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INTEGRATING CLIMATE CHANGE ADAPTATION AND MITIGATION FOR FOOD SECURITY AND SUSTAINABLE DEVELOPMENT IN THE REGION

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I. Introduction

1. The agricultural sectors, including crops, livestock, forestry and fisheries, are vulnerable to the impacts of climate change. Climate change alters the basic elements of agro-ecosystems, such as temperature, rainfall, land and water resources and biodiversity, and consequently affects global and regional food security, rural livelihoods and sustainable development. Various negative impacts have been observed and further projected in the Asia and Pacific region. South and Southeast Asia and the small Pacific Island Countries will be the most affected.

2. Agriculture, forestry and land-use change (AFOLU) are also major contributors to greenhouse gas (GHG) emissions. Opportunities exist in AFOLU for climate change mitigation through increasing carbon sequestration and reducing GHG emissions. Asia contributes to a large portion of global GHG emissions from agricultural production. At the same time, it offers significant potential for climate change mitigation in agriculture. Efforts are needed to mitigate the negative impacts of climate change and realize this mitigation potential.

3. The multiple requirements faced in the agricultural sectors call for a holistic approach and suitable policy, institutional and technical innovations to capture the synergies and manage the trade-offs among climate change adaptation, mitigation, food security and sustainable development. Special attention should be paid to assisting smallholder farmers and supporting the most vulnerable groups.

4. Some key issues need to be properly addressed for strengthening climate change adaptation and mitigation in the agricultural sectors, including climate change negotiation, financing mechanisms, proper governance, information and technology, capacity building and regional cooperation. Sound initiatives have been taken by member countries. FAO, in cooperation with the international community, member governments and other partners, has been working actively at global, regional and national levels. Still much more needs to be done.

5. This paper reviews the impacts of climate change and their implications for food security and sustainable development in the Asia and the Pacific region; analyses opportunities and options for climate change adaptation and mitigation in the agricultural sectors; discusses major policy, institutional and technical issues to be addressed; presents global and regional initiatives taken by FAO; and proposes recommendations for further actions.

II. The implications of climate change for food security and sustainable development

6. The world's agricultural sectors are facing multiple challenges. Out of the 6.4 billion total world population, the number of undernourished has recently reached 1 billion. To feed the projected world population of 9.1 billion by 2050, world food production will have to increase by 70 percent. Meanwhile, agriculture sectors are expected to continuously contribute to income generation, rural employment and economic development in many developing countries, especially in Least Developed Countries (LDCs), and provide livelihoods to 75 percent of the world's poor without degrading or depleting natural resources, the environment and ecosystems.[1]

7. Asia and the Pacific is the home to the largest concentration of the world's undernourished and the poor. Around 642 million undernourished people, accounting for 63 percent of the world's total undernourished population, and two thirds of the world's poor live, in

[1] Feeding the world in 2050, FAO, 2009.

this region.[2] More than 60 percent of the economically active population and their dependents in the region – 2.2 billion people – rely on agricultural sectors for their livelihood.[3] Faced with increased competition for nature resources and accelerated degradation of the environment and ecosystems – in a context where the population in the region is expected to grow by another 1.5 billion people by 2050 – food security and sustainable development are and will continue to be major concerns. Climate change has compounded the challenges.

8. The impacts of climate change in Asia have been observed in a number of locations including: North Asia, where an increase in surface air temperature is more pronounced; inter-seasonal, inter-annual and spatial variability in rainfall trends all across Asia; and an increasing intensity and frequency of extreme weather events, especially in Southeast Asia. Crop yields in many countries have declined, partly due to rising temperatures and extreme weather events. The retreat of glaciers and permafrost in recent years is a clear consequence of warming. The frequency of climate-induced diseases and heat stress in East, South and Southeast Asia has increased with rising temperatures and rainfall variability. Changes in terrestrial and marine ecosystems have become more pronounced.[4]

9. Future trends of climate change in Asia have been projected in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), including: acceleration of warming; rising sea levels and melting of glaciers; increase in annual precipitation in most areas during this century, with decreased summer precipitation in West and Central Asia, and decreased precipitation in South Asia from December to February; increase in occurrence of extreme weather events including heat waves and intense precipitation events in South, East and Southeast Asia. These will have significant implications for crop, livestock, fishery and forestry sectors, and consequently for regional food security and sustainable development.

