

Climate Change and Food Security

A Framework Document

*(Key messages and Summary only,
the full text is available on the FAO website)*



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KEY MESSAGES

- 1 Climate change will exacerbate food insecurity in many countries served by FAO.**
- 2 Many impacts will be arbitrated through the market place.**
- 3 Climate change will first affect already vulnerable people and food systems, but over time, the geographic distribution of risk and vulnerability is likely to shift.**
- 4 Certain livelihood groups need immediate support.**
- 5 Although the entire food system is a source of greenhouse gas emissions, the primary production component is by far the most important.**
- 6 In the food and agriculture sector, mitigation and adaptation often go hand in hand.**
- 7 Incentives are needed to persuade crop and livestock producers, agro-industries and ecosystem managers to adopt good practices for mitigating and adapting to climate change.**
- 8 Promoting agro-biodiversity is crucial for local adaptation and resilience.**
- 9 Raised productivity from improved agricultural water management will be key to ensure global food supply and global food security.**
- 10 Conservation agriculture can make a significant difference for efficiency of water use, soil quality, capacity to withstand extreme events and carbon sequestration.**
- 11 Sustainable livestock management practices for adaptation and associated mitigation should be given high priority.**
- 12 Fishing and aquatic food production offer sustainable livelihood opportunities for people living by seacoasts, rivers and lakes, but these livelihoods are threatened by climate change.**
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- 15 Learning to live with uncertainty is one way of adapting to climate change.**
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- 17 Supporting those least likely to be able to adapt to climate change is the immediate challenge.**

CLIMATE CHANGE AND FOOD SECURITY: A FRAMEWORK DOCUMENT

SUMMARY AND CONCLUSIONS – HIGHLIGHTS

Mean global temperatures have been increasing since around 1850, mainly due to the accumulation of greenhouse gases in the atmosphere. The burning of fossil fuels (coal, oil and gas) to meet increasing energy demand and the spread of intensive agriculture to meet increasing food demand, are the main causes. This process of global warming, which shows no signs of abating, is expected to bring about long-term changes in weather conditions. *These changes will have serious impacts on all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability.* Their impacts may be felt in global food markets, but are likely to be more significant in specific rural locations where crops fail and yields decline, and in both rural and urban locations where supply chains are disrupted, market prices increase, assets and livelihood opportunities are lost, purchasing power falls, human health is endangered, and affected people are unable to cope.

Agriculture, forestry, and fisheries are all sensitive to climate. Therefore their production processes – whether for food, feed, fibre, beverage, energy or industrial crops, or for livestock, poultry, fish or forest products – are likely to be impacted by climate change. In general, impacts in temperate regions are expected to be positive, and those in tropical regions negative, although there is still considerable uncertainty about how projected changes will play out locally, and projected impacts could also be altered by adoption of risk management measures and adaptation strategies that strengthen preparedness and resilience.

The food security implications of changes in agricultural production patterns and performance are of two kinds:

1. *Impacts on the production of food will affect food supply at both global and local levels.* Globally, higher yields in temperate regions could offset lower yields in tropical regions. However, in many low-income countries that have limited financial capacity to trade, and that rely heavily on their own production to cover their food requirements, it may not be possible to offset declines in local supply without increased reliance on food aid.
2. *Impacts on all forms of agricultural production will affect livelihoods and ability to access food.* Producer groups less able to deal with climate change, such as the rural poor in developing countries, risk having their safety and welfare compromised.

Besides food and agricultural production, *other food system processes e.g., processing, distribution, acquisition, preparation and consumption are equally important for food security.* Due to technological advances and the development of long-distance marketing chains that move produce and packaged foods throughout the world at high speed and relatively low cost, overall food system performance has become much less dependent on climate today than it was two hundred years ago. Now, however, there is an increased risk of storm damage to transport and distribution infrastructure, with consequent disruption of food supply chains. Also, the rising cost of energy and the need to reduce fossil fuel usage all along the food chain, have given rise to a new calculus – that of “food miles” – which should be kept as low as possible in order to reduce emissions. These factors could result in a reversion to more local responsibility for food security – a prospect that needs to be accounted for explicitly in the formulation of adaptation strategies for people who are currently vulnerable or who could become so within the foreseeable future.

