agri-Sylvo-Pastoral Exports and Markets program (US\$ 43 million) has these aims; it supports improved access to finance and matching grants for producer organizations and cooperatives in cereal, horticulture and livestock production and processing, irrigation rehabilitation and seed production. It also supports development of mechanisms such as warehouse receipts, leasing of farm equipment and input credit. The PPCR could enhance this program with IFC support to inventory guarantees and risk management.

Irrigation rehabilitation and development, together with support to local institutions to ensure sustainability, is a second pillar in Niger's agriculture, food security and "climate-smart" development strategy. A key element in irrigation development is the Kandadji scheme on the Niger, whose long term objective is construction of a barrage which would permit irrigation of an additional area of up to 122,000 ha, together with many other benefits including hydro-electric power generation. . The AfDB is a principle partner for Kandadji and is presently supporting irrigation rehabilitation together with ecosystem restoration (including water hyacinth control, reforestation and river bank restoration) in the Niger valley. Through river regulation the program would reduce vulnerability to climate risk for a broader population.

Support to local development planning is a third pillar. Niger's Community Action Program has been under way since 2003: it supports capacity building at local level to deliver local development plans covering both social services and income generating activities, together with integrated management of community ecosystems. IDA support to date has totaled US\$ 75 million, with GEF funding of US\$ 5 million focusing on sustainable land management, and an innovative afforestation program supported by the Biocarbon financed partly by IDA and partly through payments for carbon sequestration (US\$ 2.8 million for 0.82 million tons of CO₂ estimated to be sequestered by 2018). This program supports Niger's broad strategy for scaling up planting of acacia senegalensis (gum Arabic), a tree which can be interplanted with crops such as groundnuts and cowpea, is nitrogen fixing and helps to stabilize dunes. The PPCR program aims to build on the local mechanisms of this program to scale up interventions on sustainable land and water management, social protection and climate risk management. The PAC has also provided the basis for emergency funding of US\$ 7 billion in 2010 to address the food price crisis.

Niger is also well known for its farmer management forest regeneration program, which has resulted in a “regreening” of up to 4.5 million of Sahelian lands since the early 1980s. The Nigerien government is well aware of the need to improve land and water management to address soil fertility and enable sustainable intensification and enhanced productivity. Following the droughts of the 1980s rules regulating the use of trees on farms were revised, giving farmers the right to own their products. This, combined with decentralization and community empowerment, provided an enabling environment for a large-scale agro-forestry program benefiting 4.5 million people. The practice mainly involved selection and protection of tree species regenerating naturally. A signature species was *Faidherbia albida*, which improves soil fertility and provides fodder, wood fuel and fruits, diversifying income. Benefits associated with increased tree cover have also led to increased sorghum and millet yields in participating regions.

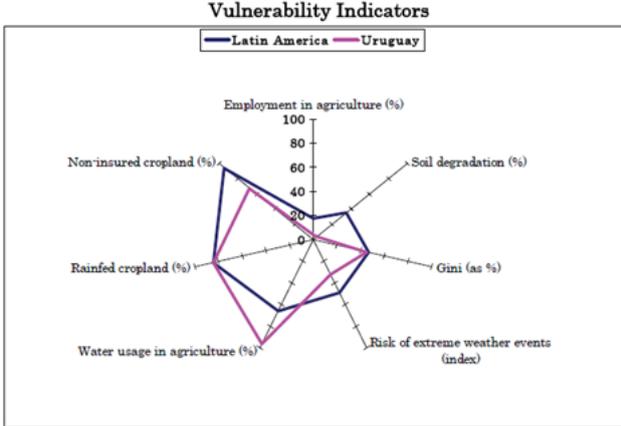
The Pilot Program for Climate Resilience was approved with a funding envelope of US\$ 110 million in November 2011 and the first program, Climate Resilient Community Action Program for US\$ 63 million, is in an advanced stage of preparation. The Program brings a sustainable land and water management, productivity enhancement and pasture and woodland management to the ongoing Community Action Program, it links this with social protection measures, it aims to mainstream resilience into key sectors and it provides for knowledge sharing and coordination. The other programs under the PPCR are also under preparation.

Niger has also received funding of US\$ 33 million from the GFASP for agricultural development, as well as from the GFRP to address the 2010 food price crisis.

Emergency support remains key for Niger. Niger’s particular vulnerabilities, human development indicators and history of political difficulties mean that emergency support must remain part of any government program.

Uruguay Country Note: A Major Exporter Vulnerable to Climate-Change Impacts which is taking measures to promote climate-smart agriculture through a range of sustainable land management approaches

Agriculture (including land-use change and forestry) is the largest contributor to GHG emissions in the country and it is also one of the most important sectors in the economy, representing 72 percent of exports and 10% of GDP.⁵⁷ But significant steps have been made in reforestation and carbon sequestration in the country, reducing the net effect of the sector on total GHG emissions. Uruguay has a land area of 176,000 km², 3.3 million people of whom 8% live in rural areas, and per capita GN@ of US\$ 9,000.



Note: Employment in agriculture (% of total employment)*; Non-irrigated cropland (% of total cropland)*; Gini*; Water usage in agriculture (% of total annual freshwater withdrawals)*; Insured cultivated land area (% of total cultivated land area)**; Soil degradation (% of total land)***; Risk of extreme weather events (index: annual average 1997-2006)****
 Sources: *World Development Indicators 2007, 2000-2007 average; **IADB, IICA, 2002/2003 figures; ***FAO AGL 2005; ****Germanwatch

Uruguay’s carbon dioxide emissions per capita in 2004 stand at 1.6tCO₂/capita, compared to the Latin America region of 2.6tCO₂/capita and the world at 4.5tCO₂/capita.⁵⁸ Reducing vulnerability to climate change and, in particular, to variations in precipitation is of increasing importance in the agricultural sector, coupled with more sustainable land management practices and production decisions.

Agriculture and its Role in the Economy

Uruguay has a population of 3.3 million, and some 85 percent of the land suitable for agricultural production, one of the highest in the world.⁵⁹ With a total land area of 176,000 km² it has 3.8 million hectares of arable land per person and is “land-abundant”. Agricultural exports average \$1.7 billion annually, and over 60 percent of the agricultural export market is within Latin America, indicating that Uruguay has a strong role to play in regional food security..

Despite the importance of agriculture in the economy, a very small percentage of this population is employed in agriculture, only 4.6 percent in 2006.⁶⁰ The reason for this is the steady decline of family operated farms and the growing proportion of larger commercial farms.

