FAO Profile for Climate Change

With this *Profile for Climate Change*, FAO outlines its priorities for its current and future work on climate change. FAO's work focuses on adaptation and mitigation in the agricultural sectors and advocates for better management of synergies and trade-offs among both. It also points to the areas where adaptation and mitigation activities merge with ongoing development efforts to improve sustainable use of natural resources for increased production, income, food security and rural development.

Ensuring food security will require substantial investments and action to adapt agriculture, forestry and fisheries to climate change challenges.

Agriculture, forestry and fisheries sectors can significantly contribute to global mitigation efforts.

Climate change and food security

Climate change adds another challenge to the world food system – a system that is supposed to feed everybody while ensuring the sustainable management of natural resources. Is mankind adequately prepared to face this challenge? How have we performed until now? Many parts of the world already face serious deterioration of production systems and the number of hungry people is now estimated to be more than a billion. This represents one sixth of the earth's population, the highest level in human history. A drastic improvement is therefore necessary in the way we produce food and use natural resources.

▸ Climate change is a major challenge to food and agriculture ◂

In the last 50 years the world population has more than doubled – from 3 billion in 1959 to 6.7 billion in 2009. In the next 40 years, it will increase another 50 percent, reaching 9.1 billion by 2050. Meeting the demand of this tripled population will put enormous pressure on the agriculture, forestry and fisheries sectors to provide food, feed and fibre as well as income, employment and other essential ecosystem services. Now, these sectors must also respond to the challenge of climate change. The aim is therefore

to dramatically increase agricultural production to meet increased demands and secure global food security, while maintaining the natural resource base and responding to the challenge of climate change through adaptation and mitigation measures (Fig.1).

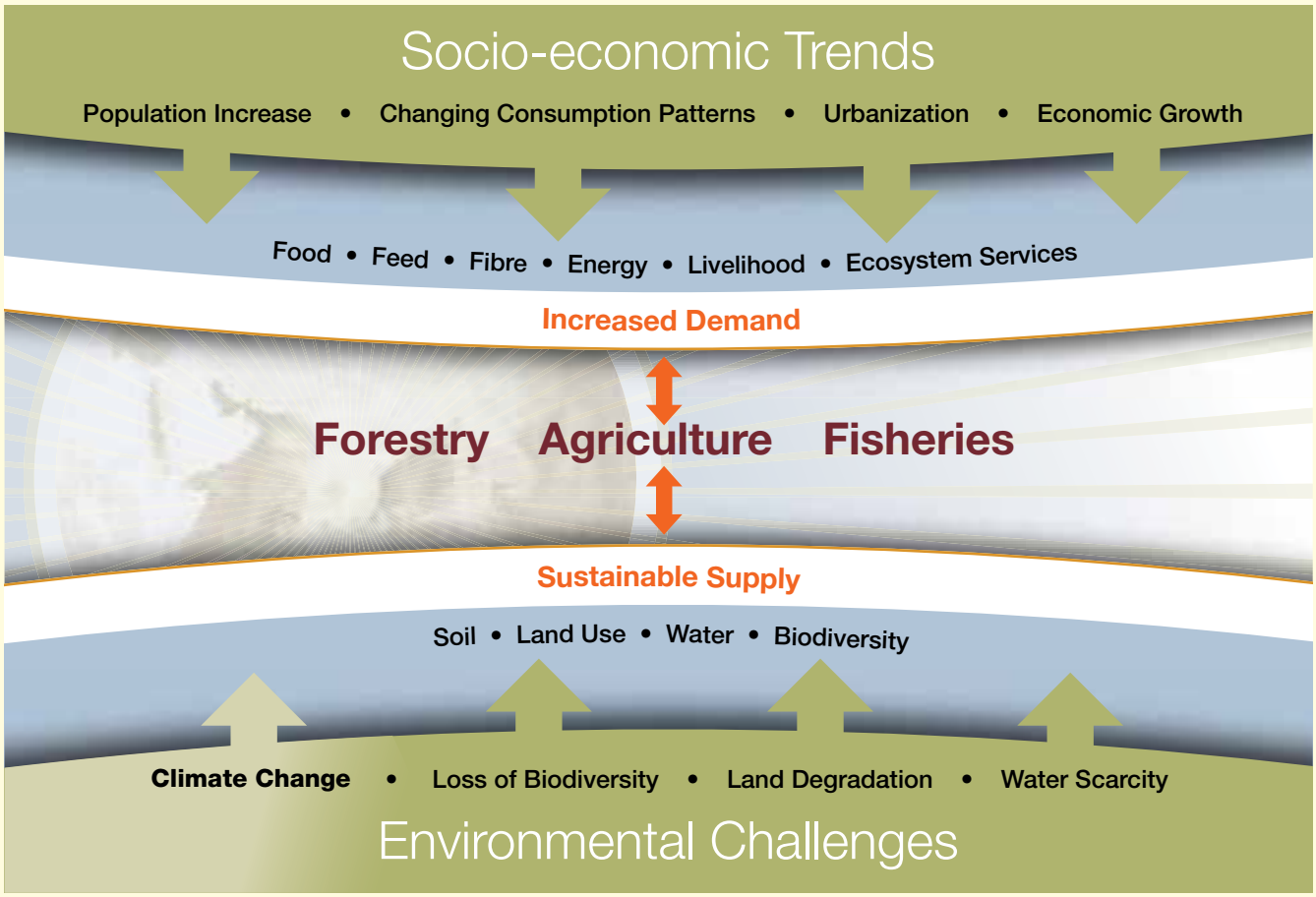
▸ Climate change must be addressed as an integral part of the overall development agenda ◂

Climate change already impacts overall development efforts. It threatens to undermine development achievements and slows progress towards the achievement of the Millennium Development Goals (MDGs), especially those dealing with hunger and poverty reduction and ensuring environmental sustainability. The agriculture, forestry and fisheries sectors are central in this regard because they are not only affected by climate change and contribute to greenhouse gas (GHG) emissions but also offer opportunities for cost-effective mitigation options with additional benefits for development and food security. Hence, with appropriate planning, climate change adaptation and mitigation initiatives can be integrated into sustainable development initiatives resulting in mutually beneficial outcomes.

▸ Climate change affects all dimensions of food security ◂

Climate change negatively affects the basic elements of food production, such as soil, water and biodiversity. More

FIGURE 1 – Climate change is one of the major challenges for agriculture, forestry, fisheries and food security



Selected projected regional impacts of climate change on food production

The higher latitudes might experience productivity increases due to higher temperatures, longer vegetation periods and CO_2 enrichment. However, in tropical and sub-tropical regions, especially in seasonally dry areas, crop and animal productivity may decrease significantly with temperature increases of 2 to 3°C causing for example:

- significant decreases in crop yields in some rain-fed African systems,
- declines of 40 to 90 percent of grassland productivity in semi-arid and arid regions,
- high levels of desertification and soil salinization in some areas in Asia, sub-Sahara Africa and Latin America, and
- increasing water stress, particularly in irrigated production systems.

Areas such as sub-Saharan Africa and South Asia may benefit from increased annual rainfall but some of these areas, such as coastal plains, may become flooded or unsuitable for agriculture due to increased salinity (IPCC, 2007a).