10. **Crops and livestock** Freshwater availability in Central, South, East and Southeast Asia is likely to decrease. Agricultural irrigation water requires a substantial increase for sustained productivity in arid, semi-arid Asia and South and East Asia. Land suitable for crop cultivation is expected to increase in East and Central Asia, but decrease in other areas, especially in South Asia. Climate change is also expected to affect the patterns of pests, diseases and weeds. A 2.5-10 percent decrease in crop yield is projected for parts of Asia in the 2020s, and a 5-30 percent decrease in 2050s, compared with 1990 levels, without considering the fertilization effects of carbon dioxide (CO_2). The natural grassland coverage, grass yields and milk yields in animals are projected to decline.[5]

11. **Fisheries and aquaculture** Sea-water intrusion is likely to increase the habitat of brackish water fisheries, but coastal inundation is likely to seriously affect the aquaculture industry and infrastructure, particularly in heavily populated mega deltas. Fisheries at higher elevations are likely to be adversely affected by lower availability of oxygen, due to a rise in surface air temperatures. Changes in oceanic circulation in a warmer atmosphere could reduce primary production in the tropical oceans. Increased frequency of El Niño events could cause a general decline in fishery production in the coastal waters of East, South and Southeast Asia. Changes in rainfall patterns in the plains could also affect aquaculture and cause migration of fish species.

12. **Forestry and biodiversity** Climate change is likely to affect forest expansion and migration, and exacerbate threats to biodiversity resulting from land use, land cover change and

[2] The State of food insecurity in the world, FAO, 2009.

[3] Building climate resilience in the agriculture sector of Asia and the Pacific, ADB, 2009.

[4] Cruz, R.V., H. Harasawa, M. Lal, S. Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafari, C. Li and N. Huu Ninh, 2007: Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

[5] Ibid.

population pressure in most of Asia. As a result of the synergistic effects of climate change and habitat fragmentation, the risk of extinction for many flora and fauna species in Asia is likely to increase. In North Asia, forest growth and a northward shift in the extent of boreal forest is likely. The frequency and extent of forest fires and the risks of invasive species, pests and diseases in Asian forests are likely to increase due to climate change.

13. **Food security** Although projections of climate change impacts on agriculture and food production vary across different emission scenarios, general consensus has been reached that while certain areas within specific sectors may gain benefits, food production in most of the region will be negatively affected, especially in South Asia. The effect of climate change will also go beyond food production to affect all elements of food security. Under the A2 scenario (a divided world with continuously increasing population; regionally oriented economic development; and slower and more fragmented technological changes and improvements to per capita income) without carbon fertilization, an additional 49 million, 132 million and 266 million people in Asia could be at risk of hunger by 2020, 2050 and 2080, respectively. [6]

14. **Environment and ecosystems** Accelerated glacier melting is likely to increase the number and severity of glacial melting-related floods, increase slope destabilisation and decrease river flows as glaciers recede. Freshwater availability in Central, South, East and Southeast Asia, particularly in large river basins such as Changjiang, is likely to decrease due to climate change, along with population growth and rising standards of living that could adversely affect more than a billion people by the 2050s. Projected sea-level rise is very likely to result in significant losses of coastal ecosystems, and a million or so people along the coasts of South and Southeast Asia will likely be at risk from flooding. Saltwater intrusion in estuaries due to decreasing river runoff can be pushed 10 to 20 km further inland by the rising sea level. The stability of wetlands, mangroves and coral reefs around Asia is likely to be increasingly threatened. Between 24 and 30 percent of the coral reefs in Asia are likely to be lost during the next 10 years and 30 years, respectively. [7]

15. Climate change is likely to exacerbate pressures on natural resources and the environment caused by the impact of rapid population growth, urbanization, industrialization and economic development. The compounded effects will ultimately impact sustainable development of most developing countries. Vulnerability to climate change varies across different geographic areas and social groups. Least developed countries and small island countries will be the most vulnerable. Smallholder farmers, forest dwellers, herders and fishers who live in fragile areas with limited access to natural resources and adaptation capacity will be the most affected.

