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Item 2.2 of the Provisional Agenda

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Thirteenth Regular Session

Rome, 18 – 22 July 2011

CLIMATE CHANGE AND GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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I. INTRODUCTION

1. The Twelfth Regular Session of the Commission on Genetic Resources for Food and Agriculture (the Commission) recognized the need to address climate change in its Multi-Year Programme of Work. In this context, the Commission agreed to add to its Multi-Year Programme of Work an additional milestone, and requested FAO to prepare a scoping study on climate change and genetic resources for food and agriculture for consideration at its next regular session.[1]

2. The Secretariat commissioned a number of sector-specific studies addressing plant, animal, aquatic, forest, invertebrate and micro-organism genetic resources, which provided state of the art overviews of the impacts of climate change on genetic resources for food and agriculture and the potential use of genetic resources in mitigation and particularly adaptation strategies.[2] This document was prepared, drawing upon the sector-specific studies and other references, to assist the Commission in its consideration of arrangements and policies for climate change and genetic resources for food and agriculture. Expected changes in climatic parameters presented in the current document are largely based on the Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC).[3]

3. This document presents the possible elements of a roadmap to improve awareness of the roles and values of genetic resources in the context of climate change and to ensure genetic resources receive adequate consideration in international discussions and debates addressing climate change adaptation and mitigation policies and programmes. Advice from the Commission on the further development of this roadmap is sought.

II. CLIMATE CHANGE AND AGRICULTURE

International policy instruments

4. The United Nations Framework Convention on Climate Change (UNFCCC) is the primary instrument for discussing and debating issues and advancing long-term cooperative action to combat climate change. The role of agriculture is not prominent in the climate change debate. Genetic resources for food and agriculture have received little explicit consideration within the UNFCCC processes, and efforts to develop a work programme on agriculture within the Subsidiary Body on Science and Technology of the UNFCCC have not yet succeeded.[4]

5. The UNFCCC recognizes the important role of forests and other terrestrial and marine ecosystems in tackling climate change. Most efforts to date have focused on climate change mitigation activities, without explicit consideration of the roles of forest genetic resources or other genetic resources in mitigation and adaptation measures. Financing mechanisms for climate change do not recognize soil carbon sequestration, although from the agriculture point of view this provides promising potential for mitigation. Crop and livestock genetic diversity are not explicitly addressed, although many developing countries have indicated interest in mitigation and particularly adaptation activities that involve crop, livestock and fish/aquatic diversity, to enhance resilience to climate change. The role of aquatic genetic resources is not specifically addressed

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[1] CGRFA-12/09/Report paragraph 78.

[2] See documents, *Climate Change and its Effect on Conservation and Use of Plant Genetic Resources for Food and Agriculture and Associated Biodiversity for Food Security* (Thematic Background Study); *Climate change and animal genetic resources for food and agriculture - State of knowledge, risks and opportunities* (Background Study Paper No. 53); *Climate change and invertebrate genetic resources for food and agriculture: State of knowledge, risks and opportunities* (Background Study Paper No. 54); *Climate Change and Aquatic Genetic Resources for Food and Agriculture - State of knowledge, risks and opportunities* (Background Study Paper No. 55); *Climate Change and Forest Genetic Resources - State of knowledge, risks and opportunities*. (Background Study Paper No. 56); *Climate change and micro-organism genetic resources for food and agriculture: State of knowledge, risks and opportunities* (*Background Study Paper No. 57*).

[3] Climate Change 2007: Synthesis Report of the IPCC's 4th Assessment Report (AR4).

[4] CGRFA-13/11/Inf. 10.

under the UNFCCC, nor is the genetic diversity of micro-organisms and invertebrates.[5]

6. In October 2010, the Committee on World Food Security (CFS) requested that the High Level Panel of Experts for Food Security and Nutrition (HLPE) – an independent body of experts – undertake a study on climate change and food security. Specifically, the HLPE was asked to "review existing assessments and initiatives on the effects of climate change on food security and nutrition, with a focus on the most affected and vulnerable regions and populations and the interface between climate change and agricultural productivity, including the challenges and opportunities of adaptation and mitigation policies and actions for food security and nutrition."[6] It will report at the 37th Session of the CFS in October 2011.

7. In general, while understanding of the need to maintain genetic diversity in order to respond to ever-changing production conditions is understood within the agriculture sector, awareness of the roles and values of genetic resources in the context of climate change and the overall capacity of agriculture to respond to climate change needs to be enhanced, especially among those currently engaged in the climate change policy discussion and debate.