In the fisheries sector, ecosystem productivity is likely to be reduced in most tropical and subtropical oceans, seas and lakes due to habitat displacement towards higher latitudes. However, climate change also provides new opportunities for aquaculture, particularly in Asia.

broadly it affects all four dimensions of food security: food availability, food accessibility, the stability of the food supply and the ability of consumers to utilize food including food safety and nutritional value (FAO, 2008a).

While all people and ecosystems are vulnerable to climate variability and change, the impacts are location specific. They depend on the nature of climate change and variability, the speed of the change, sensitivity of the area and the adaptive capacity of its people and ecosystems.

▸ The poor are most affected by climate change ◂

The world's poor and food insecure are the most vulnerable to the potential impacts of climate change and have the least capacity to adapt. They are often highly exposed to natural hazards, greatly dependent on climate-sensitive

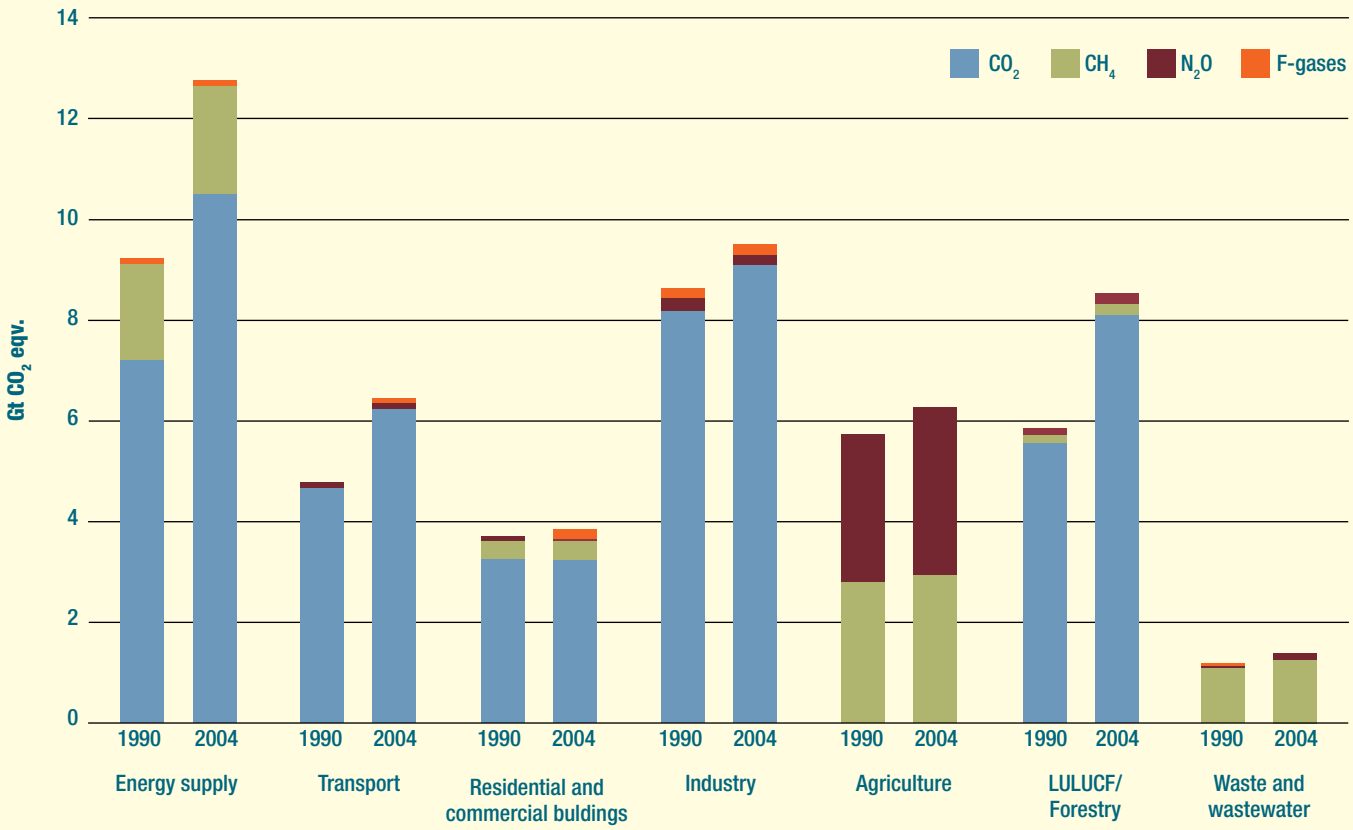
resources and have limited economic and technological resources.Least developed countries (LDCs) and small island developing states (SIDS) are therefore likely to be most affected.

The ability of individuals to cope with climate change impacts depends on economic development and institutional support as well as cultural and socio-economic factors, such as gender, household composition and distribution of household assets. For instance, women and marginalized groups, including ethnic minorities, often have little influence over national decision-making processes, and lack the means such as money, access to credit and property rights, which leaves them with reduced adaptation capacity. Adaptation to climate change therefore remains a major challenge to the rural poor and to national governments.

▸ Agriculture, forestry and fisheries contribute to climate change ◂

While agriculture, forestry and fisheries are suffering from climate change impacts, they also contribute to emissions. Agriculture accounts for 13.5 percent of global greenhouse gas (GHG) emissions or about 1.8 GtC eqv./yr (6.6 Gt of CO_2 eqv./yr, Fig.2, IPCC 2007b), mainly in the form of methane (CH_4) and nitrous oxide (N_2O) from fertilized soils, enteric fermentation, biomass burning, rice production, as well as manure and fertilizer production.

FIGURE 2 – Contribution of agriculture, land-use change and forestry to GHG emissions (Figure TS.2a. from IPCC 2007b)



Further land-use change and forestry represent 17.4 percent of total GHG emissions or 2.3 GtC eqv./yr (8.4 Gt CO_2 eqv./yr, see Fig. 2, IPCC 2007b). In the fisheries sector, CO_2 emissions from harvesting and shipping of fish and fish products are estimated at 0.05 Gt per year. About three fourths of total emissions from agriculture and land-use originate in developing countries (IPCC, 2007c).

For agriculture and forestry, the above emissions do not include overall carbon capture through photosynthesis in terrestrial ecosystems, and therefore do not express that the net carbon balance in these systems is currently positive. It is also worth noting that there is a high degree of variability and uncertainty in the calculation of emissions.

▸ Agriculture, forestry and fisheries are part of the solution to climate change ◂

At the same time agriculture, forestry and fisheries have a very high potential for reducing emissions and enhancing carbon sinks. Agriculture has the technical potential to mitigate between 1.5-1.6 GtC eqv/yr (5.5 – 6 Gt of CO_2 eqv./yr, IPCC 2007c) mainly through soil carbon sequestration in developing countries, while the biophysical mitigation potential of forestry is estimated to average 1.5 GtC eqv./yr (5.4 Gt CO_2 eqv./yr, IPCC 2001). Without the realization of a substantial part of this mitigation potential, the climate change targets cannot be met.

▸ Mitigation and adaptation can reinforce each other ◂

The overall challenge for climate policy is to find an efficient mix of mitigation and adaptation solutions that limit climate change and its impacts. In the agriculture, forestry and fisheries sectors, many mutually re-enforcing synergies and benefits exist among mitigation and adaptation actions and overall development goals. These benefits include increased agricultural production, improved food security, poverty reduction, biodiversity conservation, improved soil and water management and increased production efficiency.

