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INPUT INTO THE IN-DEPTH REVIEW OF THE AGRICULTURAL BIODIVERSITY PROGRAMME OF WORK

Integration of climate change impact and response activities

1. Recommendation XII/5 of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to the Convention on Biological Diversity (CBD) on biodiversity and climate change requests the Executive Secretary, when conducting the in-depth review of implementation of the programme of work on agricultural biodiversity to conduct an analysis to identify the elements of the guidance (presented below) already included in the existing programme of work and an assessment of the state of implementation, as well as the identification of gaps in implementation including a review of barriers and suggestions to overcome them.

2. The guidance presented by SBSTTA includes:

(i) Indications or predictions of climate-change impacts response activities on relevant ecosystems;
(ii) The most vulnerable components of biodiversity;
(iii) The risks and consequences for ecosystem services and human well-being;
(iv) The threats and likely impacts of climate change and response activities on biodiversity and opportunities they provide for the conservation of biodiversity and its sustainable use;
(v) Monitoring of the threats and likely climate-change impacts and response activities on biodiversity;
(vi) Appropriate monitoring and evaluation techniques, related technology transfer and capacity-building initiatives within the programmes of work;
(vii) Critical knowledge needed to support implementation, including *inter alia*, scientific research, availability of data, appropriate measurement and monitoring techniques technology and traditional knowledge; and
(viii) The ecosystem-approach principles and guidance and the precautionary approach.

3. Main sources of information for this study include the reports and recommendations of the Third and Fourth Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), Technical Series No. 10 and No. 25 of the Convention on Biological Diversity, third national reports submitted by Parties and responses by Parties to notification 2007-101.

* UNEP/CBD/SBSTTA/13/1.

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I. CLIMATE CHANGE IMPACT AND RESPONSE ACTIVITIES IN THE AGRICULTURAL BIODIVERSITY PROGRAMME OF WORK

4. In the appendix to decision V/5, review of phase I of the programme of work on agricultural biodiversity and adoption of a multi-year work programme, climate regulation and carbon sequestration are recognized as ecological services provided by agricultural biodiversity.

A. Assessment of implementation

5. In the review of third national reports, only three countries reported on the identification of agricultural biodiversity components that provide ecological services through climate regulation and carbon sequestration. 1/

6. Although the programme of work on agricultural biodiversity does not explicitly address climate change impacts and response activities, an analysis of Third National Reports did reveal a number of linked activities including:

- Climate change actions plans including on-farm initiatives such as: shelterbelt programs, expanded coverage of perennial forage and trees, restoration of degraded land and improved rangeland management;
- Drought watch / warning programs and the protection of water resources;
- Application of the ecosystem approach to agricultural planning;
- Assessment of the vulnerability to climate change for the agriculture, livestock and farming sectors;

7. Notification 2007-101 was sent to Parties on 3rd August 2007, requesting additional information on climate change and agricultural biodiversity. Seven Parties responded 2/ providing information on the role of agricultural biodiversity in climate change mitigation through:

- Integrating climate change mitigation and adaptation into agriculture sector plans (for example the United Kingdom Farming for the Future Programme, the Slovene Agricultural Environment Programme, and the Finland Adaptation of the Agri-sector to Climate Change report);
- Integrating agriculture into climate change planning (for example the Mexico National Strategy for Climate Change and the European Climate Change Programme working group on agriculture and carbon sinks related to agricultural soils);
- Enhancing awareness of climate change – agricultural biodiversity linkages;
- Rehabilitation of grazing and rangelands;
- Improved livestock management including limited land application of nitrogen from livestock manure and the establishment of stocking density ceilings;
- Assessment of the impacts of different crop production systems on nitrous oxide and methane emissions;
- The evaluation of carbon sequestration potential by energy crops;
- The conversion of agricultural land to perennial and mixed crops;
- Improving the efficient use of fertilizers including green manure;
- Promotion of alternatives to slash and burn agriculture;
- Promotion of conservation tillage; and
- Promotion of cover crops.

8. Additional information was provided by Parties on agriculture and climate change adaptation strategies under different climate change scenarios including through:

- Identification of possible adverse impacts on production by agro-climate zones (for example the studies, 'Impacts of Climate Change and Variability on European Agriculture);

1/ Canada, Kazakhstan, Uganda.

2/ Czech Republic, Finland, Mexico, Philippines, Poland, Slovenia, United Kingdom and Portugal on behalf of the European Community and its Member States.

- Assessment of possible behaviours of crop pathogens;
- Identification of options for appropriate crop re-conversion regimes;
- Assessment of changing needs for irrigated crops, hydrology and water management; and
- Assessment of options for climate change adaptation in the agriculture and livestock sector.