FAO's Interdepartmental Working Group on Climate Change has prepared a *Framework Document on Climate Change and Food Security* exploring the multiple effects that global warming and climate change may have on food systems and food security, and presenting strategies for mitigating and adapting to climate change for several key policy domains. Highlights from the summary and conclusions are reported here.

1. Climate change will exacerbate food insecurity in many countries served by FAO.

More frequent and more intense, extreme weather events (droughts, heat and cold waves, heavy storms, floods), rising sea levels, and increasing irregularities in rainy seasonal patterns (including flooding), are already having *immediate impacts* not only on food production, but also on food distribution infrastructure, incidence of food emergencies, livelihood assets and opportunities and human health in both rural and urban areas.

Less immediate impacts are anticipated due to gradual changes in mean temperatures and rainfall in addition to the above mentioned factors. These will affect the suitability of land for different types of crops and pasture; the health and productivity of forests; the distribution, productivity and community composition of marine resources; the incidence and vectors of different types of pests and diseases; the biodiversity and ecosystem functioning of natural habitats; and the availability of good quality water for crop, livestock and inland fish production. Loss of arable land is also likely due to increased aridity (and associated salinity), groundwater depletion and the rise in sea level. Food systems will also be affected by internal and international migration, resource-based conflicts and civil unrest triggered by climate change.

2. Many impacts will be arbitrated through the market place.

IPCC projections for continued growth in greenhouse gas emissions assume that, for the world as a whole, *economies and food demand* will continue to grow, albeit at different rates and sometimes with significant regional differences, depending on the scenario. Continued economic growth implies a continued increase in demand for animal protein as average incomes in developing countries rise, and with it, an increase in demand for water and, to a lesser extent, land for livestock production.

Food prices could increase as a result of growing scarcities of water, land and fuel, even without climate change. Additional pressures on these resources due to climate change, the introduction of mitigation practices that have the potential to create land use competition, and the attribution of market value to environmental services to mitigate climate change, also have the potential to cause significant changes in relative prices for different food items, and an overall increase in the cost of an average food basket for the consumer.

Current projections to 2030 suggest that globally, continued economic growth will push up average incomes faster than any likely price increases, demand for animal protein as a share of total food consumption will continue to increase, and the share of food in average household expenditure will continue to decline. However, recent trends, at least for some commodities, appear to be showing the reverse, with prices increasing faster than incomes, and there is some indication that price increases in low income countries may be higher than the global average.

3. Climate change will first affect already vulnerable people and food systems, but over time, the geographic distribution of risk and vulnerability is likely to shift.

Agriculturally-based livelihood systems that are already vulnerable to climate change face immediate risk of increased crop failure, loss of livestock and fish stocks, increasing water scarcities and destruction of productive assets. They include small-scale rainfed farming systems, pastoralist systems, inland and coastal fishing/aquaculture communities, and forest-based systems. People inhabiting coasts, floodplains, mountains, drylands and the arctic are most at risk.

Future vulnerability is likely to affect not only farmers, fishers, and forest-dependent people, but also low-income city dwellers, in both developed and developing countries, whose sources of livelihood and access to food may be at risk from the impact of extreme weather events and variable food prices, and who lack adequate insurance coverage. In addition, the livelihood status of agricultural workers will also change as centres of agricultural production shift or become more concentrated in the face of climate change. Risk and vulnerability within communities is also likely to vary and shift – between men and women, landowners and not, young and old, infirm and healthy.