Action is needed now, inaction will significantly increase future costs

The Intergovernmental Panel on Climate Change (IPCC) envisioned a target that would limit the increase of global temperatures to 2°C in comparison to pre-industrial times in order to prevent climate change from having irrevocable consequences and negative impacts on people, ecosystems and food systems. To reach this goal by 2050 will require emission cuts of at least 50 percent from 1990s levels. Even under the most optimistic scenarios for concerted global efforts to cut emissions, GHG concentrations in the atmosphere may take at least 20 years to stabilize (IPCC, 2007b). Therefore, effective mitigation and adaptation actions must be identified and implemented. The benefits of strong, early actions would considerably outweigh any incurred costs.

Perhaps no sectors other than agriculture, forestry and fisheries have the potential to contribute so directly to the provisions of Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC): the ultimate objective of the Convention is stabilization of GHG concentrations in the atmosphere at a level which "ensures that food production is not threatened and enables economic development to proceed in a sustainable manner."

– FAO submission to UNFCCC (FAO, 2009)

FAO and climate change

With the number of hungry people having reached 1.02 billion, 75% of whom are to be found in rural areas where the primary source of livelihood is the agriculture, forestry and fisheries sectors, FAO aims to work towards an adequate reflection of food security concerns in climate change discussions and activities.

FAO's mandate to "raise levels of nutrition, improve agricultural productivity, better the lives of rural populations and contribute to the growth of the world economy" guides its work on climate change. Based on its multidisciplinary activities in agriculture, forestry, fisheries, aquaculture, livestock, economics, rural development and food security FAO applies an integrated approach to climate change adaptation and mitigation. This means identifying current and potential challenges and assisting its Members, particularly the most vulnerable, to improve their capacities to confront the negative impacts of climate change and associated climate variability, and help identify ways to maximize any opportunities that may emerge. FAO places particular importance on identifying opportunities and practices that have potential to promote synergies among adaptation and mitigation objectives and help achieve development goals.

The Organization's work covers a broad spectrum of activities which range from local to global and from immediate actions to long-term strategies for dealing with climate change, and it is committed to an ecosystem approach that embraces agriculture, forestry and fisheries.

Core principles that guide FAO's work on climate change include:

- integrating climate change concerns into food security and development planning across all sectors and spatio-temporal scales;
- seeking a systems approach that builds on synergies in mitigation, adaptation and sustainable food production;
- working in a demand-driven, location-specific and participatory manner, considering gender-specific needs as well as priorities of indigenous and other vulnerable communities;
- addressing adaptation and mitigation as an ongoing social learning process that integrates local and scientific knowledge;
- promoting synergies between international conventions and agreements on climate change, desertification, biodiversity and forestry.

All technical units of FAO – including the Departments of Agriculture and Consumer Protection, Economic and Social Development, Fisheries and Aquaculture, Forestry, Natural Resources Management and Environment, Technical Cooperation as well as FAO's Legal Office and regional, sub-regional and country offices – implement climate change activities in their work. The Environment, Climate Change and Bioenergy Division within the Natural Resources Management and Environment Department provides overall coordination and facilitates integrated and cross-sectoral activities.

Adaptation

Adaptation to climate change is essential for any effort to promote food security, poverty alleviation, or sustainable management and conservation of natural resources. Therefore, FAO has mainstreamed adaptation into its work.

Many countries are already dealing with climate change impacts, resulting from irregular, unpredictable rainfall patterns, uncommonly heavy rainfall, increased incidence of storms and prolonged droughts. In addition, changing temperatures and weather patterns have led to the emergence of pests and diseases that affect animals, trees and crops. All these have a direct effect on the quality and quantity of yields, not to mention the availability and price of food, feed and fibre in the marketplace.

Rural communities face growing risks, including increased and recurrent crop failure, loss of livestock and reduced availability of fisheries and forest products, particularly communities in fragile environments such as mountain areas and coastal zones. More frequent and more intense extreme weather events will have serious impacts on livelihood assets in both rural and urban areas.

FAO's six priority action areas for climate change adaptation in agriculture, forestry and fisheries:

- data and knowledge for impact assessment and adaptation
- governance for climate change adaptation
- livelihood resilience to climate change
- conservation and sustainable management of biodiversity
- innovative technologies
- improved disaster risk management

Climate change adaptation: adjustments to current or expected climate variability and changing average climate conditions. This can serve to moderate harm and exploit beneficial opportunities.

Adaptive capacity: the ability to change behaviour in order to respond to a changing climate. This can include devising and implementing solutions to protect livelihoods from negative climate change impacts or allow individuals or households to benefit from positive climate change impacts.

(IPCC, 2007a)

Pro-active and anticipatory adaptation approaches must be taken that address the short-term impacts of increasing climate variability but also help local communities prepare for the long-term impacts resulting from changes in mean temperatures, rainfall, salinity and sea levels. Long-term climate change impacts can emerge gradually or arrive abruptly when certain thresholds are reached.

Adaptation should be tackled as an integrated part of sustainable development

Adaptation offers no one-size-fits-all solution. It must be an integrated, flexible process that considers the local context. It is critical for adaptation activities in agriculture, forestry and fisheries to consider both the opportunities and constraints that rural people face and the diversity of systems they rely upon.

Investments made towards climate change mitigation and adaptation should also be seen as an opportunity to increase the support to the agriculture, forestry and fisheries sectors, which has stagnated in many countries for the last decades.

Farmers, pastoralists and fishers cannot base their immediate management decisions on 30-year model projections. They need to first know what actions to take to deal with their immediate concerns, such as increasing climate variability, including extreme events. Forest managers have to apply a longer perspective for adapting forests to a changing climate, given the long lifespan of trees. The same applies to planning for water management infrastructure.

Institutional and policy incentives enable and catalyze local adaptation & mitigation action

Local people, who are the actual land managers, play a central role in adapting agriculture, forestry and fisheries sectors and food systems to climate change. Equally important are the policy and legal frameworks, as well as incentives and services for rural producers that can stimulate and guide adaptation processes and link producers to markets. National and regional policies and laws for land and water management, resource use and access, environmental conservation, livelihood strategies, crop development, land-use planning, land tenure, risk management, food security and trade have great potential to influence adaptation to climate change. To be successful, adaptation activities need the support of strong institutions with clearly defined and coordinated responsibilities.

Traditional coping mechanisms need to be complemented by scientific know-how

The concept of adapting to climate impacts is not new to farmers, forest dwellers and fishers. Traditionally, coping mechanisms for adapting to seasonal and annual climate variability have included sharing local knowledge on better crop and fish varieties, farming systems, soil, nutrient and water management technologies, energy use, forest fire management, integrated pest management and agroforestry systems.

Today, the need to increase production coupled with the speed and magnitude of the expected changes in climate mean new challenges for farmers. Most likely, their traditional ways of coping will not be enough to ensure adaptation in the medium to long term. Adaptation in agriculture, forestry and fisheries needs strong research efforts and often involves substantial changes in practices that may take a long time to implement or show benefits. Adaptation strategies must be based on iterative planning cycles that build on existing strategies, learn from the past and incorporate innovative technologies and policies at multiple levels.