16. The Hindu Kush Himalayas deserve special attention as they are the source of the nine largest rivers in Asia, providing water to more than 1.3 billion people and also home to some of the world's poorest groups. The projected temperature rise, glacier melting and hydrological cycle alterations will reduce crop production, impact livestock production and change land use patterns. The megadeltas in the Asian coastal zones with large populations and intensified socio-economic activities are highly vulnerable. For a 1 meter rise in sea level, half a million hectares of Red River delta and from 15 000 to 20 000 km^2 of Mekong River delta is projected to be flooded. In addition, 2 500 km^2 of mangrove will be completely lost, while approximately 1 000 km^2 of cultivated farm land and sea product culturing areas will become salt marshes. Coastal erosion of the major deltas is also projected due to a rise in the sea level, intensifying storm surges, and excessive pumping of groundwater for irrigation and reservoir construction upstream. [8]

17. In the Pacific Island Countries, climate change impacts include rising ocean levels, ocean warming and acidification, changing precipitation patterns, changing sunshine hours and cloud

[6] Ibid.

[7] Ibid.

[8] Ibid.

cover, altered ocean and atmosphere circulation patterns. Extreme weather events will act as "threat multipliers", causing land and marine ecosystem degradation, salinization of soils and water resources, proliferation of plant diseases, pests and invasive species, increased frequency of fires, and sea water inundation of low-lying arable land. These are likely to bring challenges to food security and sustainable development.[9]

III. Integrating climate change adaptation and mitigation in the agricultural sectors

A. ADAPTING AGRICULTURAL SECTORS TO CLIMATE CHANGE

18. Opportunities exist in agricultural sectors for mitigating the negative impacts of climate change and promoting the positive ones through proper adaptation. Practices derived from sustainable agriculture, forestry, fisheries and natural resource management can often serve as good adaptation options. Indigenous knowledge of farmers, forest dwellers and fishers for adapting to seasonal and annual climate variability – including better crop and fish varieties, farming systems, soil, nutrient and water management, forest fire management and agro-forestry systems – can be good entry points for localized adaptation.

19. In view of the speed and magnitude of climate change, indigenous adaptation practices need to be complemented by scientific know-how. Pro-active and anticipatory adaptation approaches should be taken that address the short-term impacts of increasing climate variability but also help local communities prepare for the long-term impacts, which may emerge gradually or arrive abruptly when certain thresholds are reached. When localized projections of climate change impacts are not available, "no-regrets" options – adaptive practices and actions that will be beneficial even if future impacts are not certain and climate change threats do not occur exactly as anticipated – can be adopted.

20. Summarized good practices include: (i) changing agricultural practices, such as land use and management, agriculture input use, crop and livestock varieties and planting dates; (ii) improving agriculture water management, such as integrated water resources management; proper planning, design, construction and management of irrigation systems; water harvesting systems; and on-farm water management; (iii) diversifying agricultural practices among crops, within and beyond agricultural sectors; and (iv) developing technologies for improving agricultural productivity, enabling sustainable land and water resources management, and increasing the flexibility of cropping systems.

21. The probability of significant adverse impacts of climate change on Asian forests is high in the next few decades. Improvement of tree plantation and reforestation, and protection from fires, insects and diseases could enhance adaptation and reduce vulnerability of most forests in Asia to climate change and variability. Comprehensive inter-sectoral programmes that combine measures to control deforestation and forest degradation with measures to increase agricultural productivity and sustainability are likely to contribute more to reducing the vulnerability of forests. Other likely effective measures include extending rotation cycles, reducing damage to remaining trees and reducing logging waste.

22. Changes in management philosophy could also enhance adaptive capacity. This is illustrated by integrated coastal zone management (ICZM), which is being embraced as a central organizing concept in the management of fisheries, aquaculture, coral reefs, pollution, megacities and individual coastal systems. The ICZM concept aims at maximizing the coastal zone benefits and minimizing the conflicts and harmful effects of activities on social, cultural and environmental resources. It offers good chances for sustainable management of coastal zones in

[9] Climate change and food security in Pacific island countries, FAO, 2008.

East, South and Southeast Asia and for improvement of adaptation capacity of local small communities to sea-level rise.