4. Certain livelihood groups need immediate support.

Livelihood groups that warrant special attention when devising risk management and adaptation strategies include:

- low-income groups in drought-and flood-prone areas with poor food distribution infrastructure and limited access to emergency response;
- low-to-medium-income groups in flood-prone areas who may lose homes, stored food, personal possessions and means of obtaining their livelihood, particularly when water rises very quickly and with great force as in sea surges or flash floods,
- farmers whose land becomes submerged or damaged by the rise in sea level or saltwater intrusions;
- producers of crops that may not be sustainable under changing temperature and rainfall regimes;
- producers of crops at risk from high winds;
- poor livestock keepers in drylands where changes in rainfall patterns will affect forage availability and quality;
- managers of forest ecosystems that provide environmental services
- fishers whose infrastructure essential for fishing activities, e.g. port and landing facilities, storage facilities, fish ponds and processing areas, become submerged or damaged by sea level rise, flooding or extreme weather events;
- fishing communities that depend heavily on coral reefs for protection from natural disasters and food;
- fishers/aquafarmers who suffer diminishing catches from shifts in fish distribution and productivity of aquatic ecosystems, caused by changes in ocean currents or increased discharge of fresh waters to ocean.

Within these various livelihood groups, producers at different points of the foodchain, e.g., fisher people versus fish cleaners, would have different vulnerabilities and access to coping mechanisms. Similarly, producers of different types of crops, e.g., crops for sale versus crops for home consumption, may face different risks and management options (e.g., access to irrigation water or seeds). Finally, gender and age differences affect the degree of risk faced by individuals within a vulnerable group.

Action to help members of these groups must secure their safety, accessibility to food and resources, and incomes at levels adequate for sustainable food security, now and in the

future. Actions include investing in infrastructure and promoting adoption of practices that will enable them to manage risk and assure the resilience of their existing livelihood systems, and aiding them to diversify their sources of income or change their livelihood strategies, including through migration if this is the best option.

5. Although the entire food system is a source of greenhouse gas emissions, the primary production component is by far the most important.

Greenhouse gas emissions from the food and agriculture sector contribute over one-third of the current annual total. These emissions include: release of greenhouse gases (mainly carbon dioxide) from conversion of forested area to other, primarily agricultural uses (deforestation) (18 percent), burning of crop residues after harvest (2 percent), other agricultural activity (1 percent) and use of fossil fuels as a source of energy for on-farm activity, food processing and packaging (2 percent); and release of methane and nitrous oxide from intensive livestock operations, irrigated rice paddies and application of synthetic fertilizers on cultivated land (13.5 percent). The livestock sector on its own accounts for 18 percent of total emissions, including over two-thirds of the total emissions attributable to deforestation and over one-third of total agricultural releases of methane and nitrous oxide.

6. In the food and agriculture sector, mitigation and adaptation often go hand in hand.

Mitigation of climate change involves actions to reduce greenhouse gas emissions and sequestering or storing carbon in the short-term and making development choices that will lead to low emissions in the long-term. *Adaptation to climate change* involves adjustments in natural or human systems and behaviours that reduce the risks posed by climate change to people's lives and livelihoods.

Best practices for mitigating climate change in the food and agriculture sector include:

1. *Reducing emissions of carbon dioxide and other greenhouse gases*, e.g., through reduction in the rate of land conversion, better control of wildfires, finding alternatives to the practice of burning crop residues after harvest, reduction of emissions from commercial fishing operations, and more efficient energy use by commercial agriculture and agro-industries
2. *Reducing emissions of methane and nitrous oxide*, e.g., through improving nutrition for ruminant livestock, more efficient management of livestock waste, more efficient management of irrigation water on rice paddies, more efficient management of applications of nitrogen fertilizer on cultivated fields and reclamation of treated municipal wastewater for aquifer recharge and irrigation
3. *Sequestering carbon*, e.g., through improving soil organic matter management with techniques such as conservation agriculture, involving permanent organic soil cover, minimum mechanical soil disturbance and crop rotation (also saves on fossil fuel usage); improved management of pastures and grazing practices on natural grasslands, including by optimizing stock numbers, rotational grazing; introduction of integrated agro-forestry systems that combine crops, grazing lands and trees in ecologically sustainable ways; use of degraded, marginal lands for productive planted forests or other cellulose biomass for alternative fuels; and carbon sink tree plantings.

