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Our Ref.: Your Ref.:

FAO Submission on Agriculture for SBSTA

Submission by the Food and Agriculture Organization of the United Nations (FAO) on issues related to agriculture, as requested in the conclusions of SBSTA 38 (item 9 point 4). Parties and observer organizations have been invited to provide their views *"...on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries. This should take into account the diversity of the agricultural systems and the differences in scale, as well as possible adaptation co-benefits."*

Key points

The Committee on World Food Security (CFS), informed by a report of its high level panel of experts (HLPE), has noted that adaptation to climate change is a major concern and should be an objective for all farmers and food producers, especially small-scale producers.

Agriculture, forestry, fisheries and aquaculture sectors are highly climate sensitive and thus climate change will have both direct and indirect negative impacts on these production systems.

Adaptation responses must be undertaken under uncertain future climate. "No regret" actions should be adopted which reduce current risks and vulnerabilities, restore natural resources and ecosystem services and build stronger systems that can withstand eventual future changes and shocks.

Investment in the agricultural sector will bring benefits beyond the sector contributing to long-term resilience of communities, landscapes and infrastructures.

The preservation of wild and domesticated genetic resources, the screening of traits and the breeding of suitable varieties, breeds and aquatic stock is essential for location specific adaptation responses.

Policy makers need to be provided with adequate tools and means to assess current vulnerabilities and risks and select appropriate interventions.

Rural communities need access to knowledge and climate and financial services to devise appropriate strategies including alternative livelihoods.

Regional and interregional cooperation is needed to manage common natural resources and exchange knowledge and experiences on suitable adaptive interventions.

1. Introduction

To ensure the food security of a growing world population, agriculture has to sustainably produce more food with greater resource efficiency. However, the agriculture, forestry, fisheries and aquaculture sectors are highly climate sensitive and thus climate change will have both direct and indirect negative impacts on these production systems. Already changes in climate, increased frequency and intensity of climate shocks (such as drought, flooding and extreme temperatures) as well as changing distribution and timing of rainfall are being felt and without adequate interventions, negative effects are to be expected on every dimension of food security: availability (production), access, utilization (nutrition) and the stability of these factors. Climate change will affect all countries but in agriculture-based economies, impacts in the agricultural sectors will undermine the economy as a whole, with devastating effects for livelihoods, economic development and food security of the population. Building resilient food systems is therefore a priority to ensure food security, livelihoods and economic growth. Farmers, foresters and fisher folk are also the main custodians and managers of natural resources such as land and water and can therefore greatly contribute to developing landscape adaptive approaches which also safeguard and build resilience of ecosystems, communities and other industries.

The Committee on World Food Security (CFS), in its 39th session in October 2012, discussed the relation between climate change and food security. Informed by the report on Food Security and Climate Change by its High Level Panel of Experts (HLPE), CFS members stressed that climate change poses serious threats to food security, especially for vulnerable small scale food producers' lives and livelihoods, and to the realization of the right to food. CFS noted that adaptation to climate change is a major concern and should be an objective for all farmers and food producers, especially small-scale producers. CFS has therefore invited Member States, International Organizations and other CFS stakeholders, as appropriate, while recognizing the role of the UNFCCC:

- to integrate climate change concerns in food security policies and programmes and to increase resilience of vulnerable groups and food systems.
- to create conditions that facilitate access to genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising from their use.
- to develop agricultural strategies that take into account the need to respond to climate change and to safeguard food security.

The report of the High-Level Panel of Experts on food security and nutrition (HLPE) also notes specific knowledge and data gaps which need to be addressed for appropriate adaptation strategies to be identified and adopted by millions of people whose food and livelihood security depends on farming, fishing, forests and livestock-keeping.

In May 2013, FAO organised the first International Conference on Forests for Food Security and Nutrition attended by more than 400 participants, comprising experts from governments, civil-society organizations, indigenous and other local communities, donors and international organizations. The conference among other issues, reiterated that sustainable management of forests and trees outside forests provides a robust framework for action in climate change risk reduction, resilience and adaptation by fostering additional income and diversity of food sources. Landscape approaches in agricultural development; Engagement of multiple stakeholders; and better coordination across sectors of land-use planning and management were identified as essential elements to jointly address food security in the face of climate change.