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B. Gaps in the integration of climate change impact and response activities in the agricultural biodiversity programme of work

10. The current programme of work on agricultural biodiversity calls on Parties to preserve ecosystems services associated with agricultural biodiversity including the role of agricultural biodiversity in climate change mitigation and climate regulation. In fact, agricultural biodiversity has an important role to play in adaptation planning through the provision of genetic resources for resistant crop and livestock varieties and the maintenance of ecosystem functions such as nutrient cycling.

11. There is also currently no consideration, in the programme of work, of activities to assess, identify and reduce the vulnerability of agricultural biodiversity to the impacts of climate change.

12. Furthermore, there exist significant information gaps which are not addressed in the current programme of work concerning agricultural biodiversity and climate change links, including vulnerability assessments and response activities, with regards to the impacts of climate change on livestock, pollinators and soil biodiversity.

C. Indications or predictions of climate-change impacts and response activities on agricultural ecosystems

1. Increased carbon dioxide concentrations

13. According to the fourth assessment report of the IPCC, if CO2 concentrations increase by 44% when compared to current levels a production increase under unstressed conditions of 10-25% would be expect for C3 crops. For C4 crops estimates indicate increased production of between 0 and 10%. It should be noted, however, that ozone exposure limits production increases associated with CO2.

14. When considering possible stressors, however, increases in CO2 concentration, are likely to result in the above mentioned production increases in humid temperate grasslands only with decreases in production projected for grasslands and savannahs in arid and semiarid regions.

15. The third assessment report indicated that elevated CO2 can increase the rate of legume development with positive consequences for nitrogen fixation.

16. With regards to livestock and herding, in conditions of very low Nitrogen status, possible reductions in production under elevated CO2 may be detrimental for animal health. However, this may be offset by an increase in legume growth and the shift away from less nutritious C4 grasses towards C3 crops.

2. Increased air and surface soil temperature

17. Warming of 1–2°C may increase agricultural production in humid temperate regions but is expected to decrease yields in arid, semi-arid and tropical regions. Due to a lack of information it is unclear what impact should be expected in tropical grasslands and rangelands.

18. Warming greater than 3°C, however, has projected negative impacts on agricultural production in all regions.

19. Increased air temperature also reduces productivity and conception rates and increases heat stress on livestock.

3. Increased sea temperature

20. Rising sea temperatures are predicted to shift fish habitat and may cause local extinctions of particular fish species included in aquaculture production. This is particularly true for species at the edges of current ranges, freshwater fish and diadromous species (e.g. salmon and sturgeon). For warm water fish, however, ranges and productivity is expected to increase.

4. Increased instances of extreme weather

21. More frequent extreme events such as floods and droughts may lower long-term yields by directly damaging crops or by making the timing of field applications more difficult, thus reducing the efficiency of farm inputs.

22. In fact, it is expected that the impact on animal productivity due to increased variability in weather patterns will likely be far greater than effects associated with the average change in climatic conditions.

5. Changes in precipitation

23. Decreases in precipitation are predicted by more than 90% of the simulations by the end of the 21st century for the northern and southern subtropics. This will have a serious impact on agricultural biodiversity which is already at the limit of its drought tolerance such as is the case for agricultural systems in desert margins.

24. Increases in precipitation extremes are also very likely in the major agricultural production areas in Southern and Eastern Asia, in East Australia and in Northern Europe. Such extremes will increase both drought and flood stresses on agricultural biodiversity.

25. It should be noted that climate change impact models for food, feed and fibre do not yet include these recent findings on projected patterns of change in precipitation.

6. Sea level rise

26. Sea level rise as a result of thermal expansion and the melting of ice caps and glaciers will reduce the amount of land available for cultivation. This is particularly significant for low-lying islands and coastal states.

27. Sea level rise will also result in salt-water intrusions in coastal wetlands, flooded fields and water tables.

7. Secondary impacts

28. Climate change also increases risks from fires, disease and pests. Other impacts of climate change which are expected to impact agricultural biodiversity include: (i) decreased water supply from snowcaps; (ii) salt-water intrusions and loss of arable land in coastal areas; (iii) increased frequency of landfall tropical storms; and (iv) the remobilization of dunes.

29. The negative impacts of climate change on aquaculture and freshwater fisheries, include (i) stress due to increased temperature and oxygen demand and decreased pH; (ii) uncertain future water supply; (iii) extreme weather events; (iv) increased frequency of disease and toxic events; (v) sea-level rise and conflict of interest with coastal defence needs; and (vi) uncertain future supply of fishmeal and oils from capture fisheries.