Climate Change Projections

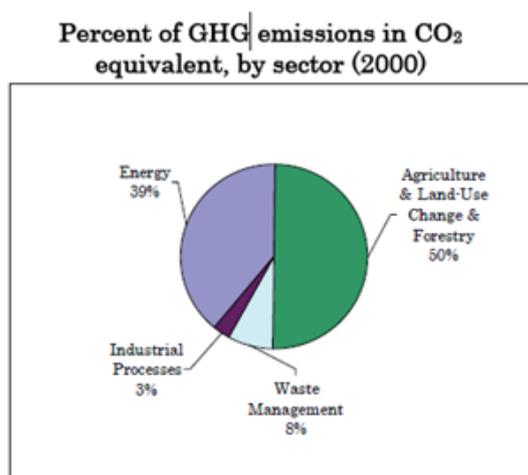
Based on climate scenarios developed by national researchers for the future 50 years, the following climatic changes with relevance to the agricultural sector can be expected for Uruguay⁶¹:

- increases in temperature – it is probable that the temperature will increase by 0.3-0.5 C by 2020, by 1- 2.5 C by 2050 and by 3.4 C by 2100;

- increase in precipitation – the amount of rainfall will increase and precipitations will reach 112mm/month (12 percent increase) by 2020 and 157 mm/month (57 percent increase) by 2100;
- rising sea levels – the climate scenarios predict a rising sea level of 5-10cm by 2020, 12-20cm by 2050 and 40-65cm by 2100;
- increased frequency and intensity of extreme weather events – rainfalls, intense winds, storms, and intense hail storms will all increase in number and intensity. Fewer days with frost and less severe frosts will be registered which could lead to a higher incidence of pests and diseases.⁶²

Climate change scenarios for Uruguay using general circulation models (GCM) available during 1990 predict yield reductions of 14 percent and 25 percent in maize at mean temperature increases of 2 C and 4 C, respectively.⁶³ According to a study on the future impact of climate change on agriculture in Uruguay⁶⁴, using General Circulation Models (GCMs) for the years 2020, 2060 and 2100, the land productivity measured in US dollars per hectare could fall to a level of 62 percent below the current level in the case of commercial farms and to 54 percent below the current level for small family owned farms by 2020 due to weather related events. Furthermore, this study determined that future temperature and precipitation increases will have a direct positive effect on land productivity for commercial and family owned farms only up to a certain level after which further temperature increases will generate an increasingly negative effect on land productivity, particularly during the summer season. Precipitation increases seem to produce a less pronounced effect than temperature increases.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions



Source: World Resources Institute <http://cait.wri.org>

The percent of greenhouse gas emissions in CO₂ equivalent in 2000 is presented in the diagram. Agriculture and land-use change/forestry contribute 50 percent of the total GHG emissions.

Of the total methane (CH₄) emissions for the year 2000, more than 92 percent were generated from enteric fermentation from livestock. Methane emissions differ by animal type as well. Cattles account for 88 percent of the total and sheep for 11 percent.⁶⁵ Regarding N₂O

emissions, more than 66 percent of these resulted from grazing animal manure, while as part of the rest were from indirect N₂O emissions generated by volatilization of this manure.

Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

Uruguay has made two updates to its National GHG Inventory, covering the period 1990-2000, with a third one being in the works, covering a period up to 2002. The inventory includes data on emissions from agriculture, land-use change and forestry, providing disaggregated data by type of emission and type of agricultural resource.

According to the Second National Communication, agriculture combined with land-use change and forestry account for 50.2 percent of GHG emissions in the country in 2000, a large portion of this being the emissions of methane from enteric fermentation from farm animals (91 percent of the total CH₄ emissions). Rice cultivation accounted for 4 to 6 percent of the total methane emission from the agricultural sector in 1998.⁶⁶ Furthermore, agriculture is responsible for 99 percent of the total nitrous oxide emissions (mostly from animal manure), 3.6 percent of total nitrogen oxides emissions (mostly from burning of agricultural waste) and 7 percent of total carbon monoxide emissions (mostly from burning of agricultural waste). Carbon dioxide emissions for the period 1990-1994 represented more than 80 percent of all gases emitted in Uruguay while as at present Uruguay registers carbon dioxide absorption.

Based on future climate change scenarios, the fishery sector will suffer a direct economic impact through an alteration in the composition of fishery resources, a reduction in catches and an increase mortality rate in some basin areas.

The total forested area in Uruguay represents close to 8 percent of the total land area. Due to the country's good climatic conditions for growing of forests, there is great potential for future forestation. Since the adoption of the Forestry Law in 1987, Uruguay has undertaken a sustainable development of forested areas which lead to the planting of around 600,000 ha of new forest areas between 1990 and 2000. As a result of this, forest plantation areas increased from about 200km² in 1987 to over 6599km² in 2000 (33 times) and the cumulative net carbon sequestration during the period 1988-2000 was estimated at 27.4 MtCO₂. The average annual deforestation rate stands at negative 5 percent.

Government Strategies for Agriculture, Food Security and Climate Resilience

The **Program of General Measures on Mitigation and Adaptation to Climate Change** (PMEGEMA) was prepared by the Climate Change Unit in February 2004 through the inter-sectoral and interdisciplinary collaboration of various Working Groups comprising professionals from various ministries, private sector and NGOs. The Program proposes a set of mitigation and adaptation response measures to climate change to be applied to the most relevant sectors of the economy, including agriculture, forestry, water resources, fisheries and biodiversity. One of the policies that Uruguay has undertaken with future climate change benefits was the passing in 1982 of the Soil Management Law that encouraged the use of soil conservation techniques which resulted in the sequestration of 1.8 million ton carbon per year over the last 20 years.⁶⁷

The **National Program for Voluntary Net GHG Emission Abatement** (PRONAVEN) is an important inter-institutional instrument aimed at improving understanding and consideration

of climate change issues at national and sectoral levels, as well as achieving the actual implementation of mitigation and adaptation options detailed in the PMEGEMA.

The **Project of Self Assessment of the National Capacity to Meet International Environmental Obligations for Improved Global Environmental Management (AECN)** provides an assessment of the country's capacity to meet in an integrated manner the commitments delineated under international environmental conventions on climate change, biodiversity and to combat desertification and droughts. The document does not make direct reference to the agricultural sector.

Agriculture Sector Initiatives

The **Ministry of Livestock, Agriculture and Fisheries (MGAP)** is responsible for formulating policies related to the protection of the agricultural sector and fisheries. It counts with a **Forestry and Agricultural Climate Change Projects Unit (UPACC)** whose mission is to identify, evaluate and promote opportunities for mitigation and adaptation projects in the agricultural sector, including forestry. It also initiates forestry and agricultural projects for Uruguay within the Clean Development Mechanism market.

The **National Institute for Agricultural Research (INIA)** counts with an **Agro-climate and Information Systems Unit (GRAS)** that has as main objective the promotion, coordination and execution of research projects and other activities related to climate change and its impact on agriculture and forestry. One of its more recent projects looks at the possible impacts of climate change on natural pastures and rice production in Uruguay as well as possible adaptation measures in this area.