This submission will review the current status of scientific knowledge, key adaption interventions which can be undertaken in the agriculture, forestry, fisheries and aquaculture sectors and specifically highlight critical gaps which require attention. It also notes the important role that the scientific community needs to play to translate data and knowledge into a format that can be utilized by policy makers and local actors to undertake and implement adaptation actions.

2. Action must begin even under scientific uncertainty

Currently there is considerable uncertainty on the scale and eventual nature of adaptation interventions which will be required in the future. Although extensive work has been undertaken on predicting climate changes and their possible effects at global levels, far less has been undertaken on impacts and indirect impacts of climate change on agriculture at national and local scales. In addition, although work has been done to look at impacts on single organisms it is very difficult to assess impacts on ecosystems which are highly complex and diverse. Little is also known on the combination of stresses (e.g. extreme heat and drought) on different land and aquatic systems. For example, in rice systems there is some evidence that the combination of heat stress and salinity stress is more adverse than each of these stresses separately.

Agriculture, forestry, fisheries and aquaculture production tends to be very context-specific and the choice of adaptation options will depend on the conditions under which they will be applied. Large-scale approaches which do not consider local environmental, social and economic contexts may lead to mal-adaptation or have other negative tradeoffs. The lack of data, knowledge and accuracy of climate change models make it difficult to ascertain what location specific changes in climate will occur and which adaptation actions are appropriate.

However, although there may be uncertainty on future changes in climate, action needs to be initiated and should begin by addressing present risks and vulnerabilities and restoring the natural resource base and ecosystem services on which the agriculture and other sectors depend. The adoption of "no regret" actions can bring immediate food security benefits as well as contribute to long-term resilience to communities, landscapes and infrastructures. Adaptation within the agricultural sector is therefore an important means to also address national development objectives.

FAO has developed a number of programmes and initiatives to support its member countries on issues related to climate change. These include FAO-Adapt (www.fao.org/climatechange/fao-adapt/en/) and the Climate Smart Agriculture (CSA) concept. Recently FAO with its partners has developed a CSA sourcebook to guide stakeholders in the implementation of national, landscape and farm level CSA approaches and interventions (www.fao.org/climatechange/climatesmart/en/). The sourcebook contains information and guidance on production practices and techniques, landscape approaches and the policy, finance, institutional and governance options to facilitate the adoption of appropriate approaches. Guidance is provided on use of diverse set of crop varieties, breeds, planting patterns, water and soil management practices as well as the adoption of integrated mixed systems tailored to the environmental and socioeconomic context.

3. Productivity must be sustainably increased within current land usage.

Many agriculture systems, especially in Africa, have low productivity and high variability in yields. This is often due to lack of access to suitable inputs such as genetic stock and resources (such as water/irrigation) and the prevalence of pests and diseases. These systems are often resource deficient, inefficient and highly vulnerable to shocks. However, agricultural systems must significantly increase production without further encroaching on sensitive and critical ecosystems. Increasing productivity and resource efficiency on existing agricultural lands is therefore a priority. This can be achieved through improved access and use of genetic resources and management practices as well as harnessing ecosystem good and services. For example, pests, diseases and weeds cause large losses in agriculture, livestock and aquaculture production. Disrupting the life cycles of these organisms, as well as supporting natural predators, can greatly reduce losses and the need for external inputs. Changes in climate and landscapes can alter both the seasonal occurrence and the geographical extent of pests, diseases and weeds as well as the transmission and dynamics with hosts, however there is currently very little research in this regards. Other important services, such as pollinators, of which 75 percent of the leading global food crops are dependent, are also under threat from climate change, although impacts on these organisms or potential dysfunctions to plant-pollinator interactions are mainly unknown. However, improved management of landscapes and ecosystems can greatly build resilience and reduce risks to shocks (such as floods), preserve natural resource base (water and soils) and may even have mitigation co-benefits by creating carbon sinks. Such holistic approaches can also allow the identification of lands to be preserved, for example avoiding the conversion and drainage of organic soils and peatlands which have high carbon and water content can safeguard water resources, reduce the risk of flooding and salinization and also be a cost-effective way to reduce green house gas emissions. However, as agriculture systems are highly varied and occur within different environmental, social and economic contexts, more work is required to understand and guide the most effective and sustainable way to adapt to climate change and sustainably increase agricultural production.