8. Lack of awareness has resulted in inadequate consideration of genetic resources in planning and implementing adaptation and mitigation measures. Increasing visibility of agriculture in the climate change debate is increasingly important, as potential adverse impacts on agricultural production are of growing concern, and solutions need to be developed with the full participation of the agriculture sector.

Impacts of climate change on agriculture

9. The IPCC Climate Change 2007: Synthesis Report provides a number of key findings regarding the impacts of climate change on systems, sectors and regions expected over the 21st century. Many of these impacts are of direct relevance to agriculture and highlight the need for adaptation and mitigation measures. Among the impacts identified by the IPCC, those most relevant to food and agriculture include:[7]

- The resilience of many ecosystems is *likely* to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (e.g. land-use change, pollution, fragmentation of natural systems, overexploitation of resources). *{WGII 4.1-4.6, SPM}* Over the course of this century, net carbon uptake by terrestrial ecosystems is *likely* to peak before mid-century and then weaken or even reverse, thus amplifying climate change. *{WGII 4.ES,Figure 4.2, SPM}*
- Approximately 20 to 30 percent of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5 C (*medium confidence*). *{WGII 4.ES, Figure 4.2, SPM}*
- For increases in global average temperature exceeding 1.5 to 2.5 C and in concomitant atmospheric CO_2 concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services, e.g. water and food supply. *{WGII 4.4, Box TS.6, SPM}*
- Crop productivity is projected to increase slightly at mid- to high latitudes for local mean temperature increases of up to 1 to 3 C depending on the crop, and then decrease beyond that in some regions (*medium confidence*). *{WGII 5.4, SPM}* At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1 to 2 C), which

[5] CGRFA-13/11/Inf. 10.
[6] CFS:2010/ FINAL REPORT, October 2010.
[7] Climate Change 2007: Synthesis Report of the IPCC's 4th Assessment Report Section 3.3.

would increase the risk of hunger (*medium confidence*). *{WGII 5.4, SPM}* Globally, the potential for food production is projected to increase with increases in local average temperature over a range of 1 to 3 C, but above this it is projected to decrease (*medium confidence*). *{WGII 5.4, 5.5, SPM}*

10. Other impacts of climate change on agriculture have been identified in various studies. It is expected that climate change will result in increased demand for water and energy in the livestock sector. Animals' water requirements increase with temperature. However, under climate change scenarios, water will become notably scarcer and its availability less predictable. Heat stress also adversely impacts livestock – reducing appetites, production and fertility, and increasing mortality rates. This is particularly concerning as in some cases long-term single-trait selection for yield has given rise to animals with lower heat tolerance.[8] Research has found that as milk yield in dairy cattle has risen, and growth rates and leanness in pigs and poultry have increased, the animals' metabolic heat production has increased and their capacity to tolerate elevated temperatures has declined.[9] This may give rise to the need to adjust breeding goals or for breed or species substitution.

11. The impacts of climate change on food and agriculture will not be limited to increased average seasonal temperatures. Other climatic features will change significantly, impacting the food and agriculture sectors. Such changes are likely to include increased occurrence of extreme heat (temperature and duration), short-term fluctuations, seasonal oscillations, sudden discontinuities and long-term variations. These will be followed by changes in winds and currents and in rainfall distribution, causing longer droughts and sudden floods at unpredictable rates and in unexpected places and seasons.

12. Ecological dynamics and equilibriums are likely to be affected. Potential consequences include asynchrony between pollinators and crop flowering, enhanced pathways for invasive alien species, and improved conditions for pests and parasites. As temperatures rise and lead to range and phenological changes, it is reasonable to expect that the distribution and abundance of arthropods, including vectors of diseases, will generally be affected, thereby affecting disease transmission Despite many uncertainties and unknowns, there is a growing consensus that climate change could lead to an overall increase in the abundance and diversity of invertebrate pests – and pest pressure – as habitats become more favourable for their establishment and development and new niches appear.[10] Furthermore, studies suggest that increases in temperature, even if small in magnitude, may have negative impact on tropical insects, including beneficial insects, because they may already be living in an environment very close to their optimal temperature.[11] Hosts and pathogens may be brought together in new locations and contexts, bringing new threats to crops, livestock and aquaculture systems, and new challenges, with the accompanying need for significant human and financial investments to address the challenges.