Uruguay has a long history of **agricultural insurance**. The government of Uruguay has 5 main instruments (programs) in place that directly support the agriculture sector in managing climate risks. All of these instruments require public sector budgetary resources to operate:

- Banco de Seguros del Estado: public insurance company which offers subsidies insurance policies as per the agreement signed with the Ministry of Agriculture (MGAP).
- Ministry of Agriculture (MGAP): it administers the premium subsidy for agricultural insurances channeled through BSE as well as the fund for reconstruction of small producers.
- Vineyard Integral Protection Fund: it is managed by the National Viticulture Institute (INAVI) and producers get paid only when damages exceed 30 percent of production.
- Fund for the Reconstruction of Small Producers: it was established to provide catastrophic coverage to small farmers affected by a large climate event in 2002 (hail and drought). This fund provided immediate indemnities to small farmers but also established a contingency fund and a premium subsidy for agricultural insurance for small farmers.
- Climate Contingency Emergency Fund: it has been created to cover excess losses for producers that already have insurance. Since insurance contracts usually have a stop loss, this public fund covers the rest of the value of production lost, which is not covered by the insurance policy.

Two changes with positive results in **carbon sequestration** occurred in Uruguay in the forestry sector: The introduction of no-tillage practices in areas with annual crops (15 percent of total area with annual crops in 2000) and the increase of areas with artificial grasslands during the period 1980-2000. These two practices led to an annual CO₂ absorption of 3,300 kton. Furthermore, the total national emissions of CO₂ for the period 1990-2000 decreased by 28 percent as a result of the CO₂ absorption generated by tree biomass. Uruguayan forestry policy has also included prohibition of harvesting of native forests. This resulted in an increase in native forest area from 667,000 ha in 1970 to 810,000 ha in 2004.⁶⁸

One of the **mitigation measures** identified in the PMEGEMA with the final aim of reducing CH₄ emissions is to improve livestock diet by increasing the sown pastureland where animals graze (estimated abatement of 24 MtCO₂e for the future 20 years). The PMEGEMA defines the various **adaptation measures** in the land-use sector. Some examples are: improving the seed bank with genetic material that would allow the preservation or increase of current crop yields when faced with future temperature increases combined with excess and deficit of humidity; promoting the sustainable management of soil, including no-tillage and other conservation methods; monitoring of pests and diseases; improving the efficiency in fertilizer use and direct sowing as this results in less soil erosion; monitoring of oceanographic variables, breeding areas, distribution, catching ability and abundance of fishery resources and verification of algal bloom episodes; implementing measures to avoid the dumping of residual waters in the coastal areas.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

The Bank has contributed to the Government's overarching goal of sustaining growth through a number of interventions in various sectors. In the agriculture sector, the Bank has assisted the authorities with progress in animal health. Beef exports were severely affected in 2001 by the outbreak of foot and mouth disease and subsequent closure of several export markets. The Bank provided financing for reducing the risk of recurrence of the disease and improving animal health. In addition, the Bank-financed **Natural Resources Management Project** is helping small and medium size farmers to switch to more environmentally friendly production techniques.

The **Integrated Natural Resources and Biodiversity Management Project** (2005 to 2011) has a budget of US\$30 million and aims to promote, particularly among groups of small and medium-sized farmers, the adoption of economically and environmentally viable integrated production systems, within a context of holistic ecosystem and natural resources management, while mainstreaming biodiversity. The global environment component of the project seeks to promote increased understanding on the role of biodiversity in agricultural landscapes, and the potential impact of various land-use practices upon biodiversity, and their economic and ecological sustainability.

The project promotes the adoption of cultural practices to conserve soils; reducing the impact of grazing; reducing the risk of erosion and enhancing the efficient use of water resources;

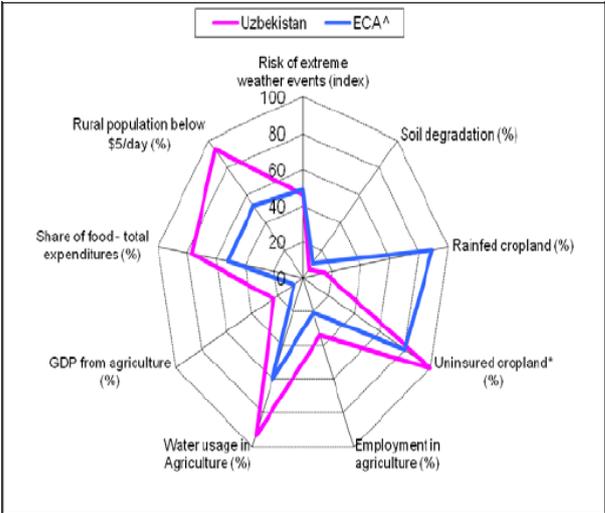
understanding the carbon sequestration potential of various land-use practices; and delineating a strategy to promote carbon sequestration in Uruguay's productive landscapes.

The main project instrument is the implementation of demand-driven subprojects that are complemented by a series of supporting activities such as: technical assistance; training aimed at raising awareness of natural resources and biodiversity conservation; management in the productive sectors; and building institutional and landowners' capacity for holistic management of natural resources that integrates biodiversity conservation into productive landscapes.

Through the *natural resources and biodiversity management* component of the project, demand-driven activities are financed to promote sustainable management of natural resources and biodiversity, through financial and technical assistance towards improving natural resources management practices in livestock production systems, with special reference to improved management of natural pastures and biodiversity. It promotes improved practices in dry land agriculture, for natural resources management systems in irrigated areas and, in biodiversity conservation. Another component of the project aims to establish demonstration areas for a sustainable use of natural resources in key micro-catchments which are of importance for biodiversity, combining sound practices for natural resources management, and creating increased public awareness on the significance, and socioeconomic importance of biodiversity.

Uzbekistan Country Note: Improving Resilience for a sector largely dependent on irrigation in a downstream country facing increasing water stresses

Uzbekistan is a landlocked country located in Central Asia. Its population is estimated at 28 million with about 60 percent of the population living in rural areas.⁶⁹ Economic growth has been robust overall, with recent annually growth rates of over 8%. Per capita GNI is US\$ 2900. The country has a surface area of 448.9 thousand km², with the majority of the landscape comprised of desert plains, with approximately 20 percent of the territory consisting of mountains and foothills in eastern and north-eastern parts of the country.⁷⁰ About 50 percent of the territory is used for agricultural production while approximately 19 percent is covered by forests⁷¹. The water resources of Uzbekistan are primarily provided by the Syr Darya and Amu Darya rivers, and their tributaries. These rivers form part of the Aral Sea basin and are shared with other riparian countries in the region.