23. Asia and the Pacific is the region most hit by natural disasters, especially water-related disasters. Climate change will further increase their frequency and intensity. The risks of local and trans-boundary plant and animal diseases may also increase. In view of the uncertainty of climate change projections, sustainable natural resource management and pro-active disaster risk management can be a good approach/entry-point, although it will require improved infrastructure systems and structural measures: proper weather and climate monitoring and forecasting systems in different time-scales and models; reliable and timely early warning systems; effective emergency response capacity; and effective social safety nets, including innovative risk financing instruments and insurance schemes to spread residual risks.

24. Biodiversity (including genetic resources) conservation and protection of fragile ecosystems in arid, semi-arid, mountain and grazing land areas are also important in this region. These can be achieved through increasing understanding of the biodiversity and ecosystem services; monitoring of regional and local ecosystem status and biodiversity trends; identifying associated impacts of climate change; incorporating suitable responses into national agriculture, forestry, fisheries, land and water strategies; and adopting adaptive and sustainable natural resource management in agricultural production.

B. MITIGATING CLIMATE CHANGE IN AGRICULTURAL SECTORS

25. Together, the agricultural sectors account for about one third of global GHG emissions. Agriculture, including crops and livestock, is responsible for 13.5 percent, mainly in the form of methane (CH_4) and nitrous oxide (N_2O) from fertilized soils, enteric fermentation, biomass burning, rice production, and manure and fertilizer production. Land-use change and forestry are responsible for 17.4 percent, mainly through deforestation. Fisheries are responsible for 0.1 percent. About three fourths of total emissions from agriculture and land use originate in developing countries. Conversion of rangelands and forests to croplands is a major cause of emissions.[10]

26. Technical potential for mitigating GHG emissions in forestry is estimated to average 1.5 GtC eqv./yr until 2050, which is equal to about 64 percent of the sector's emissions. Agriculture has a technical potential of 1.5-1.6 GtC eqv./yr by 2030, which equals about 83-91 percent of the sector's emissions. About 70 percent of mitigation potential in the agricultural sectors exists in developing countries.[11] Without significant contributions from agriculture sectors, it will be difficult to reach the target of cutting global GHG emissions by at least 50 percent from 1990s levels.

27. Asia accounts for 37 percent of global CH_4 and N_2O emissions from the agriculture sector. South and East Asia contribute 82 percent of global CH_4 emissions from rice. East Asia is projected to show large increases in GHG emissions from animal sources. In South Asia, agriculture emissions are increasing mostly because of expanding use of N fertilizers and manure to meet demands for food, resulting from rapid population growth. Up to 50 percent of the global technical potential of agriculture mitigation could be realized in Asia by reducing emissions, avoiding or displacing emissions, and removing emissions.[12]

[10] FAO profile for climate change, 2009.

[11] Ibid.

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

28. Reducing emissions can be realized through more efficient management of carbon and nitrogen flows. In the agriculture sectors, efficient feed use in livestock, technical changes in fertilization, manure management and rice farming can reduce CH_4 and N_2O emissions from livestock and crop production. In the forestry sector, reducing emissions from deforestation and forest degradation (REDD) would be one of the most cost-effective approaches. 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.

29. Avoiding or displacing emissions can be realized by improving and changing energy use in agricultural sectors. 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. Proper criteria should be established in bioenergy development to ensure food security, land and water resource sustainability, biodiversity and local livelihoods. Improving household energy systems can significantly reduce GHG emissions at a relatively low cost. Forest conservation activities can help to avoid carbon emissions. Many materials can be substituted by wood products, which store carbon and thus displace emissions.

30. Removing emissions can be realized by soil carbon sequestration above and below the ground, which globally accounts for 89 percent of agriculture's technical mitigation potential.[13] In the crop and livestock sectors, improved cropland and grazing land management, agroforestry and the rehabilitation of degraded lands are good practices. For example, reduced or no-till agriculture in association with diversified cropping patterns and increased soil cover limits soil disturbance and increases soil carbon. In the forestry sector, 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.

C. CAPTURING THE SYNERGIES AMONG CLIMATE CHANGE ADAPTATION, MITIGATION, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

31. Adaptation enables agricultural systems to be more resilient to the consequences of climate change. It is closely linked to food security, livelihoods and sustainable development. Mitigation addresses the root causes, thereby limiting over time the extent and cost of adaptation. It is related to international obligations, and must make economic sense at farm level to be realized. Mitigation and adaptation in the agricultural sectors should therefore go hand in hand and be an integral part of regional and national strategies for food security and sustainable development. A number of agricultural practices can do both. Others may involve trade-offs, some of which can be managed.