II. MOST VULNERABLE COMPONENTS OF BIODIVERSITY

30. Agricultural ecosystems identified as particularly vulnerable include: agricultural systems already at the limit of their heat and drought tolerance, agricultural areas within low latitudes, rangelands, grasslands and savannahs affected by El Niño Southern Oscillation, and agricultural systems within dry and sub-humid lands.

31. With regards to vulnerable regions, changing precipitation regimes are likely to increase water stress in some of the areas currently suitable for rain-fed crops such as in the Mediterranean basin, South America, Central America, Western Asia, Southern Europe and sub-tropical regions of Africa and Australia. Increased flooding may negatively impact agricultural production in some areas of Southern and Eastern Asia and in Northern Europe. For example, a recent study of 1,350 European plant species predicted that half of these species will become classified as 'vulnerable' or 'endangered' by the year 2080 due to rising temperature and changes in precipitation.

32. Components of biodiversity for which particular vulnerabilities have been identified include (i) livestock for which the primary breeding season occurs in the spring and summer months, (ii) perennial crops, (iii) plants at the limit of their heat or drought tolerance, and (iv) fish at the upper end of their thermal tolerance zone.

III. RISKS AND CONSEQUENCES FOR ECOSYSTEM SERVICES AND HUMAN WELL-BEING

33. The most direct impact between climate change, agricultural biodiversity and human well-being concerns food security. Declines in crops production from increased air temperatures, and more frequent and more extreme droughts and floods have been identified by the forth assessment report as leading to potential increased likelihoods of crop failure; increased diseases and mortality among livestock; potential increases in threats from invasive alien species; and negative livelihood impacts including forced sale of assets, out-migration and dependency on food relief.

34. Populations which are particularly vulnerable to the negative impacts of climate change on food security include smallholder and subsistence farmers, pastoralists and agricultural producers on marginal lands. This is, in part due to the relatively low adaptive capacity of such populations combined with a high vulnerability to extreme events.

IV. THREATS AND LIKELY IMPACTS OF CLIMATE CHANGE AND RESPONSE ACTIVITIES ON BIODIVERSITY AND OPPORTUNITIES THEY PROVIDE FOR THE CONSERVATION OF BIODIVERSITY AND ITS SUSTAINABLE USE

35. On average worldwide, in cereal cropping systems, adaptations such as changing varieties and planting times enable avoidance of a 10-15% reduction in yield under 1-2°C local temperature increases. However, the adaptive capacity of current systems in low latitudes is predicted to be exceeded once a 3°C local temperature increase is achieved.

36. Response activities to climate change can include mitigation and/or adaptation. Mitigation involves reducing greenhouse gas emissions or enhancing sinks while adaptation involves responding to the expected impacts of climate change and enhancing the resilience of ecosystems so as to minimize negative affects.

A. Mitigation

37. Sustainable land management in agricultural areas can increase carbon sequestration in the soil and, as such, techniques such as enhancing tree cover and shelterbelts, integrated pest management, conservation tillage, intercropping, and the planting of cover crops can be used to mitigate climate change. In fact, when cover crops are used in combination with conservation tillage soil carbon content can increase annually for a period of up to 50 years. Many of these practices may also have positive benefits for biodiversity.

38. Other activities which have been identified as having potential co-benefits for carbon sequestration and biodiversity include: farmer participatory approaches, consideration of local knowledge and technologies, the use of organic materials, the use of locally adapted crop varieties, water management, and crop diversification.

39. The sustainable management of grazing land can provide similar co-benefits since such lands contain between 10 and 30% of the world's soil carbon stocks. The introduction of nitrogen fixing legumes is one management technique however, which, while providing benefits for mitigation, can have negative impacts on biodiversity though the introduction of potentially invasive alien species.

B. Adaptation

40. For agricultural ecosystems, the Intergovernmental Panel on Climate Change reaffirms that vulnerability is dependent upon exposure to climate change impacts, sensitivity to changing conditions, and on the capacity to adapt to climate change.

41. Adaptation measures identified for agricultural ecosystems and grasslands include, *inter alia*: the conservation of agricultural genetic resources, the reduction of other threats to agricultural biodiversity, the restoration of degraded land with native species, integrated land and water management, disease control programmes for native livestock, and invasive species management planning.