Sustainable production practices are a good basis for action

However, traditional practices can serve as an entry point for efforts to enhance system resilience. Adaptation can incorporate a range of successfully tested methods and technologies derived from sustainable agriculture, forestry, fisheries, natural resource management and rural development. Disaster risk reduction and sustainable natural resource management have been identified as the key entry points for building the adaptive capacity of vulnerable rural communities and resilience to impacts associated with climate variability and climate change.

The "No-regrets approach"

When localised projection of climate change impacts is not available, FAO favours the "no-regrets approach". These are adaptive practices and actions which will be beneficial even if future impacts are not certain and climate change threats do not occur exactly as anticipated.

FAO's priority action areas for adaptation

Data and knowledge for impact assessment and adaptation

Countries need a sound understanding of the current and future vulnerabilities – of their food systems, ecosystems, societies and national economies – to the impacts of climate change and variability. In this regard, FAO seeks to develop innovative, user-friendly tools and methods to support decision-makers in assessing these impacts and planning adaptation strategies.

FAO actions:

- monitoring, forecasting and assessing the impacts of climate variability and climate change on agriculture, forestry and fisheries systems, taking into account socio-economic scenarios and drivers of change in agricultural sectors,
- conducting integrated vulnerability assessments for agriculture, forestry and fisheries systems and associated livelihoods,
- communicating information related to climate change impacts and adaptation in the agriculture, forestry and fisheries sectors from global to local level, and strengthening networks among stakeholders,
- transferring knowledge on impact assessment and adaptation planning through training, policy and planning advice.

Governance for climate change adaptation

Adaptation requires adjusting institutional structures and arrangements. This includes defining adequate national policy and legislative frameworks, and assigning responsibilities within the governance structures of countries and regions. Iterative planning frameworks, participatory approaches and strong stakeholder engagement should be key governance principles for adaptation. In addition, decision-making must remain flexible for dealing with the uncertainties of potential climate change impacts.

FAO actions:

- advocating at the international level for a stronger recognition of the challenges to and potential of agriculture, forestry and fisheries sectors in climate change frameworks, as well as for adequate support for financing, technology development and transfer and capacity building,
- integrating climate change adaptation into national and sub-national agriculture, forestry and fisheries sector policies, food security programmes, legislative frameworks and investment priorities,
- improving access of vulnerable groups to decision-making and natural resources,
- strengthening institutional capacities for climate change adaptation, in particular, research, extension and communication services and rural institutions,
- reinforcing national veterinary and plant health services to improve monitoring and control of pests and diseases related to climate change.

Livelihood resilience to climate change

Reliable impact scenarios are often not available at the national and sub-national level. When this is the case, adaptation planning should focus on management aimed at increasing livelihood resilience. In this context, FAO strongly argues for priority actions in sustainable land management such as land-use planning and soil and water management, and appropriate management of farming systems, livestock, forests, grasslands, fisheries and aquaculture.

FAO actions:

- promoting sustainable land and water management,
- diversifying livelihoods and income through integrated farming, forestry and fisheries systems, small-scale enterprise development and off-farm activities, and improving market access opportunities,
- documenting and evaluating adaptation strategies and local adaptation practices,
- promoting access to sustainable and affordable sources of energy in rural areas.

Conservation and sustainable management of biodiversity

The healthy functioning and resilience of ecosystems depends to a great extent on biological diversity. For FAO, the key priorities are to increase understanding of the ecosystem services provided by agricultural and aquatic biodiversity and identify associated impacts of climate change and sustainable responses.

FAO actions:

- monitoring global and regional biodiversity trends,
- enhancing biodiversity (including genetic resources) in production systems,

- incorporating responses to climate change impacts on biodiversity into national agricultural, forestry and fisheries strategies.

Innovative technologies

Traditional coping mechanisms often will not be sufficient for dealing with expected medium- to long-term impacts of climate change. Therefore, FAO supports the development and dissemination of innovative technologies related to agriculture, forestry and fisheries and rural energy demands. These should address the entire food chain and associated market development.

FAO actions:

- promoting the breeding of trees, crops, livestock and fish adapted to changed climate conditions,
- supporting the development of innovative technologies to improve the adaptive capacity of production and management systems, including alternative cropping and fish harvesting patterns, conservation agriculture, precision agriculture, organic agriculture, sustainable forest management, post-harvesting methods and innovative product development,
- identifying technologies for efficient use of inputs (energy, fertilizer, water, seeds, pesticides) and waste,
- identifying improved soil and water management and irrigation systems,
- developing strategies for disseminating new technologies and innovations, such as through NGO networks, farmer field schools or extension services.

Improved disaster risk management

Increasing frequency and intensity of extreme weather events calls for strengthened disaster risk management systems, improved local practices for risk reduction and enhanced emergency response operations. Building on its long-standing experience in sustainable development and disaster risk management, FAO prioritizes actions for disaster risk reduction as an entry point to climate change adaptation.

FAO actions:

- supporting local action for disaster risk reduction, including preparedness measures such as early warning systems, sustainable practices to reduce climate risks in agriculture, fisheries and forestry, enhanced systems for seed supply and storage as well as food preservation, improved control of pests and diseases, animal and plant health, safety-at-sea and biosecurity frameworks in aquaculture,
- expanding emergency response and rehabilitation planning, integrating “building back better” principles to foster mitigation, prevention, preparedness and adaptation,
- integrating disaster risk management strategies into agriculture, fisheries and forestry adaptation and development strategies.

Mitigation

It will not be possible to reach the global mitigation target, if the agriculture, forestry and fisheries sectors, which are responsible for a third of the GHG emissions, are not significantly contributing to mitigation. Therefore, FAO gives priority to mitigation activities in these sectors. FAO's technical knowledge gives it a unique depth and breath of expertise to support its members in realizing their mitigation potential.

Agriculture, forestry and other land-use (AFOLU) sectors are responsible for about a third of global anthropogenic GHG emissions. However, oceans, lakes, forests and agricultural lands also sequester and store large amounts of carbon, thus contributing to climate change mitigation.

FAO's four priority areas of action for climate change mitigation in agriculture, forestry and fisheries:

- strengthening the agriculture, forestry and other land-based sectors in climate change negotiations and international agreements,
- data and knowledge for mitigation,
- methods and technologies for mitigation,
- governance for climate change mitigation.

▸ Agriculture contributes to climate change, but is also part of the solution ◂

In many areas, agriculture is the main driver of deforestation, indicating the close linkages among the different land-use sectors. For mitigation activities to become effective,

Climate change mitigation: implementing policies to reduce and avoid greenhouse gas emissions and enhance sinks. Sinks refer to reservoirs – natural such as forests or oceans or man-made such as landfills and tree plantations – that absorb carbon from the atmosphere.

Climate change mitigation potential: the amount of mitigation that could be realised over time. The technical mitigation potential is the amount that is technically feasible to achieve. Economic mitigation potential is the financially feasible subset of technical mitigation.

(IPCC, 2007a)

leakage, i.e. displacing emissions between sectors and areas, has to be minimized. Thus, a comprehensive land-use approach is necessary. Such an approach should include forestry and agriculture, and consider the need for increasing production to ensure food security.