13. In aquatic ecosystems, the most severe effects of climate changes will be felt by populations in restrictive circumstances. Examples include farmed fish in ponds, pens, cages and raceways; and wild or stocked fish in shallow lakes and reservoirs, and streams and rivers in conditions of low flow and stagnation; as well as in shallow coastal waters, with special habitat features and communities, such as those of coral reefs, sea grass beds and agricultural wetlands. Aquatic ecosystems and their biota account for the largest carbon and nitrogen fluxes on the planet and act as its largest carbon sinks. In addition to the continuous rain of calcifying micro-organisms to the ocean floor, the calcium carbonate in the skeletal structures of marine invertebrates, particularly echinoderms, and the carbonates precipitated in marine fish intestines

[8] See Background Study Paper No. 53, p. 20.
[9] Zumbach, B., Misztal, I., Tsuruta, S., Sanchez, J.P., Azain, M., Herring, W., Holl, J., Long, T. & Culbertson, M. 2008. Genetic components of heat stress in finishing pigs: development of a heat load function. *Journal of Animal Science,* 86: 2082–2088. Dikmen, S. & Hansen, P.J. 2009. Is the temperature-humidity index the best indicator of heat stress in lactating dairy cows in a subtropical environment? *Journal of Dairy Science*, 92: 109–116.
[10] See Background Study Paper No. 54, p. 10.
[11] Kjøhl, M. Nielsen A. & Stenseth, N.C. 2011. Potential effects of climate change on crop pollination. FAO, Rome.

make huge contributions to global carbon storage.[12] Disturbances caused by climate change could adversely impact this essential ecosystem service.

14. The effects of climate change will also depend on current production conditions. Areas already being impacted by other stressors, such as pollution, or areas where production levels are at or near upper levels of sustainability, will likely be impacted earlier and more significantly by climate change. Production systems that rely on highly selected genetic resources might be increasingly vulnerable to climate change impacts such as disease spread. If production levels decrease, there will be pressure to cultivate marginal lands or implement unsustainable practices that over the long-term, degrade lands and resources, and adversely impact biodiversity on and near agricultural areas. In this regard, already food insecure people in the developing countries will be most adversely affected by climate change.

III. RESPONDING TO CLIMATE CHANGE WITHIN THE AGRICULTURE SECTOR – GENETIC RESOURCES AS A BASIS FOR ADAPTATION

15. As entire landscapes, ecosystems and production systems are affected by climatic change, increasing application of the ecosystem approach in agriculture and natural resources management will be beneficial. Indeed, responding to climate change will not be effective if the focus is solely on a particular resource rather than on the overall production system, the agriculture ecosystem and its associated biodiversity.[13]

16. The ecosystem approach provides an overall framework for the agriculture sector to plan and implement adaptation strategies in relation to climate change. The approach is holistic, and thus facilitates looking across production systems for threats, opportunities and constraints in order to effectively plan and respond to changing conditions resulting from climate change and other factors. A main focus of the ecosystem approach is on maintaining ecosystem functions, diversity and resilience, which will be essential to optimize the adaptation capacity of agricultural systems.

17. The impacts and implications of climate change for the management and use of climate plant genetic resources for food and agriculture and associated biodiversity are likely to place new pressures on conservation of landraces of crop species. Consolidating collections of wild species is important as they can be a key resource for climate change adaptation, providing researchers with genes and traits for biotic and abiotic resistance. Genetic material in genebanks plays an increased role for adapting agriculture to climate change, including for screening for different characters. Breeding strategies and priorities (crop by crop and region by region) and strong seed systems are also key[14]. Overall, strategies and approaches are needed to facilitate the adaptation of agricultural systems to climate change through better management of crop varieties and seed systems[15].

18. Conservation of invertebrate genetic resources useful to agriculture and food is necessarily based on whole organisms *in situ*. Healthy agricultural ecosystems will provide much of this, but natural habitats as a source of soil invertebrates, biological control agents and pollinators will also be important, in as yet unpredictable ways.[16] Increases in CO_2, changes in water availability and increases in temperature will alter plant chemistry, phenology, growth and distribution, and these changes in the physiology, form and biomass of plants will in turn alter the quality and composition of the leaves, which can affect the growth and development of herbivores and those that prey on them.