32. The IPCC 4th Assessment Report identified four main categories of terrestrial mitigation options: improved cropland management; improved grassland management; restoration of degraded land; and restoration of organic soils. Within these main categories, many options are often the same as those needed to increase productivity, food security and adaptation, such as restoring degraded agricultural land and grasslands with a high production potential, agriculture water management and agro-forestry. The following are some examples of these good practices.

33. **Restoration of degraded lands** The carbon storage potential of eroded and degraded soils can be restored by practices such as re-planting, use of nutrient supplements, manures and composts, conservation agriculture, soil and water conservation and more adapted cropping systems. These practices also support adaptation and provide other important benefits such as: increasing crop yields and income; reducing financial risk by using local inputs; and increasing resistance to pests and crop diseases through improved soil fertility. Forest restoration,

[13] Food security and agricultural mitigation in developing countries: options for capturing synergies, FAO, 2010.

reforestation and tree planting could be a means for increasing yields of forest products and improving associated livelihoods while restoring degraded lands.

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

35. **Improved rice cultivation** Rice is the staple food and widely grown in Asia. It is also a significant contributor of CH_4 emissions. Study shows that combined options of high-yielding varieties, improved fertilizer use, shifting to rice-wheat production systems, alternating dry-wet irrigation, and utilizing crop residues for renewable energy can reduce GHG emissions while building resilience by conserving water, reducing land requirements and reducing fossil-fuel use.

36. **Agriculture water management** Asia and the Pacific is the region most heavily hit by water disasters. Climate change will worsen the situation. Good practices in agriculture water management include irrigation modernization, water-saving irrigation, water harvesting and on-farm water management. While building climate resilience in the agricultural sectors, improved water management also reduces CH_4 and N_2O emissions from irrigated crop production, and increases carbon sequestration by supporting crop land, grazing land, and peat land management.

37. **Aquaculture**. 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 the number of cultured species, and providing new opportunities for marine farming arising from sea encroachment on coastal lands. Integrated agriculture-aquaculture systems can use water resources more efficiently. Meanwhile, compared to other sources of animal protein, such as meat and milk, aquaculture provides nutritious food with a low carbon footprint.

38. **Agro-forestry** While increasing farmers' resilience to climate change and improving food security and rural livelihoods, agro-forestry systems increase carbon storage and may also reduce soil carbon losses stemming from erosion. Options include combining crops with trees for timber, firewood, fodder and other products, and establishing shelter belts and riparian zones/buffer strips with woody species.

39. **Biogas** Produced through the anaerobic digestion of animal dung, biogas has been implemented at the household and village levels in China, India, Nepal and Viet Nam to generate cooking fuel and electricity. Biogas production improves indoor air quality and livelihoods; decreases the strain on scarce resources; saves women's labour time; and provides organic fertilizer.

40. Many of these options are cost-effective and suitable to smallholder farming in developing countries, and should be given high priority for scaling up. The overall challenge is to find an efficient mix of mitigation and adaptation solutions that can capture the synergies and manage the trade-offs, and integrate them into strategies and programmes for food security and sustainable development at different levels.

41. Asia and the Pacific region presents a diversified agroecological and socioeconomic context. There is no "one size fits all" solution in climate change adaptation and mitigation in agricultural sectors. Strategies must be holistic to embody all sectors; comprehensive to integrate technical options with policy, institutional and financing innovations; and tailored to the local agro-ecosystem. Indigenous approaches need to be complemented with scientific know-how.

IV. FAO's work in climate change adaptation and mitigation in the agricultural sectors

42. Various initiatives have been taken by the international community, regional and sub-regional bodies, government departments, academic institutions, non-governmental organizations and the private sector on climate change adaptation and mitigation in the agricultural sectors in the region. FAO, in cooperation with member governments, rural communities and other concerned partners, has been working on a broad range of climate change issues which cut across all levels, producing knowledge, providing policy advice and building capacities to support necessary adaptation and mitigation measures.

A. WORK AT INTERNATIONAL LEVEL

43. FAO actively supports the United Nations Framework Convention on Climate Change (UNFCCC) in highlighting the important role of the agriculture and related sectors for climate change. In addition, FAO:

- provides technical support to the climate change negotiations, taking into account the specific needs of developing countries;
- supports and contributes to 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;
- 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; and
- facilitates the integration of climate change into food security, agriculture, forestry and fisheries policies

FAO also fosters interaction and coherence among the different conventions, treaties and bodies.