Best practices for adapting to climate change in the food and agriculture sector include:

1. *Protecting local food supplies, assets and livelihoods against the effects of increasing weather variability and increased frequency and intensity of extreme*

events through risk management in general and for risks specific to different ecosystems (marine, coastal, inland water and floodplain, forest, dryland, island, mountain, polar, cultivated), through research and dissemination of crop varieties and breeds adapted to changing climatic conditions and through introduction of tree crops to provide food, fodder and energy and enhance cash income.

2. *Avoiding disruptions or declines in global and local food supplies due to changes in temperature and precipitation regimes* through more efficient agricultural water management in general, more efficient management of irrigation water on rice paddies, improved management of cultivated land, improved livestock management and use of new, more energy-efficient technologies by agro-industries.
3. *Protecting ecosystems through provision of environmental services*, e.g., use of degraded or marginal lands for productive planted forests or other cellulose biomass for alternative fuels, CDM carbon sink tree plantings, watershed protection, prevention of land degradation, protection of coastal areas from cyclones and other coastal hazards, preservation of mangroves and their contribution to coastal fisheries, and biodiversity conservation.

7. Incentives are needed to persuade crop and livestock producers, agro-industries and ecosystem managers to adopt good practices for mitigating and adapting to climate change.

Practices that constitute adaptive responses to climate change have been advocated since the Rio Earth Summit as *good practices for sustainable management of forests, grasslands, fisheries, livestock and arable croplands*. However, incentives to make their adoption attractive are often lacking. These can take several forms, including information, technology transfer and regulations as well as both positive and negative monetary incentives, including polluter and user pays principles, getting rid of perverse incentives that exist (e.g. subsidies), and the like.

One relatively new incentive mechanisms is *payments for environmental services* where farmers and communities are compensated for the climate change mitigation benefits they generate through changes in upper watershed management, management of protected areas, rehabilitation and sustainable management of grasslands, and reforestation and afforestation. These payments could potentially also increase adaptation capacity, since many locations where better ecosystem management and use of more sustainable food production practices are most needed are often those where current livelihood systems are most vulnerable to increasing climate variability as a consequence of climate change. If well designed, such payments could increase the capacity of food producers to insure against risk by diversifying income sources, and also potentially increase employment opportunities for women and youth. Also, as their income source would be more secure, they could be more inclined to invest in inputs, such as tools needed for adapted land management practices. This increased demand would in turn inspire the private-sector input-supply chain to make the required equipments and inputs available in the local markets.

Adaptation to climate change necessitates substantial changes in policies and investment decisions. *Certified Emissions Reduction (CER) trading* is permitted by the Kyoto Protocol and is an instrument that can be used as an incentive for investment in mitigation. However, CER certification methodologies are not yet well-developed and this has limited development of projects in the agriculture sector for funding under the *Clean*

Development Mechanism (CDM).

Changes in variability of the prevailing weather conditions and the corresponding *shortening of available time windows for field work*, be it for land preparation, weeding, pest management or harvest, would invariably result in higher demand for human labour, animal traction or mechanized farm power to carry out the respective work in a shorter available timeframe. They also require a higher degree of flexibility to get into operation as soon as the weather conditions permit. In mechanized farming systems, shorter time windows results in increasing machinery investments. Where this is not possible, untimely operations would result in yield reductions and eventually in complete crop failure or harvest loss. Where there is a shift from labour to mechanisation, people whose livelihoods depended on employment, can lose their livelihoods and consequently reduce their access to food.