Mitigation potential in the AFOLU sectors must be tapped

According to The Stern Review (2006) reducing deforestation and forest degradation would be one of the most cost effective mitigation approaches. The biophysical mitigation potential of forests is estimated to average 1.5 GtC/yr (5.4 Gt CO_2/yr, IPCC, 2001) until 2050, an amount that equals about 64 percent of the sectors' emissions. Additionally, agriculture could provide an estimated technical mitigation potential of 1.5-1.6 GtC eqv./yr (5.5–6 Gt CO_2 eqv./yr, IPCC, 2007c) by 2030, which equals about 83–91 percent of the sectors' emissions.

Emission reductions and creation of sinks can be supported through changes in production practices and farming systems

Existing forestry and agricultural practices and measures already provide mitigation opportunities. The IPCC 4th Assessment Report identified three broad categories for the mitigation of GHGs: reducing emissions, avoiding or displacing emissions, and removing emissions.

- **Reducing emissions:** adoption of better management practices and more efficient management of carbon and nitrogen flows can reduce emissions caused by agriculture, forestry and fisheries. For example, it is possible to reduce methane (CH_4) emissions from livestock by making more efficient use of feeds, or to decrease nitrous oxide (N_2O) emissions from crop production by adopting more efficient nitrogen management practices. Also technical changes in production systems, such as fertilization, manure management and rice farming, as well as shifts in production practices and changes in food consumption patterns provide options to reduce GHGs (FAO, 2006). The reduction potential of these practices is site specific. In the forestry sector, reducing emissions from deforestation and forest degradation (REDD) is an important mitigation option which FAO is actively supporting. In the fisheries sector, emissions can be limited by decreasing the use of fishmeal in aquaculture, lowering post-harvest losses, increasing waste recycling and reducing excess fishing capacity.
- **Avoiding or displacing emissions:** the energy efficiency of the agriculture sector can be improved. In addition, fossil fuel energy used in agricultural production can in some cases be replaced by biofuels produced from wood, agricultural feedstock, residues, algae and fish waste. Assessments of the mitigation potential of bioenergy use need to take food security and resource availability into account. Sustainability criteria are required to ensure sustainable soil and water management, and protect biodiversity and nature reserve areas. At the same time, the rights and livelihoods of the local people must be safeguarded. Improving household energy systems can significantly reduce GHG emissions at a relatively low cost. Forest conservation activities can help to avoid carbon emissions. Furthermore, many materials can be substituted by wood products which store carbon and thus displace emissions.
- **Removing emissions:** GHGs can be absorbed from the atmosphere through sinks. In the forestry sector, activities such as afforestation, reforestation and forest restoration can increase carbon capture from the atmosphere and lock it into plant biomass, roots and soils. Sustainable forest management can help maintain the forest carbon. Carbon sequestration in crop- and grasslands and agroforestry also has the potential to make a significant contribution to GHG mitigation.

  According to the IPCC, 89 percent of agriculture's technical mitigation potential lies in soil and biomass carbon sequestration through different management practices, such as improved cropland and grazing land management, agroforestry and the rehabilitation of degraded lands. For example, reduced or no-till agriculture in association with diversified cropping patterns and increased soil cover limits soil disturbance and increases soil carbon.

Many of these practices are especially relevant in developing countries which could ideally realize some 70 percent of the global technical mitigation potential of agriculture (Fig. 3) (IPCC, 2007c).Many of the mitigation options may be cost neutral, as they require low investments and technical inputs, and may even be profitable since they can increase agricultural productivity over time while improving resilience and ecosystem services (Smith *et al.,* 2007; McKinsey, 2009). Moreover, many of the technical options are well known and, with suitable support, could be adopted relatively quickly and widely.

▸ Transforming technical potential into practice ◂

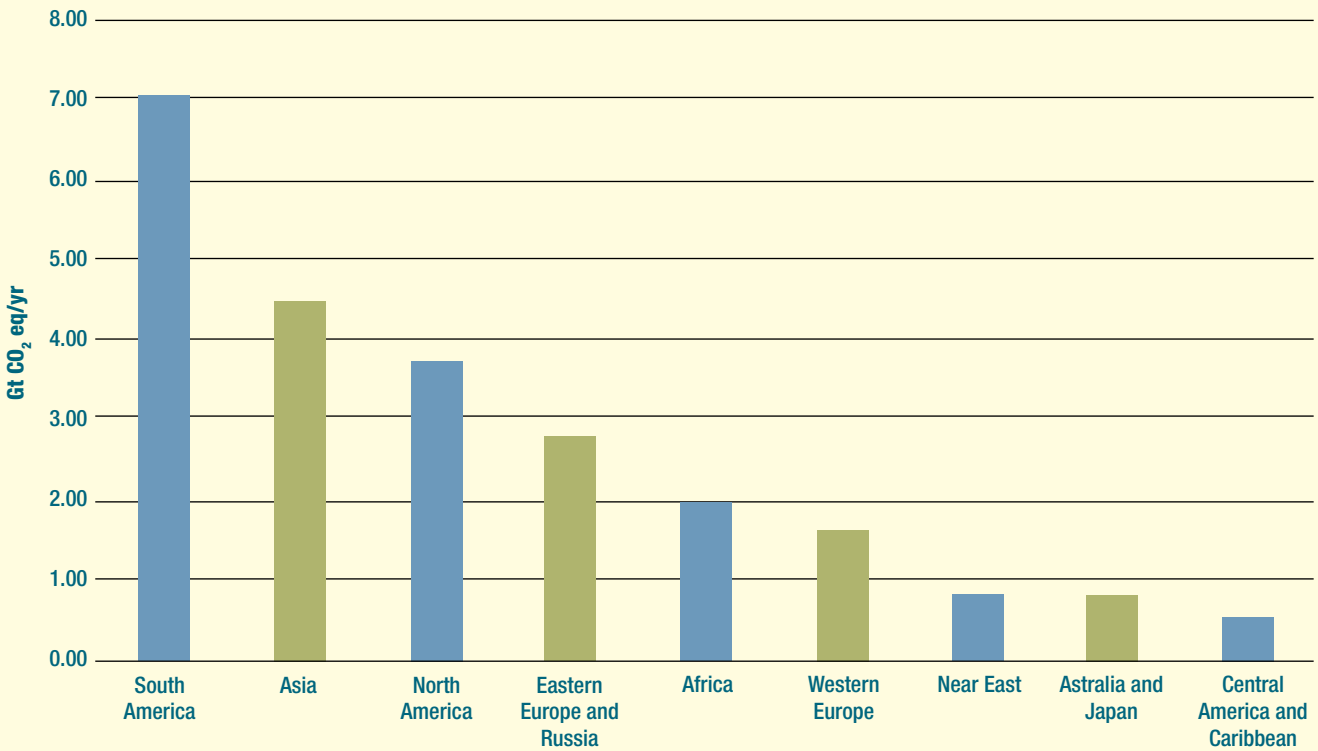
Despite this potential, it remains a challenge to identify financially feasible mitigation mechanisms and to create the required capacity and infrastructure for implementation, especially for smallholders. While suitable technologies and practices exist, more work is needed to develop technologies over a wider range of farming systems and agro-ecological zones. In addition, simple but effective, accurate and verifiable methodologies for measuring and accounting for changes in carbon stocks are required, particularly in the context of monitoring commitments and allowing the development of carbon financing mechanisms.