4. Genetic resources

Maintaining a high diversity of genetic resources means maintaining options for coping with climate change. To sustain current levels of food and fiber production and to meet future challenges, plants, animals and micro-organisms within and outside agriculture systems must have the biological capacity to adapt to a changing climate. Farmers, livestock keepers, forest managers and fish farmers must have access to the suitable genetic resources to adapt their production systems. The utilization of different varieties and breeds and their wild relatives is fundamental in developing resilience to climate shocks and longer-term climate change. However, there are currently critical gaps and limited knowledge on the suitability of different crop varieties, livestock breeds, aquatic stock and tree species and varieties to be used for climate change adaption purposes in different environmental, social and economic contexts. This is particularly the case for less commercial varieties or other traditional food sources which are however essential for smallholders and subsistence farming. Not only is there a need to conserve genetic resources, it is fundamental that the needed research is undertaken to identify genetic traits which are key for adaptation, such as resistance to droughts, salinity, floods, pests and diseases as well as other information such as nutritional content and suitability in different farming systems and ecosystems. For example, in future decades there will be major changes in consumer demands for meat and dairy products, especially in developing countries. This will cause major shifts and changes in current livestock production systems, however there is limited knowledge of the impacts of climate change such as on the availability of feeds as well as on changes in the distribution of pests and diseases or the suitability of breeds to new climatic conditions or shocks such as heat stress. Considering the length of time required to develop new varieties, breeds and aquatic stock, prompt action is needed. The FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) has stressed that the key role of genetic resources in climate change adaptation is often underestimated and that there is a need to further promote the understanding of and the technical knowledge on the roles and importance of genetic resources for food and agriculture in climate change adaptation and mitigation programmes. To contribute to addressing these issues, the CGRFA has recently adopted a Programme of Work on climate change and genetic resources for food and agriculture (see annex 2 for more details).

5. Adequate assessment and monitoring tools for decision making

A key challenge is integrating emerging climate change research with traditional knowledge and using the data to create guidance that is useful for policy and financial planning. Multiple objectives need to be achieved at different temporal and spatial scales and synergies need to be created between food security, poverty reduction and climate change responses and across sectors. However, to identify appropriate adaptation responses requires the integration of social, economic (including farm and household data and especially of vulnerable groups) and biophysical data (including GIS and remote sensing data) and a better understanding of the direct and indirect influences on agricultural and rural systems. Tools need to enable decision making in spite of uncertainty and provide an understanding of costs, limitations and even tradeoffs which different actions may have. There is also a need to understand short and long-term gains to ensure that short-term actions results into long-term adaptive responses. Currently in most sectors there are few indicators to measure adaptation “success” and this is particularly the case for the agriculture, forestry, fisheries and aquaculture sectors. However, such metrics are important for measuring adaptation benefits and increasing the efficiency of future adaptation investments. Applying a landscape approach in the field and mechanisms to facilitate effective intersectoral coordination will be essential.

Climate change will not only affect production but also other stages of the food value chain causing reductions in both food quantity and quality. Impacts range from issues related to food safety, such as increased prevalence of pathogens and toxins, to impacts on infrastructure such as damage to storage facilities or roads. However research on the effects of climate change on post production is limited and more work is needed to identify "hotspots" and provide suitable, simple and affordable solutions to reduce food losses and preserve food quantity, quality and nutritional value. Improved processing, storage and access to markets also allows for surplus to be used when needed or sold at markets when prices are more favorable, improving food security, income stability and reducing vulnerability to shocks. Finally a better understanding is required of consumer behaviour, the methodologies needed to encourage changes in food preference and consumption patterns.