8. Promoting agro-biodiversity is crucial for local adaptation and resilience.

Biodiversity in all its manifestations, e.g., genes, species, ecosystems, increases resilience to changing environmental conditions and stresses. Genetically diverse populations and species-rich ecosystems have greater potential to adapt to climate change. FAO promotes the use of indigenous and locally adapted diversity of plants and animals as well as the selection and multiplication of crop varieties and autochthonous races adapted or resistant to adverse conditions.

Effective use of genetic resources can reduce negative effects of climate change on agricultural production and farmer livelihoods. Moreover, as it is women who are traditionally the carriers of local knowledge about the properties and uses of wild plants and the keepers of seeds for cultivated varieties, they have an important role to play in protecting biodiversity. Providing appropriate compensation for this service could guarantee a sustainable livelihood to these women, many of whom belong to vulnerable and food insecure groups.

Breeding plants and animals for tolerance to drought, heat stress, salinity and flooding will also become increasingly important. FAO is actively promoting rebuilding of national capacities in developing countries to breed such crops, especially those that are not being attended to by the private sector. The Global Partnership Initiative for Plant Breeding Capacity Building (GIPB), facilitated by FAO, was launched on the margins of the first Governing Body Meeting of the International Treaty on Plant Genetic Resources and intends to contribute to Article 6 of the Treaty with respect to sustainable use of plant genetic resources.

9. Raised productivity from improved agricultural water management will be key to ensure global food supply and global food security.

With respect to agricultural water management, increasing water scarcity and changes in the geographic distribution of available water as a result of climate change pose serious risks for irrigated agricultural production globally. With a more variable climate and as a result of less reliable weather patterns it will be essential to increase the water storage capacity for agriculture in order to maintain global food supplies while also satisfying other competing uses for agricultural water. Looking ahead to 2030, irrigated areas will come under increasing pressure to raise productivity with respect to water, both to buffer the more volatile rainfed production (and maintain national production) and also to respond to declining levels of this vital renewable resource. This risk will need to be managed by progressively adjusting the operation of large scale irrigation and drainage

systems to ensure higher cropping intensities and start closing gaps between actual and potential yields.

Key adjustments for maintaining cropped areas include:

- optimising operational storage, i.e., manageable water resources such as water stored behind a dam,
- controlling releases to obtain better hydraulic performance and salinity control,
- optimising crop water productivity.

Allocations and releases of water to agriculture across river basins are a pre-requisite for improved operational performance. Well targeted investments in small scale water control facilities and the upgrading of larger scale facilities, together with associated institutional reforms, will pay off in the medium term. Other strategies that can be used to increase water productivity directly or that have indirect water-saving benefits include:

- reducing soil evaporation through adoption of conservation agriculture practices,
- planting more water-efficient crop varieties,
- enhancing soil fertility to increase yields per unit of water utilized,
- decreasing runoff from cultivated land, reducing crop water requirements through micro-climatic changes, and
- reusing wastewater for agricultural purposes.

Finally, in the longer term, a transition toward more precision irrigated agriculture in water stressed areas needs to be anticipated. As specialized tools and equipment are a pre-requisite for conservation agriculture and precision irrigated agriculture and subsequently for the improved water productivity, incentives are needed to allow the demand for these inputs to materialise where expansion of commercial agriculture is desirable.

10. Conservation agriculture can make a significant difference for efficiency of water use, soil quality, capacity to withstand extreme events and carbon sequestration.

The conversion of natural systems to cultivated agriculture, using conventional methods, results in loss of soil organic carbon on the order of 20-50 percent compared to the pre-cultivation amount. It is now proven that *non-conventional practices such as conservation agriculture help in improving soil quality and raising soil organic carbon levels*. A global application of zero-till methods to all cultivated land could theoretically result in a total yearly sequestration of up to 3 billion tonnes of carbon per year, for about 30 years. This is nearly the equivalent of the annual net increase in atmospheric carbon dioxide of anthropogenic origin that we are currently experiencing. While carbon sequestration is not a substitute for action to permanently lower emissions, it can help buy time for the necessary transformations to occur.