19. Natural enemies with narrow host ranges may be more sensitive to climate change than

[12] See Background Study Paper No. 55, pp. 6, 16.
[13] See Background Study Papers No. 57 and 54.
[14] See Climate Change and its Effect on Conservation and Use of Plant Genetic Resources for Food and Agriculture and Associated Biodiversity for Food Security (Thematic Background Study).
[15] See document, *Seed security for food security in the light of climate change and soaring food prices: challenges and opportunities*, COAG/2009/Inf.7.
[16] See Background Study Paper No. 54, p. 8.

generalist herbivores and predators because they are of necessity precisely synchronized with the development of their hosts, and could become locally extinct if their interactions become decoupled. The amount of carbon in the soil will be increased and decreased by the action of soil invertebrates and micro-organisms, and if this could be managed so as to increase carbon in the soil it might provide a means of reducing atmospheric CO_2.[17]

20. Maintaining genetic diversity has long proven, in crop production, to be an essential strategy to reduce and prevent impacts to crop diseases.[18] This is also relevant to abiotic stresses, such as salinity and drought. While it is difficult to predict the effects that climate change will have on the distribution and severity of pests and diseases, greater genetic variation across space and time could potentially reduce disease transmission and the effects of crop pests.[19]

21. Agroforestry systems are examples of agricultural ecosystems with high structural complexity that can offer advantages in the context of global warning. Although the primary crops of interest (coffee, cacao) are sometimes grown in more intensively managed systems with little shade cover; the more structurally complex systems have been shown to buffer crops from large fluctuations in temperature,[20] thereby keeping crops in closer-to-optimal conditions. The more shaded systems have also been shown to protect crops from lower precipitation and reduced soil water availability[21] because the overstory tree cover reduces soil evaporation and improves soil water infiltration. Agroforestry systems also protect crops from extreme storm events (hurricanes, tropical storms, etc.) in which high rainfall intensity and strong winds can cause landslides, flooding and premature fruit drop from crop plants.[22]

22. In the livestock sector, many generations of natural selection and human-controlled selective breeding and husbandry in a wide range of production environments, have given rise to great genetic diversity expressed as species, breeds and populations that are adapted to a diverse range of conditions including extreme climates and severe disease and parasite challenge. This diversity has the potential to play an important role in adapting livestock production to the effects of climate change. It is largely maintained *in situ* within livestock production systems, much of it by small-scale farmers or pastoralists.[23]

23. Most adaptation by aquatic organisms, wild and farmed, to the stressors associated with climate change is being accomplished through natural selection to their changed and more changeable environments. The most important traits, which are highly interactive, include: survival; fecundity; tolerance to lower water quality (in terms of available oxygen, acidification, increased or reduced salinity, increased turbidity and siltation, and increased levels of pollutants) and; resistance to diseases, parasites and toxic blooms; as well as, particularly for aquaculture, the commercial traits of fast growth, good feed conversion and high product quality.[24]

24. In the context of climate change, aquaculture and fisheries will have to place increased reliance on species, stocks and strains that can live and perform adequately in a wide range of environments. For ecological and economic reasons, this will favour the use of fish that feed at lower trophic levels and that have relatively short production cycles. In warmer waters of variable quality, air-breathing species will have increased potential, especially in aquaculture.

25. The ecosystem approach calls for an adaptive approach to management. This will be essential because adaptation and mitigation measures in diverse agricultural systems will require

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[17] See Background Study Paper No. 54, p. 7.
[18] Finckh MR, et al. 2000. Cereal variety and species mixtures in practice, with emphasis on disease resistance. *Agronomie*, 20: 813–837.
[19] Lin BB. 2011. Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change. *Bioscience*, 61: 183–193.
[20] Lin BB. 2007. Agroforestry management as an adaptive strategy against potential microclimate extremes in coffee agriculture. *Agricultural and Forest Meteorology*, 144: 85–94.
[21] Lin BB, Perfecto I, Vandermeer J. 2008. Synergies between agricultural intensification and climate change could create surprising vulnerabilities for crops. *BioScience*, 58: 847–854.
[22] See Background Study Paper No. 56.
[23] See Background Study Paper No. 53, p. 28.
[24] See Background Study Paper No. 55, p. 7.

learning and adjusting over time, as knowledge is gained and as impacts are better understood. Understanding how the entire dynamic of the system is affected by climatic change will be increasingly important. For example, predicting and responding to potential impacts on pollination, soil biodiversity, mycorrhizal associations, and pest and disease outbreaks and spread are essential to maintaining and enhancing agricultural production.