V. MONITORING OF THE THREATS AND LIKELY CLIMATE-CHANGE IMPACTS AND RESPONSE ACTIVITIES ON BIODIVERSITY

42. Guidance on cost effective tools and methods to assess the threats and likely impacts of climate change faced by biodiversity in the identified vulnerable areas was compiled from a literature review conducted by the Secretariat, as well as from the Technical Series No. 10 and No. 25; the report of the twenty-fourth meeting of the Subsidiary Body for Scientific and Technological Advice of the United Nations Framework Convention on Climate Change on the five-year programme of work on impacts, vulnerability, and adaptation to climate change; 3/ the Intergovernmental Panel on Climate Change Technical Guidelines for Assessing Climate Change Impacts and Adaptations; 4/ and the Further Development of Tool Kits for the Identification, Designation, Management, Monitoring and Evaluation of National and Regional Systems of Protected Areas (UNEP/CBD/WG-PA/1/4).

43. The Intergovernmental Panel on Climate Change technical guidelines for assessing climate change impacts 5/ identifies six steps for analysing vulnerability:

1. Definition of the problem;
2. Selection of the methods;
3. Testing the methods;
4. Selection of scenarios;
5. Assessment of biophysical and socio-economic impacts; and
6. Assessment of autonomous adjustments.

44. Tools identified in the technical guidelines include: experimentation, impact projections, empirical analogue studies, and expert judgement. To evaluate current impacts, observations and literature reviews are also useful tools.

45. For agricultural biodiversity, tools and methods assessing the impacts of climate change on food security, crop and livestock vulnerability and production levels are particularly relevant. Examples of such tools and methods are presented in table 1 below. The tools and methods presented below do not

3/ UNFCCC. 2006. FCCC/SBSTA/2006/L.17

4/ T.R.Carter, M.L.Parry, H.Harasawa, and S.Nishioka. Technical Guidelines for Assessing Climate Change Impacts and Adaptations. 1994

5/ T.R.Carter, M.L.Parry, H.Harasawa, and S.Nishioka. Technical Guidelines for Assessing Climate Change Impacts and Adaptations. 1994

represent all possibilities; rather they provide examples of some of the more commonly implemented tools and methods as identified through research conducted by the Secretariat.

Table 1: Examples of tools and methods to assess vulnerability

Impacts of Climate Change	Tools and Methods	
	Physical Processes	**Vulnerability**
Sea Level Rise	Sea level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) 6/	Coastal Vulnerability Index (CVI) 7/
	Continuous Global Positioning System 8/	
Increased Air Temperatures	Meteorological Stations (e.g. National Climate Data Center, 9/ Climate Anomaly Monitoring System 10/)	Community-based Risk Screening Tool – Adaptation & Livelihoods 11/
		ILRI: Mapping Climate Vulnerability 12/
Changing Precipitation Regimes	Meteorological Stations (e.g. Global Precipitation Measurement 13/)	Palmer Drought Severity Index 14/
	Satellite Monitoring (e.g. International Satellite Land Surface Climatology Project 15/)	The Mesoamerican Regional Visualization and Monitoring System 16/
		Global Information and Early Warning System 17/
Increased Frequency of Extreme Events	Global Hazards / Extremes Monitoring (e.g. Tropical Atmosphere Ocean Project 18/)	Emergency Food Security Assessment 19/
		Disaster Risk Index 20/

VI. APPROPRIATE MONITORING AND EVALUATION TECHNIQUES, RELATED TECHNOLOGY TRANSFER AND CAPACITY-BUILDING INITIATIVES WITHIN THE PROGRAMMES OF WORK

46. Although there are many capacity-building initiatives concerning the impacts of climate change and response activities on agricultural biodiversity, there are no references to capacity-building within the programme of work itself.

47. Examples from other frameworks include:

- FAO: Training Modules for Climate and Flood Forecast Applications in the Agriculture Sector 21/
- United States Department of Agriculture: Agricultural Adaptation to Climate Change 22/

6/ http://www.icsm.gov.au/icsm/tides/SP9/PDF/IOCVIII_acoustic_errors.pdf
7/ http://cdiac.ornl.gov/epubs/ndp/ndp043c/sec9.htm
8/ http://www.bom.gov.au/pacificsealevel/cgps/cgps_fact_sheet.pdf
9/ http://www.ncdc.noaa.gov/oa/ncdc.html
10/ http://www.cpc.noaa.gov/products/global_precip/html/wpage.cams_opi.shtml
11/ http://www.iisd.org/security/es/resilience/climate_phase2.asp
12/http://www.ilri.org/Infoserv/webpub/Fulldocs/MappingClimateVulnerability/MappingClimateVulnerability.pdf
13/ http://gpm.gsfc.nasa.gov/
14/ http://www.drought.noaa.gov/palmer.html
15/ http://www.gewex.org/islscp.html
16/ http://servir.nsstc.nasa.gov/
17/ http://www.fao.org/giews/english/index.htm
18/ http://www.pmel.noaa.gov/tao/
19/ http://www.wfp.org/operations/Emergency_needs/index.asp?section=5&sub_section=6
20/ http://gridca.grid.unep.ch/undp/
21/ ftp://ftp.fao.org/docrep/fao/008/af967e/af967e00.pdf
22/ http://www.ers.usda.gov/publications/aer740/