44. Important global events related to climate change have been convened, including: the 2008 High-Level Conference on World Food Security: the challenges of climate change and bioenergy; and the 2009 World Summit on Food Security. FAO has also issued relevant strategy and policy papers, including *FAO Profile for Climate Change* (2009), *Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies* (2009), *Climate change Implications for Fisheries and Aquaculture* (2009), *Climate Change and Food Security: A Framework Document* (2007) and *Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities* (2007).

45. Some core principals have been advocated and followed in FAO's work, including: integrating climate change issues into food security and development planning across all sectors and spatio-temporal scales; seeking a system approach that builds on synergies in mitigation, adaptation and sustainable food production; working in a demand-driven, local-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; and promoting synergies between international conventions and agreements on climate change, desertification, biodiversity and forestry.

B. WORK AT REGIONAL AND SUB-REGIONAL LEVELS

46. In Asia and the Pacific region and its sub-regions, FAO works to increase awareness of the impacts of climate change and catalyse regional and sub-regional cooperation, capacity building and knowledge sharing on adaptation and mitigation. FAO also supports countries in harmonizing policies, programmes, strategies and regulatory frameworks for addressing climate change in agriculture, forestry and fisheries, and in integrating climate change into regional and sub-regional programmes for food security.

47. Specifically, FAO has:

- co-sponsored the International Symposium on Climate Change and Food Security in South Asia (2008);
- formulated the documents on *Climate Change and Food Security in Pacific Island Countries* (2007);
- disseminated knowledge and tools for trans-boundary pest and diseases control;
- worked on addressing water scarcity by providing policy and technical assistance and capacity building on irrigation modernization and agriculture water management;
- promoted conservation farming, integrated pest management (IPM), sustainable forestry management, responsible fishery and biodiversity conservation; and
- provided policy and technical supports to the South Asian Association for Regional Cooperation (SAARC), the Association of Southeast Asia Nations (ASEAN) and the Mekong River Commission (MRC) on climate change and food security.

48. FAO has advised regional technical commissions, such as the Asia-Pacific Forestry Commission (APFC), in putting climate change considerations onto their agenda; and is coordinating an APFC-recommended review of forestry and climate change issues and priorities for the region. Relevant regional programmes and projects have been implemented and are under implementation, including the Global Environment Facility-funded project on livestock waste management in Southeast Asia; the FAO Technical Cooperation Programme project on linking communities to voluntary carbon markets in forestry; the Germany-funded project on bioenergy and food security in Thailand and Cambodia; the European Commission-funded project on linking information and decision making to improve food security in the Lower Mekong Basin (LMB) countries; and the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD).

49. In view of the ever-increasing demands from the region over the past few years, FAO's Regional Office for Asia and the Pacific has identified climate change adaptation and mitigation in agriculture and nature resources management as one of the five priority areas in its Regional Priority Framework 2010-2019; established an internal multidisciplinary team – Climate Change Working Group – comprised of technical staff from all concerned technical areas; and formulated a specific Unit Result and relevant work plan under the framework of FAO work and budget plan for 2010-2011 biennium.

C. WORK AT NATIONAL AND LOCAL LEVELS

50. FAO provides technical support for the formulation and implementation of National Adaptation Programmes of Action (NAPA) and National Appropriate Mitigation Actions (NAMA) as well as national strategies for REDD; 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; and implements a wide range of global, regional and national programmes and projects on climate change adaptation, mitigation and disaster risk reduction at national and sub-national levels.

51. Specific programmes and projects implemented and under implementation in this region include: the FAO TCP projects on disaster risk management and community livelihood adaptation in China, Nepal and Philippines; the Spanish-funded UN joint programme on national climate change adaptation strategy in China; the UNDP trust fund project on climate change adaptation in Bangladesh; the One UN project on enhancing coordinated and integrated disaster risk reduction and climate change adaptation actions in Viet Nam; crop monitoring and yield forecasting in Pakistan and UN-REDD in Indonesia, Papua New Guinea and Viet Nam. Some new projects are being initiated in Cambodia, India, Thailand and Viet Nam.