Note: Employment in agriculture (% of total employment)*; Rained cropping (% of cropland)*; Water usage in agriculture (% of total annual freshwater extraction)*; Uninsured cropland (Estimate); Soil degradation (% of total land)***; Risk of extreme weather events (additional 1:20 year events 2070-2100 Vs. 1961-1990)****; Share of food – % of total expenditures *****; GDP from Agriculture*; Rural population below \$5/day*****; Sources: *World Development Indicators 2008; **, *** FAO AGL 2005; **** Baettig, M. et al., 2007. ***** ECA Databank. ^ECA statistics come from transitions and developing economies of Eastern Europe and Central Asia, where available

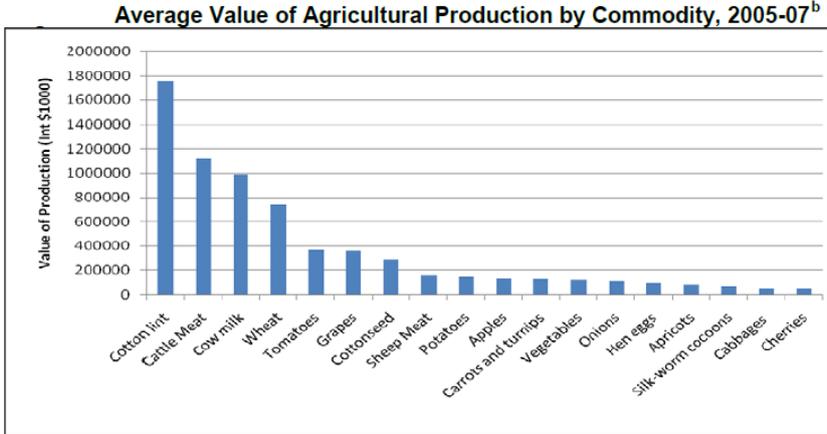
Agriculture is a significant land-use in Uzbekistan, with natural pastures occupying 40 percent and croplands 12 percent of the surface area of the country.⁷² Due to the arid conditions, more than 85 percent of the cropland in the country is irrigated, with area of irrigated cropland comprising approximately 10 percent of the land area of Uzbekistan.

Agriculture and its Role in the Economy

Agriculture is of vital importance to Uzbekistan, in terms of employment, rural livelihoods, food security, and exports. Approximately 34 percent of the population is employed in agriculture, 23 percent of the country’s GDP, and 40 percent of the country’s exports are derived from the sector.⁷³

Agriculture has traditionally been a strong and relatively stable contributor to Uzbekistan’s economy. Despite structural and non-structural changes to the agriculture sector post-independence, agricultural GDP increased marginally at an average annual rate of 0.5 percent from 1990-2000.⁷⁴ Post 2000, the sector has expanded strongly at a robust average annual rate of 6.8 percent from 2000-2007.⁷⁵

Cotton is the primary source of exports (Uzbekistan is the world’s fifth largest producer and second largest exporter of the commodity). At the commodity level, cotton lint, cattle meat, cow milk, wheat, tomatoes, grapes, and cottonseed made the most significant contribution to the average value of agricultural production in Uzbekistan from 2005-2007. Approximately 60 percent of the value of agricultural production is derived from the annual and perennial crop sectors, while the livestock sector produces the remaining 40 percent.⁷⁶ Although field crops like cotton and wheat are grown extensively and occupy a large percentage of the cropping land, other crops like tomatoes, grapes, potatoes, and apples make a significant contribution to the value of agricultural production on a proportional basis, as they can garner a higher price.⁷⁷



Source: Adapted from <http://faostat.fao.org>

Climate Change Projections

Historical data indicates that Uzbekistan is characterized by a highly variable climate that has already experienced an increase in mean temperature, extreme hot days and plant evapotranspiration (aridity).⁷⁸ Climate projections for the future indicate, on average that Uzbekistan will be exposed to⁷⁹:

- A 1.9°C to 2.4°C increase in mean annual temperature by 2050, with regional differences, with the greatest warming projected to occur in winter and spring
- An increase in mean annual precipitation by 15-18 percent by 2050, with the greatest seasonal increase in summer
- A progressive worsening of the projected water deficit of Uzbekistan at the Aral Sea basin level, as water demand increases (especially for irrigation), whilst secured water withdrawals decline in both the Amu Darya and Syr Darya catchments, with the water deficit projected to increase over 500 percent from 2 km³ in 2005 to 11-13km³ in 2050.
- A more marginal and risky agricultural production environment, as increasing temperatures result in greater crop evapotranspiration, offsetting projected increases in precipitation and resulting in a more arid production environment that is more reliant on already stressed and deficient water resources.
- An increased exposure to new pests and diseases for agricultural crops and livestock due to changes in the temperature and precipitation regime.
- An increased length of growing season, especially in northern areas, providing opportunities for new crops, increased productivity and changes to cropping patterns.

Contribution of Agriculture and Land-use Change to Greenhouse Gas Emissions

As of 2005, the agriculture sector accounted for approximately 12 percent of Uzbekistan’s greenhouse gas (GHG) emissions and was second behind the energy sector, which produced the majority of the GHG emissions for the country at 83 percent.⁸⁰ The land-use change and forestry sector has historically been a net emitter of GHG in Uzbekistan since 1990, primarily as a result of deforestation and land-use change. However, for the most recent assessment in 2005 the sector has been a small net sink of GHG, primarily due to a sharp decline in the use of swamp land for rice cultivation.⁸¹ On the other hand, agriculture has an important role to play in the mitigation of GHG emissions, with many of the practices that have benefits for both productivity improvement and adaptation also having synergistic mitigation benefits.

Sector	MtCO ₂ e	percent
Energy	150.0	83.0
Electricity & Heat	38.6	21.3
Manufacturing & Construction	19.9	11.0
Transportation	8.9	4.9
Other Fuel Combustion	42.8	23.6
Fugitive Emissions [1]	39.9	22.1
Industrial Processes [2]	3.4	1.9
Agriculture	21.1	11.7
Land-Use Change & Forestry	--	--
Waste	6.4	3.5
Total	180.8	

Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

The downside risks for Uzbekistan outweigh any potential benefits that may result for the agriculture sector as a consequence of climate change.⁸² Even for particular crops and agro-ecological zones that could benefit from climate change, Uzbekistan will be better positioned to take full advantage of such opportunities, if investments and structural changes are implemented in the agricultural sector to increase productivity and associated “adaptation deficit” to the present climate.⁸³

Government Strategies for Agriculture, Food Security and Climate Resilience

The Second National Communication of Uzbekistan, published in 2008, is the primary document that assesses the impact and outlines adaptation options to respond to projected future climate hazards. The document includes climate projections for Uzbekistan to 2100 and undertakes a preliminary vulnerability assessment of sectors including agriculture, water resources, and biodiversity and ecosystems. This assessment includes an analysis of climate

change impacts, as well as broad recommendations on potential adaptation and mitigation options for each sector. Adaptation options are identified and action plans are defined within the Second National Communication and linked background documents. This has been complemented by a Bank supported initiative⁸⁴ which linked vulnerabilities to adaptation responses, adapted to specific river basins and agro-ecological regions. Recommendations agreed upon include scaling up support to access improved technologies, together with support to land consolidation to facilitate cost-effective uptake, support to drought resistant crop and livestock breeding, irrigation and drainage rehabilitation and salinity control, and optimization of fertilizer application.