Ensuring land tenure security and use rights, providing adequate credit or insurance, and disseminating information about new technologies are key issues to be tackled to allow farmers to make the necessary transitions.

▸ Climate change financing mechanisms must secure equitable access to smallholders ◂

The challenge is to design financing mechanisms for the remuneration of environmental services in general and mitigation services in particular that are provided by smallholder agriculture and forestry. These financing mechanisms need to offer incentives for providing and safeguarding ecosystem services such as watershed protection, carbon sequestration and biodiversity provision. For smallholders to participate and benefit from mitigation funds and financial rewards and adopt mitigation practices, mechanisms need to be designed that cover up-front investment costs. Institutional arrangements are needed that aggregate the mitigation reductions across smallholders in order to reduce monitoring and transaction costs.

FIGURE 3 – Technical mitigation potential of agriculture by 2030 (data IPCC, 2007c)



FAO's priority action areas for mitigation

Strengthening the agriculture, forestry and other land-based sectors in climate change negotiations and international agreements

To meet the global mitigation goals, it is vital that the UN climate change framework provides further incentives for AFOLU-based mitigation activities. As a neutral actor, FAO is well placed to support such activities.

FAO actions:

- advocating for the creation of a supportive governance regime for mitigation in AFOLU and fisheries at UNFCCC negotiations,
- advocating at the international level for adequate support for financing, technology development and transfer and capacity building for agriculture, forestry and fisheries (including REDD),
- strengthening the synergies between mitigation, adaptation and development for priority actions in agriculture, forestry and fisheries,
- improving cooperation and synergies between international agreements and institutions.

Data and knowledge for mitigation

It is critical to generate precise information on the emissions from different production systems, products and agro-ecological zones in order to determine the most effective mitigation actions and enable informed policy choices. FAO gives high priority to identifying and supporting farming systems and land-use transitions that generate mitigation as well as food security and adaptation benefits. Systematic research on appropriate mitigation practices and technologies is needed to enable farmers and forest dwellers to contribute to mitigation goals. In addition, effective generation and dissemination of knowledge for climate change mitigation activities is important.

FAO actions:

- creating a global emissions database for different farming systems, fisheries, forestry and agro-ecological zones based on a lifecycle approach,
- mapping forestry and farming systems with a high mitigation potential,

- analysing the impacts of mitigation practices on natural resources, farm incomes, trade and food security,
- supporting the exchange of information on technologies and practices for the reduction and removal of emissions.

Methods and technologies for mitigation

Payment for mitigation will only be feasible when it is possible to measure, report and verify (MRV) the reduction of emissions or the sequestration of carbon in soils and biomass. Therefore, FAO supports the development and testing of MRV systems suitable for both national and smallholder implementation as it is an important step towards realizing the mitigation potential of agriculture, forestry and other land-use sectors. This can be complemented by improving applied financing mechanisms that take into account the specific nature of agricultural production.

FAO actions:

- facilitating the establishment of national MRV systems for mitigation in agriculture and forestry,
- piloting sustainable land management measures and integrated land-use systems with communities to demonstrate multiple benefits of mitigation measures,
- developing tools, protocols and methodologies for accurate measurement and verifiable carbon accounting and improving country capabilities in monitoring and reporting,
- documenting and evaluating mitigation strategies and practices.

Governance for climate change mitigation

The involvement of farmers, forest-dependent people and fishing communities in agricultural mitigation is a tremendous challenge, especially in developing countries. Mitigation requires appropriate institutional structures. There is a need to build and strengthen national and local institutions to undertake MRV and for managing financing systems.

FAO actions:

- increasing awareness and understanding of the roles of agriculture, forestry and fisheries sectors in climate change mitigation at national and local level,
- integrating climate change mitigation into agriculture, forestry and fisheries sector policies, food security programmes, trade and legal and investment frameworks while avoiding possible leakage and trade distortion,
- supporting countries in their work to include and safeguard rights and tenure security of indigenous people, marginalized groups and local communities including mechanisms for ensuring their participation in the planning and implementation of mitigation activities and in the sharing of benefits,
- assisting countries in developing their Nationally Appropriate Mitigation Actions (NAMAs) and in developing and implementing national REDD strategies,
- developing and supporting institutions in efforts to link smallholder agriculture to carbon finance mechanisms, payments for environmental service schemes and microfinance.

Interactions in practice

Decisions on adaptation and mitigation in agriculture, forestry and fisheries are made in a development context which comprises many goals beyond climate change actions. Adaptation is closely linked to sustainable development, food security and livelihoods. Mitigation is related to international obligations, and must make economic sense at farm level to be realised. There are various strategies for adaptation and mitigation, some providing multiple benefits others requiring complex trade-offs.

▸ Mechanisms are needed that reward synergies among adaptation, mitigation, food security and development ◂

Adaptation-mitigation synergies or trade-offs in agriculture, forestry and fisheries at the global, regional and local levels are poorly documented. It is necessary to create and support synergies which can contribute to sustainable agriculture. Where trade-offs are significant, guidance in project and policy development is essential to decrease harmful impacts. Mechanisms need to be developed that specifically reward synergies among mitigation, adaptation and development activities, an example being payments for environmental services.

▸ Multiple benefits are often region- and system-specific ◂

Strategies that offer multiple benefits include reduced deforestation, forest conservation and management, improved pasture management, sustainable production intensification, integrated food-energy systems, adoption

of innovative agricultural implements and machinery with low energy requirements, as well as a wide set of soil and water conservation technologies. All these strategies tend to increase the resilience of production systems while providing carbon sequestration or reducing land-based GHG emissions. However, it is important to recognize that these synergies are often region- and system-specific, and need to be evaluated on a case-by-case basis.

For example, increasing irrigation and fertilization, which is necessary to maintain production in marginal semi-arid regions, may also greatly enhance the ability of soils to sequester carbon. N_2O emissions can be minimized or mitigated through the implementation of appropriate soil and water management practices. Under scenarios with increased precipitation, especially at mid-latitudes, a shift from fallow systems to continuous cultivation, including cover crops, can maximize production under the new conditions and, at the same time, increase soil carbon sequestration.

▸ Trade-offs must be recognised and dealt with ◂

Some mitigation responses may not be conducive to adaptation and may conflict with food security – and vice versa. For instance, bioenergy production for liquid biofuels and some land conservation programmes may lead to competition for land and water resources that are crucial for enhancing system resilience and safeguarding food production. Clear criteria and indicators are necessary to steer decision-making for the cultivation of energy crops. FAO facilitates standard setting for sustainable biofuels production.

The following examples illustrate the multiple benefits of agricultural practices helping to pave the way to a productive, resilient and environmentally sound agriculture, forestry and fisheries.

Silvopastoral system in Peru

Agroforestry

Agroforestry can play an important role in adaptation by providing benefits such as:

- **increasing resilience to climate extremes, through improved water retention and enriched soil fertility,**
- **diversifying income sources and providing income buffers during crop failures,**
- **enhancing productivity.**

At the same time, agroforestry can contribute to climate change mitigation through carbon sequestration in vegetation and soils.