52. UN-REDD is a collaborative initiative among FAO, UNDP and UNEP. It was launched in September 2008, with two overriding objectives: assisting developing countries to prepare for

participation in a future REDD mechanism; and supporting the development of guidance and standardized approaches based on sound science. It mainly addresses issues on monitoring, reporting and verification (MRV), stakeholder engagement, multiple benefits and a strong institutional framework including payment structures. It started in nine countries and aims to expand after the pilot phase. In the Asia Pacific region, Indonesia, Papua New Guinea and Viet Nam joined the programme at its outset; Bhutan, Bangladesh, Cambodia, Nepal, Solomon Islands and Sri Lanka are the new "observer" countries. Negotiations are underway to include emission reduction from improved agriculture activities into REDD-plus programmes.

V. Issues to be further addressed

53. To better realize the potential of the agricultural sectors in climate change adaptation and mitigation in the region, as well as to capture the synergies and manage the trade-offs, a number of key issues need to be further addressed.

54. **Data and information generation** Reliable data and information on climate change impacts and their local implications, as well as the emissions from different production systems and agro-ecological zones, are necessary for scientific planning and informed decision making. Due to various limitations, localized climate change data and information are often not available at national and local levels. Assessment of location specific risks and vulnerabilities and provision of need-based climate information to vulnerable communities helps to reduce the risks through better decisions. It is critical to further develop and disseminate user-friendly tools and methods; and to collect and analyse data and information on climate change impacts and GHG emissions from agricultural sectors.

55. **Science and technology development** To adapt the agricultural sectors to the expected impacts of climate change, further science and technology development is needed to breed new crop, plant and animal species; improve adaptive capacity of production and management systems; promote efficient use of agricultural inputs and wastes; and integrate them into typical farming systems and agro-ecological zones. To realize the mitigation potential in the agricultural sectors, further research on mitigation technologies relevant to Asian farming systems is needed; suitable MRV systems for application at both national and smallholder levels are important for monitoring commitments and developing carbon financing mechanisms.

56. **Financing mechanisms** UNFCCC estimates global annual adaptation costs in 2030 to be US$14 billion for agriculture, forestry and fisheries, and US$11 billion for the water sector. The average cost in Asia and the Pacific will be higher compared with other regions. Low or no-cost mitigation activities are available in this region, such as low- or no-tillage farming and reducing methane emissions from rice fields. Around 18 percent of global economic mitigation potential in agricultural sectors is found in Asia. Currently agriculture, specifically soil carbon sequestration, has been largely excluded from the main climate financing mechanisms. The limited available financing windows are mainly for mitigation. Innovative financing mechanisms are needed to include agriculture, reward synergistic actions, and address specific needs of smallholder farming.[14]

57. **Governance of adaptation and mitigation** Relevant policy and legislative frameworks need to be established to assign responsibilities within the governance structures. Land tenure and water-rights issues need to be better addressed to allow farmers to make necessary changes in land management and farming practices. To ensure the effectiveness of mitigation activities, a comprehensive land-use approach should be adopted to minimize leakage, i.e. displacing emissions between sectors and areas. A proper planning approach and mainstreaming procedure should be adopted to incorporate agricultural adaptation and mitigation into NAPA and NAMA, and mainstream them into agriculture and development plans.

[14] Building climate resilience in the agriculture sector of Asia and the Pacific, ADB, 2009.

58. **Agriculture in global climate change negotiations and UNFCCC processes** Currently, agriculture is not fully reflected in the global climate change negotiation text. It is also excluded from the main climate financing mechanisms. Although REDD-plus is recognized as a central issue in the Copenhagen Accord, the agriculture sector and food security are not mentioned. Some submissions from developing countries responding to the Copenhagen Accord on their mitigation actions specifically included agriculture; however, it is still far from being fully reflected.

59. **National and local capacities** Continuous national and local capacity building is needed to: upscale indigenous climate-proofing practices; disseminate updated information and technologies; and strengthen climate change monitoring and analysis, vulnerability assessment, strategy and policy formulation, institutional innovation, integrated planning, proper mainstreaming and implementation, and MRV of mitigation activities.