Agriculture Sector Initiatives

The main objectives of Uzbekistan's agricultural policy in recent years have been to:

- i. maximize and stabilize export revenues from agricultural outputs;
- ii. achieve food security through self-sufficiency in wheat production; and
- iii. improve rural standards of living through promotion of rural employment and enhanced social stability

Currently the mainstreaming of climate change into the policy initiatives of the agricultural sector is still in its infancy. Climate change has been addressed to a minor extent in policy documents such as the **National Strategy of Sustainable Development** and the **Water Saving and Rational Water Use in Irrigated Land Tenure Strategy**.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

Drainage, Irrigation and Wetlands Improvement Project (US\$ 74million): The project aims to increase the productivity of irrigated agriculture, employment and incomes in Karakalpakstan, one of the poorest regions in Central Asia; improve the water quality of the Amu Darya River by safe disposal of the drainage effluent, and enhance the quality of wetlands in the Amu Darya delta; and develop the institutions for improving water management, operation and maintenance of the irrigation and drainage systems, and for promoting sustainable irrigated agriculture through participatory irrigation management.

Ferghana Valley Water Resources Management Project (US\$ 82million): The Fergana Valley has abundant surface water resources and large quantities of good-quality groundwater resources, but there is a lack of drainage facilities, and therefore the area suffers from water logging and soil salinization. At present, both of these constrain agricultural production; degrade the environment, and damage housing and public infrastructure. Soil degradation, low water-use efficiency, over-irrigation, weak infrastructure and institutions, and a lack of farmers' incentives are the main factors impeding the productivity and sustainability of irrigated agriculture in the project area, and tend to reinforce each other. Thus, the objective of is to improve agricultural production in areas affected by water-logging, and to reduce damage to housing and infrastructure from rising ground water levels and salinity in the project districts.

There are three components to the project. The first is improvement of irrigation and drainage network. This component aims at addressing the problem of high groundwater levels by financing improvements in the surface irrigation and drainage network as well as installation of subsurface horizontal and vertical drainage wells. The second is institutional strengthening and agricultural development support, including support to public institutions, to private farmers (water users) organizations, information technology and laboratory equipment, training and study tours. The third component is project management, monitoring and evaluation of project impact.

Rural Enterprise Support Project (Second Phase: US\$ 75million; First phase US\$ 43million): This project aims to address the lack of farmers' incentives to improve production and productivity, as a result of a history of the public sector input supply, agro-processing, and marketing systems, which deprive farmers of choice, raise the cost of their purchases, and lower the price of their sales. The objective is to increase the productivity and financial and environmental sustainability of agriculture and the profitability of agribusiness. The rural enterprise finance component aims to enhance access to commercial financial services and reduce the risks associated with lending to the agriculture sector. The irrigation and drainage component aims to improve water management of irrigated areas. The rural training and advisory services component provides training and advisory services to newly independent farmers in various farm management skills and increases availability of technical information and advisory services.

The potential beneficiaries under this project (a rural population of about 400,000 people living on 162,000 hectares of irrigated land and the people providing goods and services to farms in the area) would have increased incomes through greater crop yields, lower costs of production, value-added from processing, and access to markets and credit sources. Resulting improvements in farm productivity and profitability would set the stage for growth in the rural economy, and in the national economy at large. Elimination of state intervention in production and marketing and the transfer of land and water rights to private operators would provide the foundation for environmentally sustainable and profitable agriculture. The initiation of transparent rural financial services would introduce farmers to commercial finance and intermediation, and to financial responsibility. By acquiring significant freedoms in decision-making and economic activities, restructured farm units would become a catalyst for the development of a variety of complementary production services, value-added processing and marketing functions, and a broad array of agribusinesses likely to generate rural employment.

Europe and Central Asia Regional Program on Reducing Vulnerability to Climate Change in Agricultural Systems: Uzbekistan is one of four countries participating in this three year program of analytical and advisory activities, designed to better determine the potential impacts of climate change on the agricultural sector. Work was carried out with key stakeholders to develop practical recommendations to strengthen the resiliency of their agricultural sectors in the face of climate change. The overall objective of this program is to enhance the ability of countries in the Europe and Central Asian region to mainstream climate adaption into agricultural policies, programs and investments.

In coordination with the Uzbekistan Ministry of Economy, Ministry of Agriculture and Water Resources and Ministry of Environment, an awareness raising and consultation workshop on reducing vulnerability to climate change in Uzbekistan's agricultural systems was held in May 2010. Ongoing, analysis and economic modeling was conducted. Following a series of workshops priorities were agreed upon, including improved irrigation, drainage and salinity management, and development of improved crop and livestock varieties.

Central Asia Hydromet Program: Uzbekistan is also participating in a regional program to upgrade the hydro-meteorological services of the Central Asian countries, and to improve the relevance of services provided to stakeholders including the agricultural sector. The program is jointly funded by IDA and the Pilot Program for Climate Resilience, one of the programs under the Climate Investment Funds.

Vietnam: Integrating Climate and Disaster Risk Management into a Rapidly growing Economy, through Productivity, Diversification and Sustainability in Agriculture, Water Resources, Fisheries and Forestry

Introduction

Vietnam, with a population of 88 million, has experienced impressive economic growth over the decade and now has a per capita GNI of US\$ 1,100. It is also “land-scarce”. Much of its land area of 301,000 km² is mountainous and Vietnam has an arable land ratio of only 0.073 hectares per person. Land is known as “white gold” according to a Vietnamese proverb. GDP grew at 7% over the 2000-2008 period. After a decline in 2008-9 caused by global external shocks, growth has shown impressive recovery although Vietnam is facing some macro-economic pressures. Vietnam has also made great progress in improving social indicators over the past 20 years. Poverty rates have declined from 37% to 15% over the 1998-2008 period, literacy is 93% and life expectancy 75 years. Access to basic infrastructure has improved dramatically. Vietnam is increasingly recognizing that the pollution natural resource degradation associated with the growth of the recent decades need to be addressed if growth is to be sustained. Hence Vietnam seeks to continue with economic growth and reforms in a socialist market economy over the coming years by focusing on the “three E’s”- efficiency, environment and equity.