- IISD: Coping with Global Change – vulnerability and adaptation in Indian agriculture 23/

VII. CRITICAL KNOWLEDGE NEEDED TO SUPPORT IMPLEMENTATION, INCLUDING *INTER ALIA*, SCIENTIFIC RESEARCH, AVAILABILITY OF DATA, APPROPRIATE MEASUREMENT AND MONITORING TECHNIQUES TECHNOLOGY AND TRADITIONAL KNOWLEDGE

48. The fourth assessment report of the IPCC identifies several uncertainties including:

- Knowledge of CO^2 and climate responses for most crops other than cereals;
- Research on the combined effects of elevated CO^2 and climate change on pests, weeds and disease;
- Impacts of climate change alone on pest ranges and activity;
- Impacts of climate change on pollinators;
- Enhanced crop model inter-comparison;
- Impacts of climate change on gums and resins, and medicinal and aromatic plants;
- Research on how current strategies to cope with extreme events foster or constrain longer-term adaptation; and
- Knowledge of crop responses to climate change also needs to be extended to more crops of interest to smallholders.

49. Parties also identified knowledge gaps including:

- Links between agricultural biodiversity, climate change and bio-energy production;
- Regional specific models;
- Information on lessons learned and the elaboration of specific adaptation measures; and
- Long-term studies on climate change impacts on agricultural biodiversity.

50. Technical Series No. 10 and No. 25 also identify key research needs although these are not specific to agricultural biodiversity. Knowledge needs identified by the Technical Series include additional research on:

- The relationship between biodiversity and ecosystem structure and the delivery of ecosystem services;
- Which ecosystem functions are most vulnerable to species loss;
- Projected climate change impacts on soil biodiversity;
- The effects of energy activities on biodiversity; and
- Indicators.

VIII. THE ECOSYSTEM-APPROACH PRINCIPLES AND GUIDANCE AND THE PRECAUTIONARY APPROACH

51. Since the ecosystem approach takes a broad perspective to management, it has been identified as a potential methodology through which the multiple impacts from climate change, including on biodiversity, can be reflected in comprehensive and responsive adaptation planning.

52. Additional information on the ecosystem approach is available in the review of implementation of the ecosystem approach conducted at the twelfth meeting of SBSTTA (UNEP/CBD/SBSTTA/12/2) which recommended that the Conference of the Parties:

(a) *Urges* Parties, other Governments and relevant organizations, as appropriate, and subject to funding and availability of technical capacity, to:

(i) Strengthen the promotion of the ecosystem approach in ongoing communication, education and public awareness activities;

23/ http://www.iisd.org/publications/pub.aspx?id=633

(ii) Further promote the use of the ecosystem approach in all sectors and enhance inter-sectoral cooperation, as well as promote the establishment of concrete national and/or regional initiatives and pilot projects;

(iii) Implement further capacity-building initiatives to applying the ecosystem approach, using, *inter alia*, the tools made available through the sourcebook and other sources of information, as appropriate;

(iv) Recalling decisions VI/12, paragraph 2 (a), and VII/11, paragraph 9 (d), of the Conference of the Parties, urge Parties, other Governments and relevant organizations to continue submitting case-studies and lessons learned and provide further technical input to the Source Book;

(v) Further facilitate the full and effective participation of indigenous and local communities in the development of tools and mechanisms for the application of the ecosystem approach;

(vi) Strengthen and promote the use of the ecosystem approach more widely and effectively as a useful tool for formulation of national biodiversity strategies and action plans and in other relevant policy mechanisms; and

(b) *Invites* Parties to:

(i) Take into account the application of the ecosystem approach in the achievement of the Millennium Development Goals;

(ii) Develop effective cooperation at all levels for the effective application of the ecosystem approach;

(iii) To provide a framework for the promotion of the ecosystem approach, as appropriate;

(iv) Give consideration to the challenge of incorporating land and marine tenure in the application of the ecosystem approach; and

(v) Provide information on outcomes and progress in these activities through the national reporting process and their national clearing-houses.