11. Sustainable livestock management practices for adaptation and associated mitigation should be given high priority.

Land use by the livestock sector, including grazing land and cropland dedicated to the production of feed, represents approximately 70 percent of all agricultural land in the world. Moreover, current prices of land, water and feed do not reflect true scarcities, leading to overuse of resources and major inefficiencies in the livestock sector. Full-cost pricing of inputs and widespread adoption of *improved land management practices by both intensive and extensive livestock producers* would help to resolve the balance between competing demands for animal food products and environmental services in more sustainable ways.

Overgrazing is the greatest cause of degradation of grasslands and the overriding human-

influenced factor in determining their soil carbon levels. Consequently, in many systems, *improved grazing management*, such as optimizing stock numbers and rotational grazing will result in substantial increases in carbon pools. Improved pasture management and integrated agro-forestry systems that combine crops, grazing lands and trees in ecologically sustainable ways are also effective ways to conserve the environment and mitigate climate change, while at the same time providing more diversified and secure livelihoods for inhabitants.

Digestive processes and wastes from ruminant livestock that eat a great deal of fibrous material are an important source of methane, especially in intensive production units where large numbers of animals are concentrated in a relatively small space. *Providing a more balanced diet* that is not too high in roughage can simultaneously improve productivity and reduce emissions of methane from each animal. *Management of manure* so as to avoid build-up and release of methane is also important: various techniques that are efficient and economically feasible exist that could be more widely applied. *Improving feed conversion ratios* in order to limit expansion of area used for feed crops also bears substantial mitigation potential. Finally, *more efficient management of irrigation water on rice paddies and of nitrogen fertilizer applications on cultivated fields* can reduce emissions of both methane and nitrous oxide.

12. Fishing and aquatic food production offer sustainable livelihood opportunities for people living by seacoasts, rivers and lakes, but these livelihoods are threatened by climate change.

Some 200 million people and their dependents worldwide, most of them in developing countries, live by fishing and aquaculture. Fish provide an important source of cash income for many poor households and are a widely traded food commodity. In addition to stimulating local market economies fish can be an important source of foreign exchange. Fishing is frequently integral to mixed livelihood strategies, in which people take advantage of seasonal stock availability or resort to fishing when other forms of food production and income generation fall short. Fishing often is related to extreme poverty and may serve as a vital safety net for people with limited livelihood alternatives and extreme vulnerability to changes in their environment. However, the *viability of fishing as a sustainable livelihood is threatened by climate change*.

Fishing communities that depend on inland fisheries resources are likely to be particularly vulnerable to climate change; accessibility to water resources and arrangements with other sectors for sharing and re-use will become a key to future sustainability. Climate change is also likely to have substantial and far-reaching impacts on coastal fisheries and fishing communities. Major physical impacts of climate change to the marine system will be changes in ocean currents, a rise in average temperature, sharpening of various gradient structures and large and rapid increase of freshwater discharge which often trigger an increase in chemical nutrients, typically compounds containing nitrogen or phosphorus, resulting in lack of oxygen and severe reductions in water quality and in fish and other animal populations (eutrophication). Biological responses to these changes are expected to be ratchet-like, i.e. once a threshold is reached, things shift from one phase to another. Fishing is essentially a “hunting” activity, so its success or failure is heavily dependent on the vagaries of nature. Climate change is creating more anomalies, both in failures and bonanzas, among multiple species, as well as a drastic shift in the areas where small, migrating fish are found. Finally, coastal peoples and communities that depend on fishing in locations where relocation is inevitable due to a rise of sea level will require extra

support, as they must not only migrate, but in many instances must also find new, unfamiliar ways to earn a living.