Structure of Agriculture and Role in the Economy

Agriculture accounts for 21% of GDP and 23% of exports. 72% of people live in rural areas. Arable and permanent crop-land account for less than 30% of land area and forests 45%.⁸⁵ Despite the scarcity of fertile land, Vietnam has succeeded over the last 20 years in attaining very rapid growth in production of rice, and has moved from being a “food-insecure” country in 1990 to a major global rice exporter^{xxii}. 65% of production is now exported, and Vietnam accounts for over 20% of total world trade in rice. 34% of agricultural land is developed with irrigation infrastructure, allowing for intensive farm systems. Aquaculture production, much of it in brackish water, has expanded very rapidly and comprised 2.9 million tons in 2009, with exports totaling US\$ 4.7 billion⁸⁶. Inland and marine capture fisheries are also important. Vietnam is producing and trading an increasing quantity of other high value products, such as coffee, cashew nuts and vegetables. The country has also succeeded over the last 20 years in reversing deforestation through a substantial re-greening program, although addressing the restoration of natural forest ecosystems remains a challenge. There has been less success in addressing the loss of coastal mangrove forests and broader coastal degradation. Despite progress, challenges remain in tackling rural poverty especially in the hilly and mountainous areas, and 90% of Vietnam’s poor live in rural areas.

^{xxii} Partly as a result, and partly because of overall rising prosperity, The Vietnamese authorities have been able to expand the concept of food security from a narrower one of food availability to a broader one of accessibility and affordability, food safety and nutritional balance (“Beyond the Rice Bowl: Building on Past Gains to Enhance the Quality, Sustainability, and Equity of Growth in the Mekong Delta” Vietnamese/WB Joint Research program 2011).

Climate Variability and Change

Vietnam, with a very large population living in coastal areas, and much of agricultural production centered in the Mekong delta, is among the countries most exposed to climate variability and change. The annual average value of losses reported by the Central Committee for Flood and Storm Control (CCFSC) over the same period is estimated at equivalent to 1 percent of annual GDP. According to the latest global analysis, Vietnam lies in fourth position out of 162 countries in terms of human exposure to floods and tenth out of 89 countries in terms of human exposure to cyclones (storms). The CCFSC data show that the estimated value of damage from natural hazards in recent years has been much higher than the long-term annual average. Losses in 2009 from Storms Ketsnan and Mirana were estimated at US\$ 1 billion.

Models are uncertain but temperatures are predicted to rise by 2 to 4 degrees centigrade over the century. Total annual average rainfall is expected to increase, by as much as 10% in the Red River Delta in the north, but, especially in the south, precipitation expected to decrease during the dry season, perhaps by as much as 20%⁸⁷. Sea-levels will also rise, though the global models vary widely in their projections, from 18 to 70 centimeters over the century; but low-lying areas already experience storm-surges and saline intrusion. Temperature increases are estimated to have the principle negative impact on crop yields, while sea-level rise and saline intrusion could seriously affect 500,000 ha of rice cultivation area, accounting for 7% of annual production.⁸⁸ These estimates, however, do not take into account the costs of increasing uncertainty. Natural disasters, mostly from flooding, are estimated to cost the country an annual average loss of 1% of GDP, and the evidence points to an increasing frequency of extreme events in the last 20 years⁸⁹. In any event, adaptation is a priority, and producers are already adjusting.

Agriculture's Role in GHG Emissions

Estimates of agriculture's contribution to GHG vary widely, but WRI estimates indicate that together with land-use change and forestry the sector contributes 36% of national GHG emissions (see below). Much of this is from paddy rice and livestock. There is scope to reduce GHG emissions and capture potential climate mitigation finance through improved rice cultivation approaches (including sustainable rice intensification and reduced tillage), livestock management practices (including manure management, biogas and animal husbandry), increasing the growth of trees in the production landscape as well as through the ongoing re-greening program. A recent study has analyzed the potential and the constraints in some detail⁹⁰. Regarding forests, Vietnam has made impressive progress in reversing deforestation over the last 20 years and forest cover has increased substantially.

Vietnam

Sector	MtCO ₂ e	%
Energy	87.1	48.4
Electricity & Heat	22.0	12.2
Manufacturing & Construction	28.2	15.7
Transportation	20.3	11.3
Other Fuel Combustion	14.5	8.1
Fugitive Emissions [1]	2.1	1.2
Industrial Processes [4]	15.6	8.7
Agriculture, forestry and land-use change	64.7	36.0
Waste	11.6	6.5
International Bunkers	0.8	0.4
Total	179.8	



Source: World Resources Institute, Climate Analysis Indicators Tool (CAIT); Based on 2005 estimates

Vietnam’s Agriculture and Rural Development Strategy

Recent strategies include the *Tam Nong* Agriculture and Rural Development Strategy, which emphasizes a new balanced growth path with food security, trade, environment and rural development providing the building blocks for broad based growth. In 2009, the Vietnamese government issued the *National Food Security Strategy and Agricultural Land Planning toward 2020*. Key related strategic documents include the National Targeted Program (2008) to respond to Climate Change, the Water Resources Development Strategy to 2020, and the Strategy for Natural Disaster Prevention, Response and Mitigation to 2020. Vietnam’s Climate Change Targeted Program to 2020 aims to integrate climate change into agricultural plans and projects, including agricultural water management. Vietnam Is now “mainstreaming” climate into broader development planning, addressing both resilience and low carbon growth, with development policy support planned in this area^{xxiii}. Implementation constraints relate to availability of information and reporting systems, institutional capacities and coordination at local as well as central level including clarity of jurisdiction, and enforcement incentives.

Regarding agriculture, strategies favor increasing value-added across a range of commodities but including rice, producing, marketing and processing a broader range of horticultural and livestock products, and continuing with sustainable expansion of aquaculture. The recent joint studies on rice value chains suggest that Vietnam dedicate less area to rice, allowing small-holders to expand production of a range of high-value products while permitting larger-scale producers to take advantage of the economies of scale that modern, productive, high quality rice cultivation and processing favors. There are ongoing programs to enhance agricultural productivity, with a focus on technologies, sustainable land and water management farming practices, chemical residue management, value chain enhancement and related infrastructure.

^{xxiii} The Economics of Adaptation to climate change study (2010) included Vietnam as a focus country for study. It addressed rural infrastructure as part of agriculture and rural development adaptation measures, coastal zone management, forests and fisheries.

Vietnam has also been working to improve the overall enabling environment for modernizing the sector. Measures include improvements in land administration and cadastral services (a program of US\$ 95 million is under way), where improvements in food safety, especially in livestock, with broader objectives of improving productivity and reducing the environmental footprint of livestock production, processing and marketing (with an ongoing program of US\$ 80 million), and continued improvements in rural infrastructure and connectivity. An ongoing rural finance program (US\$ 200 million) aims to increase economic benefits to rural private enterprises and households by increasing their access to a range of financial services including term lending. Vietnam has also worked to strengthen decentralized approaches and community driven development.