Paddy rice and livestock production system in Indonesia

Integrated rice-livestock systems

Integrated rice and livestock production systems, traditionally found in West Africa and parts of Asia, reduce methane emissions, improve irrigation water efficiency and increase production. Additional benefits include:

- providing varied income sources,
- improving performance of cultivated agro-ecosystems,
- enhancing food security through a diversified production system.

Aquaculture

Aquaculture can provide nutritious food with a low carbon footprint compared to other sources of animal protein. In contrast to the potential declines in agricultural yields in many areas of the world, climate change opens new opportunities for aquaculture such as:

- increasing numbers of species are cultured,
- the sea encroaches on coastal lands, providing new opportunities for marine farming,
- integrated agriculture-aquaculture can use water resources more efficiently.

Fish farming in China

Compost production in Malawi

Restoration of degraded lands

The carbon storage potential of eroded and degraded soils can be restored by practices such as re-planting, usage of nutrient supplements, manures and composts, conservation agriculture, soil and water conservation and more adapted cropping systems. In addition, these practices support adaptation and provide other important benefits such as:

- increasing crop yields and income,
- reducing financial risk by using local inputs,
- improving resistance to pests and crop diseases through improved soil fertility.

Implementation mechanisms

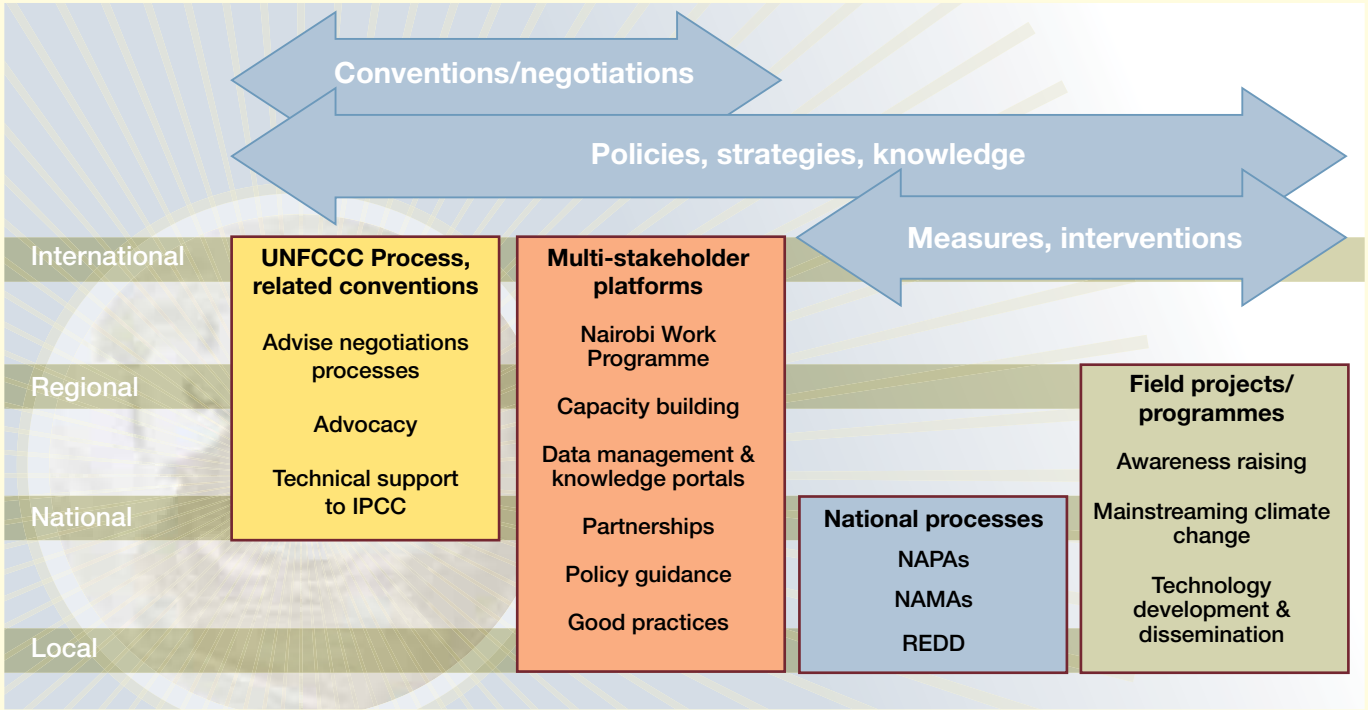
FAO works on a broad range of climate change issues. Adapting to climate variability and change closely relates to its development mandate and is thus widely reflected in a large part of FAO's work. Mitigation of climate change is a relatively new field but it builds to a large degree on FAO's earlier technical work on sustainable management of land and aquatic systems, payments for environmental services and collaboration with rural-based organizations. FAO works across all levels, producing knowledge, providing policy advice and building capacities to support necessary adaptation and mitigation measures. FAO's work is embedded in a range of local and international processes (Fig. 4).

- **International level:** FAO actively supports the UNFCCC process highlighting the important role of the agriculture and related sectors for climate change. FAO provides technical support to the climate change negotiations, taking into account the specific needs of developing countries. FAO supports the implementation of the Nairobi Work Programme which was developed to help all countries improve their understanding of climate change impacts and make better informed adaptation decisions.

  FAO promotes dialogue and awareness at international level related to climate change impacts on food security and on the roles of agriculture, forestry and fisheries in adaptation and mitigation.

  FAO facilitates the integration of climate change into food security, agriculture, forestry and fisheries policies. It also fosters interaction and coherence

FIGURE 4 – Major implementation mechanisms for FAO's work



among the different conventions, treaties and bodies including Commission on Sustainable Development (CSD), UNFCCC, United Nations Convention to Combat Desertification (UNCCD), Convention on Biological Diversity (CBD), United Nations Forum on Forests (UNFF) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

- **Regional and subregional levels:** FAO works to increase awareness of the impacts of climate change and catalyze regional and subregional cooperation, capacity building and knowledge sharing on adaptation and mitigation. For example, FAO actions address transboundary issues such as prevention and control of pests and diseases, and access to water and biodiversity resources. FAO supports countries in harmonizing policies, programmes, strategies and regulatory frameworks for addressing climate change in agriculture, forestry and fisheries in the regions and subregions, and in integrating climate change into regional programmes for food security.

- **National to local level:** FAO provides technical support for the formulation and implementation of National Adaptation Programmes of Action (NAPAs) and NAMAs as well as national strategies for REDD. FAO also supports countries, in particular low-income food-deficit countries (LIFDCs), in integrating adaptation and mitigation issues into agriculture, forestry and fisheries sector policies, food security programmes and legal and investment frameworks. FAO implements a wide range of programme at national and sub-national level for adaptation, mitigation and disaster risk reduction. These include, for example, projects under the Environment and Climate Change thematic window of the United Nations Development Programme (UNDP)/Spain MDG Achievement Fund and the coordination of programmes on National Forest Monitoring and Assessment/ Integrated Land-use Assessment.

Partnerships

Partnerships play a crucial role in FAO's work on climate change at all levels and are vital to addressing cross-cutting issues. FAO's most important partners are its Members.

The organization also has a longstanding established cooperation with the Rome-based agencies – International Fund for Agricultural Development (IFAD), World Food Programme (WFP) and Bioversity International. In fact, the Rome-based agencies have created a partnership strategy that includes climate change as one of its topical areas. The Consultative Group on International Agricultural Research (CGIAR) is a partner in many technical fields.