13. Meeting growing demand for bioenergy should not undermine food security.

Demand for bioenergy has been growing because of the rising cost of petroleum and the mitigation benefits of reducing reliance on fossil fuels. Biofuel crops have potential for large-scale production, but production and processing of these crops requires fossil fuel inputs. Hence their use will only contribute to climate change mitigation if the fossil fuel savings exceed the amount used. Moreover, regardless of mitigation potential, most sources of liquid biofuels are currently not commercially viable without subsidies, mandates and/or tariffs. If subsidised production of biofuel from field crops becomes an important factor in global agricultural markets, this will create additional competition for land and water, putting upward pressure on food prices and increasing the risk of continued deforestation and other adverse environmental consequences.

So-called “*second generation biofuels*,” which rely on biomass from woody matter and crop residues rather than cultivated crops, may be more efficient and create less competition for scarce land and water resources, although competition with grass based livestock systems may occur locally. Over the last few years there has been marked acceleration in the development of economically feasible technologies for the production of ethanol from wood chips and other non-food plant life (cellulosic ethanol), and the technologies are now being commercialized in the US, Canada, Brazil, Europe and Japan.

Planted forests account represent only 7 percent of global forest cover, but they account for over half of global industrial roundwood production. There is significant potential for further expansion of planted forests on marginal lands or lands released from crop or livestock production. Increasingly, *sustainable industrial roundwood for bioenergy use* will come from planted forests rather than native forests.

Less publicised, but equally important, is the *energy demand of both rural and urban poor*. In many parts of the developing world the poorest people use manure, twigs and low grade biomass for cooking and heating and nothing but human force in their productive activities. As they become less poor and move up economically, they switch to fuel wood moving progressively to charcoal, kerosene, gas and electricity and integrating animals and simple tools. At a certain level of development they will manage to integrate some level of mechanization, irrigation and fertilization that implies a switch to fossil fuels.

In both household and economic activities the “energy ladder” follows and influences the “economic ladder.” Attempts to alleviate hunger and to promote rural development and food security must be accompanied with efforts to promote the role of energy as a key component of those attempts. Many parts of the developing world are suffering from lack of adequate energy/farm power resources for agricultural and food production itself. Better management of biomass sources of fuel for household use is essential to reduce deforestation, control carbon dioxide releases, and address the energy poverty that constrains sustainable development in many parts of the world.

Although the debate about biofuel / food security tradeoffs has so far focused mainly on how to manage competing demands on scarce productive resources, it is equally important to focus on energy saving and efficient energy use that will contribute to reduced demand for energy, including bioenergy.

14. New patterns of pests and diseases will emerge, affecting plants, animals and humans alike and posing new risks for food security, food safety and human health.

Changes in vectors for climate-responsive pests and diseases and emergence of new diseases could impact both the food chain and people's physiological capacity to obtain necessary nutrients from the foods consumed. Vector changes are a virtual certainty for pests and diseases that flourish only at specific temperatures and under specific humidity and water irrigation management regimes. This will expose crops, livestock, fish and humans to new risks to which they have not yet adapted. Where such vector changes can be predicted, varieties and breeds that are resistant to the likely new arrivals can be introduced as an adaptive measure. A recent upsurge in the appearance of new viruses may also be climate-related, although this link is not certain. Viruses such as avian flu, ebola, HIV-AIDS and SARS have various implications for food security, including risk to the livelihoods of small-scale poultry operations in the case of avian flu and the extra nutritional requirements of affected persons in the case of HIV-AIDS, for example.

15. Learning to live with uncertainty is one way of adapting to climate change.

Although there is a solid scientific basis for global climate change projections, *reliable information* about how climate change will play out in specific locations is still largely lacking. Knowledge about the future will always be uncertain, but improving the science can help reduce the current high degree of uncertainty about potential local impacts of climate change. Other priorities include recognizing the need for decision-making in the face of uncertainty, bridging the gap between scientific and traditional perceptions of climate change and promoting adoption of practices that are consistent with the principles of the precautionary approach and adaptive management and that will strengthen resilience and sustainability of vulnerable livelihood systems.