Government's strategy for climate-smart agriculture aims to maintain productivity and sustaining livelihoods in the face of climate change by including specific support for: (i) ensuring the availability of better seeds with higher tolerance for drought, salinity, and flood immersion; (ii) developing and promoting economically effective and environmentally sound technical packages; (iii) Improving technical services, especially for plant protection and animal health; (iv) Improving systems for water resources management, including reservoirs, irrigation canals, sluices, pumping stations, sea and river dykes and other infrastructure, plus well functioning management institutions; (v) Improving post-harvest and storage methods and facilities; (vi) protecting and restoring coastal mangroves and supporting good aquaculture practices, including a transition to aquaculture in brackish water; (vii) Protecting forests and watersheds and (viii) developing improved land and water management systems to reduce emissions from paddy rice and livestock while enhancing productivity.⁹¹ Some programs supporting these measures are summarized below.

Agricultural water management is a key area of focus in climate-smart agriculture. The objective of a US\$ 206 million water resources management program (started in 2011) is thus to protect and enhance the utilization of water resources in the project provinces of the Mekong delta region Mekong Delta Region in order to sustain gains in agricultural productivity, provide access to water supply for rural households, and contribute to climate change adaptation. The program aims to address salinity and flood risks and improve agricultural water productivity.

"Climate-smart" aquaculture, fisheries and coastal zone management is also a priority. Fish and fish products now constitute nearly 50% of dietary protein in Vietnam, and the sector accounts for 6% of GDP and 10% of employment.⁹² Aquaculture systems are well adapted to brackish water conditions. Vietnam is increasingly concerned with the management of coastal resources to support the sustainability of its fisheries. It is focusing on supporting institutional capacity building and delineation of responsibilities, resource management, mapping, information and communications, good practices for sustainable aquaculture production and coastal resource management, and good practice for sustainable near-shore capture fisheries including community rights based management. Its program also includes support to safe harbors and reduction of vulnerability to natural disasters.

Vietnam aims to address the specific concerns of poor mountainous communities through the targeted Northern Mountains Poverty Reduction project, where poverty incidence remains high at 44% and 30% of the population are considered ‘food poor’. The US\$ 150 million program, for which implementation started in 2010, has a specific focus also ethnic minorities and women. It aims to reduce poverty by investing in community driven approaches to productive in infrastructure, agriculture and off-farm activities , increasing access to markets and reducing vulnerability to natural disasters while strengthening community institutions. .

Vietnam has also addressed deforestation through a re-greening program and a specific focus on supporting sustainably managed small-holder plantation forests, while seeking to conserve biodiversity in special use forests. It also supports decentralized capacity building to provide support services and monitor outcomes.

Vietnam’s Strategy for Natural Disaster Prevention, Response and Mitigation to 2020 has placed emphasis on community preparedness. A substantial program is under way to mitigate the impacts of natural disasters, including improved climate and weather forecasting and early warning systems, improved hydromet services across all sectors (including agriculture), flood mapping and revision of building codes, community preparedness, river bank stabilization and sea-dyke systems, safe harbors for fishing boats, and protection of key infrastructure, as well as contingency financing mechanisms.

Conclusion

Vietnam, one of the most “climate-challenged” countries in the world, is seeking to combine productivity and modernization objectives with broader sustainable land and water management and climate resilience.

Yemen Country Note: The Challenge of balancing Food Security, the Need for short term Cash Returns and “Climate-smart agriculture in a water stressed environment

Agriculture and its Role in the Economy

Agriculture comprises 15% of GDP and over half of employment, though only 7% of the land area of is cultivable. With an average of 0.2 ha of arable land per person Yemen is not “land-abundant”. Total land area is 528,000 km² and the population is 24 million, growing at about 3% per annum. Per capita GNI is US\$ 1060 and 69% of people live in rural areas. 32% of the population is “food-insecure” and more than 90% are net food buyers. Although cereals account for 54% of cultivates area Yemen produces less than 20% of the wheat it consumes. Agriculture and forestry contribute 27% of GHG emissions.

Farmers in Yemen cope with harsh natural conditions, including lack of arable land, poor soils, chronic scarcity of water, and periodic floods. Agriculture is mainly restricted to plateaus of the basins in highlands (by rainfed and groundwater irrigation), coastal floodplains of wadis (by spate irrigation), and terraces on the sides of the mountains (by rainfed and water-harvesting). In many areas terraces have not been maintained, and much land is now badly eroded, and with little organic matter. Average annual rainfall is around 160 mm, but this does not represent the extreme variability of the country ecosystems. Water availability is erratic, with recurrent droughts and floods.

Rural areas have lower incomes and poorer standards of living than urban areas. In 2000, only 30 percent of rural population had access to improved sanitation, versus 88 percent of urban population. Food insecurity is estimated at 37.3 percent in rural areas in Yemen, compared with 17.7 percent in urban areas. Literacy rates are low, especially for women.

Irrigation plays a significant role in Yemeni agriculture, but its beneficial effect on food production is restricted by low performances and qat cultivation. Agriculture uses about 90 percent of water resources, and irrigation covers about 40 percent of the cultivated areas. Irrigation has traditionally used flood irrigation (basin or fallow), with low efficiency ranging from 35 to 45 percent. Drip irrigation has been introduced in demonstration plots only, and the high cost of sprinklers limits their adoption to few farms across the country. Qat is the main cash crop; it is a mild stimulant chewed by many Yemenis on a daily basis, but not exported significantly because it is highly perishable. Qat covers about 10 percent of the total cultivated area, and consumes 40 percent of the irrigation water. Over the last 25 years, the area under qat more than tripled, with consequent negative effects on water use. Groundwater irrigation has also expanded rapidly in recent decades, facilitated by cheap energy prices, and many aquifers are overdrawn. Even without climate change it is estimated that most aquifers will be largely depleted, reducing agricultural potential by as much as 40%.⁹³

Climate Change Projections

The effects of climate change in Yemen are uncertain, but higher temperatures and more variable rainfalls can be expected, bringing additional heat stress to an already water-stressed. There is no consensus among the 21 global climate models in the IPCC Fourth Assessment Report about the sign of the projected changes in winter, summer, or annual rainfall or its distribution pattern over Yemen (Wilby, 2008). Yemen has a complex situation as the country lies in the latitudinal band where global circulation models differ in projected precipitation trends. The effect of complex topography of the highlands is poorly modeled in current global climate models and there are few, if any, regional climate models that provide detailed scenarios for Yemen. Although there is a wide divergence in projections of the trend of average annual and seasonal rainfall, there is general agreement amongst the models that temperatures will steadily rise and that there is likely to be an increase in variability of rainfall including extreme events.