In line with the United Nations "Delivering as One" initiative, FAO works closely with many UN agencies and platforms on climate change, such as UNFCCC, UNDP, UNEP, UNCCD, UNISDR, UNFF, UNICEF, UNESCO, CBD, WHO and WMO. For example, FAO implements the UN-REDD Programme jointly with UNDP and UNEP and participates in a programme on climate change for the implementation of the United Nations Convention to Combat Desertification (UNCCD) with the Global Mechanism of the UNCCD. It is a member and chair of the Collaborative Partnership on Forests (CPF) and the Global Partnership for Climate, Fisheries, and Aquaculture (PaCFA). In addition, through its participation in the Global Terrestrial Observing System (GTOS) partnership, FAO is developing a framework for the establishment of standards and reporting guidelines for variables that affect climate in the terrestrial domain. Furthermore, FAO works closely on climate change issues with the World Bank and regional development banks, donors, universities and research institutions, IPCC as well as with international, national and local non-governmental and civil society organizations and the private sector. Innovative public-private partnerships and the involvement of private sector enterprises are key in the development of carbon markets and technologies for mitigation.

UN-REDD

PROGRAMME

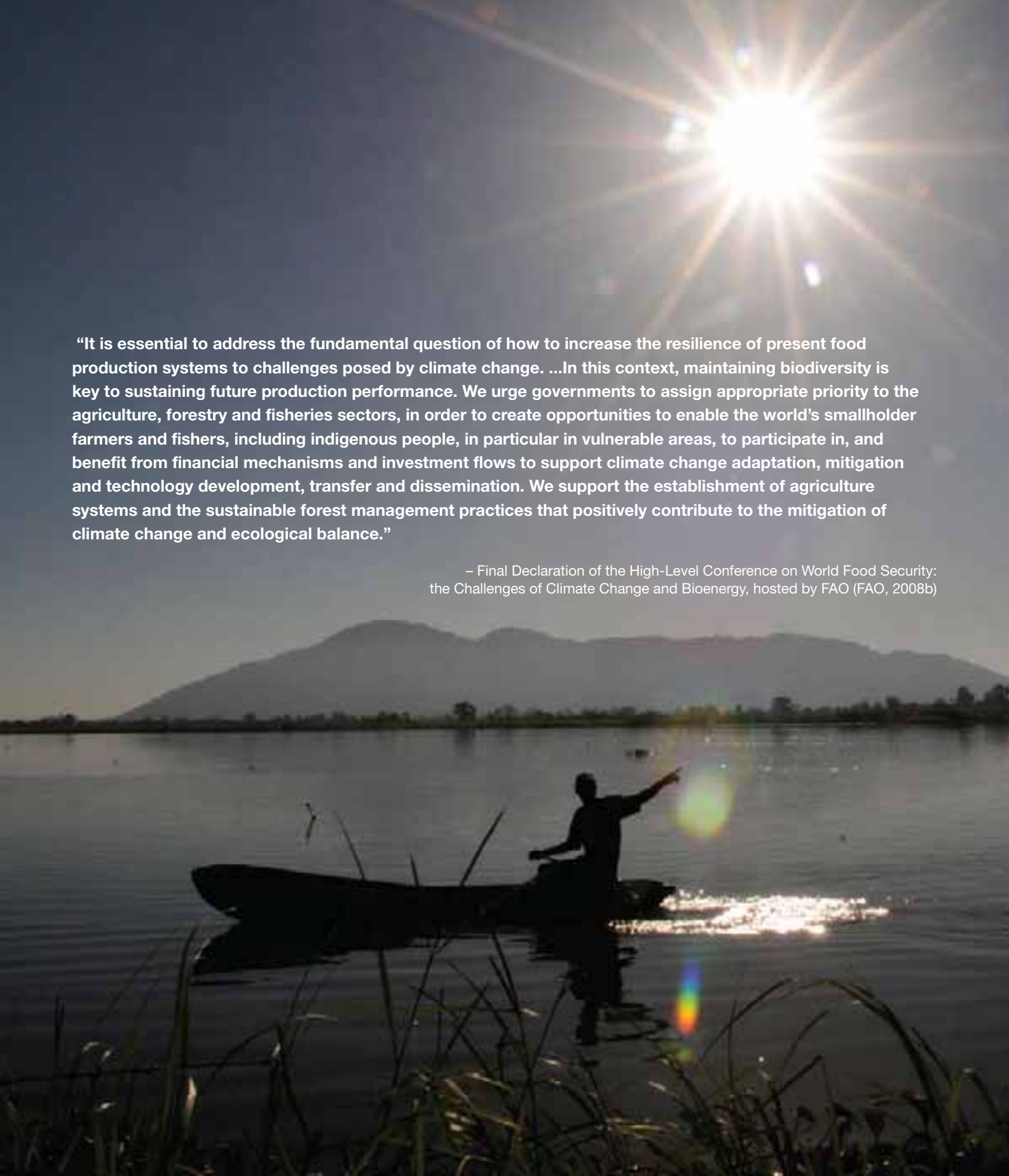
UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

The UN-REDD programme, a collaborative initiative among FAO, UNDP and UNEP, was launched in September 2008 with two overriding objectives:

- assisting developing countries to prepare for participation in a future REDD mechanism,
- supporting development of guidance and standardized approaches based on sound science.

The UN-REDD programme provides support to countries in the form of capacity development, governance advice and technical assistance that will ensure their effective participation in REDD. The main components of the UN-REDD programme address MRV, stakeholder engagement, multiple benefits and a strong institutional framework including payment structures.

The UN-REDD programme started in nine countries and aims to expand after the pilot phase.



"It is essential to address the fundamental question of how to increase the resilience of present food production systems to challenges posed by climate change. ...In this context, maintaining biodiversity is key to sustaining future production performance. We urge governments to assign appropriate priority to the agriculture, forestry and fisheries sectors, in order to create opportunities to enable the world's smallholder farmers and fishers, including indigenous people, in particular in vulnerable areas, to participate in, and benefit from financial mechanisms and investment flows to support climate change adaptation, mitigation and technology development, transfer and dissemination. We support the establishment of agriculture systems and the sustainable forest management practices that positively contribute to the mitigation of climate change and ecological balance."

– Final Declaration of the High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy, hosted by FAO (FAO, 2008b)

Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CH_4	methane
CO_2	carbon dioxide
CPF	Collaborative Partnership on Forests
CSD	Commission on Sustainable Development
CSO	civil society organization
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GHG	greenhouse gas
Gt	giga tonnes
GTOS	Global Terrestrial Observation System
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LIFDC	low-income food-deficit countries
LULUCF	Land use, Land-use Change and Forestry
MDG	Millennium Development Goal
MRV	measuring, reporting and verifying
N_2O	nitrous oxide
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programmes of Action
NGO	non-governmental organization
REDD	Reducing Emissions from Deforestation and Forest Degradation
UNISDR	United Nations International Strategy for Disaster Reduction
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
WFP	World Food Programme
WMO	World Meteorological Organization

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This FAO profile on climate change has been produced through a process involving all technical departments and regional and sub-regional offices.

FAO's vision is a world free of hunger and malnutrition where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner.

More information on FAO's work on climate change

http://www.fao.org/climatechange

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