Increasing weather-related losses are causing private sector insurers to restrict the types of natural disasters or catastrophic events that can be insured and it is not clear whether public sector safety net programmes will be able to pick up all of the slack. Since climate-related risks affect us all in one way or another, *innovative insurance schemes* such as a global re-insurance fund for climate change damage, or expanded local coverage of weather-based insurance are likely to be needed.

It is possible to reduce risks by mainstreaming *national risk management policy frameworks* in policies and programmes for sustainable development. These should include pre-event preparedness, risk mitigating strategies, reliable and timely early warning and response systems, and innovative risk financing instruments to spread residual risks. Critical public sector priorities are to address widening systemic risks that affect agricultural production and to support the private sector to develop insurance products for less severe events and for individual, independent farm risks.

16. Adopting an integrated strategic approach represents the best way forward.

Food security is the outcome of food system performance at global, national and local levels, and is often directly or indirectly dependent on *terrestrial and aquatic ecosystem services*, e.g., soil and water conservation, watershed management, combating land degradation, protection of coastal areas and mangroves, and biodiversity conservation.

Food and agriculture practices that would provide these services and/or reduce emissions or sequester carbon in developing countries represent good adaptation options for

vulnerable livelihood systems. However, adaptation is more than this. For DFID, “Adaptation is about reducing the risks posed by climate change to people’s lives and livelihoods.” In many instances, technological or institutional innovation may hold the key. Just as industrialization has speeded up the process of climate change, so too has it speeded up man’s capacity to innovate.

The IPCC has recognized the merit of an *integrated strategic approach* for responding to climate change, but since resources for mitigation and for adaptation are managed through different funding mechanisms, they are still treated separately on the international climate policy agenda of the UNFCCC/COP and its subsidiary bodies. Perhaps equally important are the current institutional frameworks built on sectoral lines. If the various ministries cannot work together, perhaps new, integrated institutional structures are needed. Using food security as an entry point for evaluating priorities for food system responses to the challenge of climate change may offer an opening for developing a more integrated approach.

17. Supporting those least likely to be able to adapt to climate change is the immediate challenge.

Climate change adaptation requires the use of good agricultural, forestry and fisheries practices to meet changing and more difficult environmental conditions, and the systematic introduction of improved risk management measures in all parts of the world where the impacts of climate change are expected to be felt, and where food security may be at increased risk. FAO can contribute to *climate change adaptation in a variety of ecosystems*, including agro-ecosystems (crops, livestock, grasslands), forests and woodlands, inland waters and coastal and marine ecosystems. There are numerous potential adaptation options available; FAO’s role is to codify these and help local people understand which ones are most applicable to their particular circumstances.

FAO works to build capacities at the national, local and community levels to raise awareness and prepare for climate change impacts. At the government level, the goal is to mainstream climate change strategies and actions in agricultural policies and programmes to reduce vulnerability and provide local communities with site-specific solutions. FAO provides a neutral forum for sharing information about best practices, holding technical discussions and facilitating negotiated solutions, should this be required. Ongoing activities with rural communities and research institutions provide practical information to countries through global data sets and assessments of scientific evidence, analytical tools and models, crop forecasting and impact monitoring and information dissemination on climate change-related risks. The ultimate goal is not to enforce a pre-selected mitigation practice or adaptation option on any impacted community or population group, but rather to inform and promote local dialogue about what the impacts of climate change are likely to be and what options exist for responding to it in ways that sustain livelihoods and reduce risk. Thus the final word on the relationship between climate change and food security will be written, not by FAO experts, but rather by the people themselves whose lives are most immediately affected and whose choices will determine whether their future will be more or less food secure.