The agriculture and forestry sectors contribute to Yemen's GHG emissions, accounting for 37 percent of the total GHG emission in the country (1995 numbers).⁹⁴

Main Threats and Opportunities Posed by Climate Change to Agriculture and Food Security

The Yemen's Draft National Food Security Strategy Paper (NFSSP) indicates an alarming state of food insecurity at both macro- and household levels. The prevalence of child malnutrition is extremely high: over 40 percent of children are moderately underweight and over 57 percent are moderately stunted. Food security in Yemen is undermined by limited internal production, high prices, poor supply chain efficiency, and lack of national food reserves. Food prices in Yemen will increase over the long-term, reflecting higher world prices, declining oil exports, and weakening exchange rate. While higher prices would increase incentives for domestic food production, the capacity of agriculture to respond is limited. The efficiency of the cereal supply chain in Yemen is affected by archaic procurement. The low flexibility affects the steady supply of cereals, especially in periods of high competitiveness.

Food insecurity in Yemen is expected to increase under climate change, due to lower and more variable internal productions. Under higher temperatures and more variable rainfall events, irrigated agriculture will be threatened by groundwater depletion, while rainfed agriculture will be dwindling due to flood and draught extremes. Floods will result in soil erosion, damages to agriculture infrastructure, and losses in rural economy. If groundwater abstraction continued in the same rate (two and half time more than recharge) people living in the highlands (65 percent of the total population) will be forced to leave their homes leading to possible economic crisis and social unrest in the country. A pessimistic climatic change scenario with no adaptation action would exaggerate price rises and food insecurity and would push several million people below the poverty line, with direct consequences on health and malnutrition. The livestock sector which plays a critical role in food security strategies will also likely be impacted by climate change as a consequence of changes in pasture productivity, nomadic livestock patterns and increased disease burdens.

Government Strategies for Agriculture, Food Security and Climate Resilience

The Yemeni agricultural strategy aims at promoting economic growth through diversification of the base economy, provision of basic services, and improvement of efficiency in agriculture and fisheries. It is the goal to reach annual growth rates targets of 5.4 percent and 7.8 percent for the agricultural sector and the fisheries sector respectively.

Food security is a high priority in the Yemeni Government, which created a Food Security Council in 2007. Presently the EU is assisting Yemen in the establishment of a Food Security Secretariat to which a series of ad hoc task forces chaired by line Ministries will be attached. The Yemen-EC Country Strategy Paper (CSP) 2007 – 2013 highlights the continued need to support food security measures in Yemen, in line with other development cooperation activities.

An Inter-Ministerial Committee for Climate Change Coordination (IMCCC) has been set up in response to the need for institutional strengthening and capacity building in climate related issues and streamline and coordinate cross-sectoral activities. This shows a strong political commitment, beyond the traditional entities, for coordinating and nurturing mainstreaming of climate resilience into the overall development program of Yemen. The 4th Five-Year Socio-Economic and Development Plan for Yemen (2010-2015) is being finalized, climate change in expected to be mainstreamed into development planning in this plan.

Programs to Support Climate-Smart Agriculture: Successes and Challenges

Three World Bank studies have been done for Yemen on modeling climate change and agriculture: (i) An Evaluation of Climate Data and Downscaling Options for Yemen (Wilby, 2009; Dresden, 2009); (ii) Climate Modeling for Rainfed Highlands of Yemen (Bernhoffer and Baarfus, 2009), and (iii) Assessing the Impacts of Climate Change and Variability on the Water and Agriculture Sectors, and the Policy Implications (World Bank, 2010).

The World Bank is involved in a series of agricultural and water projects such as (i) the Groundwater and Soil Conservation Project (GSCP, US\$40 million plus additional financing of US\$15 million) to be closed on October 31, 2011, (ii) Sana'a Basin Water Management Project (US\$24 million) closed on June 30, 2010, and (iii) Water Sector Support Project (US\$90 million) become effective on December 15, 2009.

The World Bank and IFAD are financing the Rainfed Agriculture and Livestock Project (RALP) which is being implemented over 5 governorates and aims to preserve and improve traditional cereal seeds through traditional seed producer associations; soil and water conservation; and improvement in livestock practices (US\$36 million, including US\$20 million from the World Bank and US\$16 million from IFAD and will close in June 2012). The Agro-biodiversity and Climate Adaptation project (US\$5 million with US\$4 million from the GEF) will start in August 2010 will complement the GSCP and RALP to develop coping options for farmers to deal with climate change, and will develop a Climate Resilient Strategy for Rainfed Agriculture.

Building on the Draft National Food Security Strategy Paper (NFSSP), the EU, IFAD, the World Bank and other partners are providing assistance to Yemen as part of the Global Food Price Crisis Response System (US\$ 10 million) and the Global Agricultural and Food Security Program

Yemen has a coastline of 2230 km, and fisheries play an important role in Yemen, both as a source of livelihoods for coastal communities, and to export revenues. An ongoing fisheries program (US\$ 32 million) aims to improve sector governance and improve also the quality of marine products that are marketed and sold. The Fisheries Resource Management and Conservation Project for Yemen will contribute to achieve economic growth through the development of the fisheries sector. The project consists of the following components: Component 1) will strengthen the Ministry of Fish Wealth (MFW) resource management capacity to undertake more effective fisheries research, resource management and fish landing regulation activities at the governorate level. Component 2) will support the improvement of facilities and handling procedures at existing fish landing sites to avoid deterioration in fish quality due to unsanitary conditions, delays in handling and auctioning of fish at these sites as well as the shortage of ice needed to maintain fresh fish quality. Component 3) will assist cooperatives to strengthen their management skills and improve their ability to operate and maintain their physical assets. Component 4) will provide the Ministry of Fish Wealth (MFW) with support for project implementation, as well as assisting them in conducting technical and economic analysis of the need for future ports and landing sites along the Qusayer-Mukalla-Bir Ali corridor and the Red Sea Coast.

Yemen is participating in the PPCR (Pilot Program for Climate Resilience) under the Climate Investment Funds. It is well advanced in preparing its Strategic Program, which is likely to have a strong agriculture and water management focus. It will include programs for scaling up support to rainwater harvesting and sustainable agriculture in hilly areas, improved water resource management more broadly, improvements in weather and climate services, and coastal zone/fisheries management.

Opportunities Ahead

Addressing the food security challenges requires a mix of policy reforms and scaling up of food security enhancing investments.^{xxiv} The reduction of fuel subsidies, qat consumption, and groundwater use are essential policy measures that need to be addressed to take on the food security challenge in Yemen. However, preliminary analysis shows that rising fuel prices will increase poverty and limiting groundwater use will reduce food production and agricultural incomes in the short and medium run. In addition, traditional farmers, growing cereals, will shift to qat productions which are the only lucrative plants that can cover high production cost. While the suggested policy reforms are inevitable and important for improving long-term food security, there is need for complementing these reforms with

^{xxiv} Yemen has been facing political instability in 2011, and many international development agencies have temporarily suspended operations.

investment projects and programs (i) to secure food availability at national level starting with assessing national cereal supply chain in Yemen, (ii) increase rural non-farm income to improve access to food at household level, (iii) reduce groundwater use for agriculture and increasing soil and water productivity, and (iv) improve health and nutrition awareness, family planning and targeting of social transfer.

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