26. This means that it is now essential to enhance efforts to predict impacts on agricultural production systems and model the relationships between climate change and the distribution of specific genetic resources, and to identify geographical areas where agro-ecological shifts driven by climate change are likely. Vulnerable locations and resources might be identified for more in-depth investigation and to determine strategies for adapting production to changing conditions.

27. While there is uncertainty as to the full impacts of climate change, access to and development and use of a wide portfolio of genetic resources will remain the essential insurance policy that enables responses to future changes in production conditions. As most food production systems will be hit by climate change, the affected countries will be pushed to seek common, internationally coordinated solutions. Such solutions will include reliance on diversity, either of the species currently in production or of new species entirely, often coming from other countries. The need to maintain genetic diversity will only grow with the severe and rapid changes that are anticipated to occur because of climate change. It is critically important for policy-makers to keep this increasing interdependence in the use of GRFA in mind when developing policies concerning the conditions under which genetic resources can be accessed and used, and the ways in which benefits derived from their use should be shared.[25]

IV. TOWARDS A ROADMAP ON CLIMATE CHANGE AND GENETIC RESOURCES FOR FOOD AND AGRICULTURE

28. The Commission in considering further work in relation to climate change and genetic resources needs to be aware of the many initiatives that are underway to address climate change, including within FAO, so as to identify how the potential roles of genetic resources for food and agriculture can best be positioned.

29. The current document has put forth the perspective that agricultural production and food security will be significantly, and overall adversely, affected by climate change unless appropriate response mechanisms are implemented. Despite the efforts made, including high-level discussions, impacts on agriculture resulting from climate change have not been adequately considered within the main international processes established to discuss, debate and agree on mitigation and adaptation measures. This has limited opportunities for the agriculture sector to participate adequately in planning and implementing mitigation and adaptation measures, and resulted in a lack of awareness of, and attention to, the critical roles and values of genetic resources that underpin agricultural production. Indeed, genetic resources have been virtually ignored. Although the issue of climate change has slowly mainstreamed into the international development agenda, there often seems to be a general disconnect between climate change and agriculture and food security.

30. In 2009, the World Summit on Food Security recognized the challenges that climate change presents to food security.[26] More recently, in 2010, in The Hague, the Global Conference on Agriculture and Food Security and Climate Change considered linkages between agriculture, food security and climate change. Both processes highlighted the risks arising from climate change and suggested ways forward.

31. FAO's activities in climate change cover all departments and agricultural sectors (natural resources, agriculture, livestock, forestry and fisheries), as well as cross-sectoral topics (water, bioenergy, biodiversity and climate risk management). The Interdepartmental Working Group on

[25] See Background Study Paper No. 48, p. 6.
[26] The Declaration of the world summit on food security is available at: ftp://ftp.fao.org/docrep/fao/Meeting/018/k6050e.pdf

Climate Change and the Climate Change, Energy and Tenure Division (NRC) play an important role in coordinating these activities. Building on this, FAO has recently called for an integrated climate change programme with expanded work on adaptation, which builds on current activities and is consistent with the UNFCCC and the scientific work of the IPCC.

32. In February 2011, FAO's Programme Committee recommended that FAO coordinate cross-cutting issues, such as climate change, across FAO's strategic objectives. The FAO Framework Programme on Climate Change Adaptation, called FAO-Adapt, is a concrete tool for achieving these goals.

33. FAO plays an important role in assisting Member Countries with climate change issues related to food security. The Organization's programme on climate change falls within the major objective of ensuring food security, and includes the promotion of practices for the mitigation and adaptation of agricultural systems; the reduction of emissions from the agricultural sector; the development of practices aimed at reducing vulnerability and increasing the resilience of agricultural systems to climate-related risks; strengthening national and regional climate observing systems and networks; climate and/or disaster risk management in agriculture and allied sectors; and data and information collection, early warning and dissemination. FAO is initiating programmes to assist countries in developing "climate smart" agricultural strategies that include adaptation and mitigation. For instance, conservation agriculture is promoted as one of the promising approaches.[27]

34. The Commission might wish to consider the scope of action that needs to be taken over the next several sessions, possibly through the preparation of a *roadmap on climate change and genetic resources for food and agriculture*, identifying steps to be taken under the direction of the Commission to enhance global understanding of the need for greater consideration of agriculture and specifically genetic resources for food and agriculture in planning climate change adaptation and mitigation measures and identifying specific measures countries can take to address this matter.