60. **Multidisciplinary and trans-boundary cooperation** Multidisciplinary teamwork needs to be further strengthened at all levels and areas. Stronger trans-boundary cooperation is vital in a number of issues, such as: climate change modelling and projection; trans-boundary water, forestry and marine resources management; trans-boundary crop, plant, and animal disease control; large-scale disaster and emergency control; and biodiversity conservation. Efforts are needed from all parties to advocate for sufficient inclusion of agricultural aspects in global climate change negotiation texts and financing mechanisms.

VI. Conclusions and recommendations

A. CONCLUSIONS

61. The region's agricultural sectors are vulnerable to climate change. South Asia, Southeast Asia and the Pacific Island Countries will be the most affected. It is possible to mitigate most of the negative impacts and promote the positive ones through changing agricultural practices, improving water management, diversifying agricultural activities, developing science and technologies, changing management philosophy and adopting an integrated disaster risk management approach.

62. Agricultural sectors are also major contributors to GHG emissions. Without a significant contribution from these sectors, it will not be possible to realize the global climate change mitigation target. Agricultural sectors offer high potential for climate change mitigation, mainly through carbon sequestration but also through reducing emissions. Possible options include improving cropland and grassland management, and restoring degraded land and organic soils.

63. Opportunities exist in agriculture sectors for capturing the synergies among climate change adaptation, mitigation, food security and sustainable development. Good practices include restoring degraded agricultural land and grassland, switching from bare to improved fallows, integrated nutrient and soil management, agriculture water management, agro-forestry, conservation farming, and waste and residue management. Many of these options are cost-effective and suitable to smallholder farming in developing countries.

64. FAO, in cooperation with member countries, rural communities and other concerned partners, has been working actively in climate change adaptation and mitigation in the agricultural sectors, mainly through supporting the formulation of strategy and action plans and their mainstreaming into agriculture and development planning; technology transfer and capacity building; field programme formulation and implementation; and advocating agricultural aspects in climate change negotiations.

65. To realize the potential of the agricultural sectors in climate change adaptation and mitigation, capture the synergies and manage the trade-offs, a number of key issues need to be further addressed, including: data and information generation, science and technology development, financing mechanisms, governance of adaptation and mitigation, inclusion of

agriculture in global climate change negotiations and UNFCCC processes, national and local capacities, and multidisciplinary and trans-boundary cooperation.

B. RECOMMENDATIONS

66. The conference may request FAO to further assist member countries in the following areas:

1. **Formulating and mainstreaming strategies and action plans,** including formulating a regional strategy on climate change adaptation and mitigation in agricultural sectors; providing advice on the formulation of relevant national strategies and action plans; assist in preparing risk management plans and contingency plans at decentralized levels (provinces and districts) and advocating and facilitating the mainstreaming of these strategies and action plans into agriculture, food security and development plans at different levels.

2. **Providing advice on policy, institutional and technical innovations** to member governments, sub-regional and regional bodies, agricultural commissions and committees and cooperation networks for integrating climate change adaptation and mitigation in agricultural sectors for food security and sustainable development.

3. **Assisting in technology development and dissemination,** especially summarizing and disseminating indigenous knowledge; identifying and piloting updated technologies in crop, livestock, forestry, fishery, land and water management and MRV for climate change adaptation and mitigation. Modern and low cost information and communication technologies (ICTs) could support connecting technology development, agriculture support services and end-users.

4. **Organizing capacity building** on the formulation and implementation of relevant strategies and policies, updated technologies and good practices for climate change adaptation and mitigation in the agricultural sectors at regional, sub-regional, national and local levels. Enhancing the technical capacity of agriculture service providers, local farmer/comunity networks, cooperatives and community based organisations (CBOs) on climate change adaptation is required to ensure sustainability.

5. **Formulating and implementing pilot programmes/projects** on climate change adaptation and mitigation in agricultural sectors at regional, sub-regional and country levels, such as the extension of UN-REDD.

6. **Supporting agricultural sectors in climate change negotiation,** especially advocating the inclusion of agriculture aspects in climate change negotiation texts; the creation of a work programme on agriculture within the climate change convention process; and the inclusion of agriculture and fisheries into financing and technology transfer mechanisms.

7. **Facilitating regional cooperation** through the establishment of regional cooperation networks, to strengthen awareness raising, policy dialogue, information exchange and sharing, technical cooperation and capacity building on climate change adaptation and mitigation in agricultural sectors.