35. The potential elements of a *roadmap on climate change and genetic resources for food and agriculture* might include: (i) strategies and policies – integrative and enabling policy development; (ii) tools and technologies for genetic resources and climate change; (iii) forging partnerships; and (iv) monitoring progress – enhanced consideration of genetic resources in climate change adaptation and mitigation measures. These four elements or pillars are elaborated in the annex of the current document. The Commission may wish to consider action needed at the national, regional and global levels in the further development of the roadmap.

36. The Commission may wish to agree on an overall objective or outcome for their work in relation to climate change and genetic resources and to provide a basis to guide the preparation of a *roadmap on climate change and genetic resources for food and agriculture*. For example, the main outcome sought could be to ensure that: *The roles and values of genetic resources for food and agriculture are understood in terms of achieving food and nutritional security and in terms of enabling countries to plan and implement adaptation and mitigation strategies, in the context of climate change and anticipated impacts of climate change on food and agricultural production, now and in future.*

[27] FAO, 2010. "Climate-Smart" Agriculture Policies, Practices and Financing for Food Security, Adaptation and Mitigation.

V. GUIDANCE SOUGHT:

37. The Commission may wish to:

i. Agree on the need for a *roadmap on climate change and genetic resources for food and agriculture*, building on the possible elements shown in the annex of the current document, and request its Secretary to further the development of the roadmap;

ii. Stress that Members of the Commission take appropriate action to ensure that genetic resources for food and agriculture are given adequate consideration in planning and implementing their country's national adaptation programmes of action (NAPAs) and nationally appropriate mitigation actions (NAMAs) and encourage national representatives to the UNFCCC to include agricultural and the management of genetic resources for food and agriculture;

iii. Request its Secretary to continue to collaborate with the Executive Secretary of the CBD in relation to genetic resources and climate change, as provided for in the joint work plan, and with the Secretary of the UNFCCC, given the need to further integrate national biodiversity and agricultural biodiversity strategies and action plans and climate change adaptation and mitigation measures;

iv. Request its Secretary to transmit to the HLPE the Background Study Papers related to genetic resources and climate change as a contribution to the study on climate change and food security; and

v. Request its Secretary to, whenever possible, raise awareness of genetic resources and climate change in the international arena such as CBD and UNFCCC as well as Rio +20.

ANNEX

PROPOSED ROADMAP ON CLIMATE CHANGE AND GENETIC RESOURCES FOR FOOD AND AGRICULTURE

The possible objective and elements of a *roadmap on climate change and genetic resources for food and agriculture*:
Objective: *The roles and values of genetic resources for food and agriculture are understood in terms of achieving food and nutritional security and in terms of enabling countries to plan and implement adaptation and mitigation strategies, in the context of climate change and anticipated impacts of climate change on food and agricultural production, now and in future.*

i. **Strategies and policies:**

- Integrate relevant climate change-related activities into the implementation of the *Global Plans of Action* for plant and animal genetic resources at all levels as appropriate.

- Raise awareness of the roles and values of genetic resources for food and agriculture in planning and implementing climate change adaptation and mitigation strategies at all levels.

- Widely disseminate the sector-specific studies on climate change made available to the Commission to relevant climate change and biodiversity processes.

- Consider preparation of a synthetic document on climate change and genetic resources for food and agriculture for policy makers.

ii. **Tools and technologies for genetic resources and climate change:**

- Continue the technical work undertaken by FAO to assist countries to prepare and implement climate change adaptation and mitigation measures, and to identify and fully exploit the potentials of genetic resources for climate change adaptation and mitigation, within National Adaptation Programmes of Actions.

- Develop or adapt guidelines as necessary for the implementation of the ecosystem approach in agricultural systems in light of climate change adaptation.

- Request Intergovernmental Technical Working Groups to consider providing further advice within their respective mandates.

iii. **Forging Partnerships:**

- Forge partnership among agriculture and biodiversity and climate change organizations including, *inter alia,* the CBD, CGIAR centres, UNFCC, to enhance collaboration and to identify further opportunities to enhance awareness of genetic resources in relation to climate change and further exploit the potentials of genetic resources for climate change adaptation.

- Continue FAO’s participation in meetings of the UNFCCC as an observer to stress the importance of genetic resources for food and agriculture in the context of climate change.

iv. Monitoring progress:

- Develop indicators and mechanisms to monitor progress towards the objective of the *roadmap on climate change and genetic resources for food and agriculture*.

- Continue FAO's work on indicators in relation to climate change and genetic resources for food and agriculture.