6. Improving the capacity of agricultural sectors and especially smallholders to respond to climate change

Adaptation to climate change is information-intensive as farmers', fisher folk and forest managers need the ability to assess weather, determine planting cycles and other management interventions, make long-term planning and evaluate the risk of gradual climate change and extreme events. Services and extension mechanisms are needed to allow farmers to understand and use this knowledge. For examples climate services would improve planning and provide warning for extreme events or potential pest outbreaks. However this requires improvements in global meteorological data (including the essential climate variables - ECVs), remote sensing information as well as the tools to analyze and disseminate the information. In addition a major challenge will be the agreement of the data providers to make the information freely available. Farmers, fisher folk and foresters also need simple tools to allow them to understand how their system could be affected, assess risks and provide guidance on how to make modifications which improve resilience, increase production and resource efficiency. In addition, communities need to have improved access to information on suitable diversification options which may include livelihoods outside of the agriculture sector. Communities also require improved social protection, safety nets and insurance mechanisms and schemes.

7. Transboundary cooperation

Mechanisms need to be created to support collaboration and exchange of knowledge between stakeholders, especially at the regional but also at the interregional levels. Such partnerships can support responses in relation to transboundary issues such as the sustainable management of natural resources such as watersheds and fish stocks or the prevention and control of pests and diseases. In addition, such collaboration can allow countries encountering new challenges and climate and weather patterns to receive advice from countries who are accustomed to such conditions. Mechanisms should also be created to support technology transfer, capacity building and policy advice in this regards the new Doha Work Programme on Article 6 could support and act as a catalyst to achieve the above objectives.

Annex I: Methods and Tools

The following annex provides a number of useful methods and tools developed by FAO and its partners for undertaking various assessments and monitoring which provides fundamental information for informed planning of climate change adaptation practices.

COYOTE: Crop monitoring and yield forecasting for early warning systems

The "CM Box" (Crop Monitoring Box) is a toolbox for agrometeorological crop monitoring and yield forecasting. It is an automated software suite with a "visual menu" that offers easy access to database that holds all the data needed to analyse the impact of weather on crops. The tool is useful for risk analysis, monitoring and forecasting crop production, which is an essential input to food security planning. The tool can compare maps of current yield expectations with historical average conditions. The CM Box is meant to offer an easy solution to rapidly setting up an operational crop monitoring and forecasting system. In the initial phase, reference data as well as real-time satellite and weather data can be provided by FAO based on international sources, but over the period, more and more national data can be used. Interested countries receive a combination of training, hardware, software customized for local use, as well as the real-time data required to operate the system in-country. The package can be tailored to suit the countries' specific requirements, based on national preferences as well as available expertise, methods and data. FAO is updating the core of the CM Box developing a new tool called **COYotE** (CrOp Yield Estimation).
Details at: www.fao.org/nr/climpag/aw_6_en.asp or www.foodsec.org/tools_cw_01.htm

FAO-MOSAICC (for MOdelling System for Agricultural Impacts of Climate Change)

Mosaicc is a system of models designed to carry out each step of the impact assessment from climate scenarios downscaling to economic impact analysis at national level. The four main components of the methodology are a statistical downscaling method for processing GCM (Global Circulation Models) output data, a hydrological model for estimating water resources for irrigation, a crop growth model to simulate future crop yields and finally a CGE (Computable General Equilibrium) model to assess the effect of changing yields on national economies. The modelling system also comprises documentation on methods and tools, as well as user manuals and sample data. The system will be installed in candidate countries and national institutions in which training will be organized.
Details at: www.fao.org/climatechange/mosaicc/en/

Local Climate Estimate Tool

The Local Climate Estimate Tool (New_locClim), is a software program and database, provides estimates of average climatic conditions at any location on earth based on the FAOCLIM database. The programme can create climatic maps, extract data in various formats from the database for further processing and can display graphs showing the annual cycle of monthly climate and the crop calendar. The tool provides growing season characteristics based on a comparison of rainfall and potential evapotranspiration and estimates of monthly, 10-day and daily values of common climate variables. The programme includes the current updated version of the FAOCLIM database of almost 30 000 stations worldwide, but users can also process their own data and prepare maps at any spatial resolution. Computer application programs (in Microsoft Excel) are included in the CD-ROM to help simplify complex calculations.
Access and download the tool at: www.fao.org/nr/climpag/data_5_en.asp

Farm Adaptive Dynamic Optimization (FADO)

Farm Adaptive Dynamic Optimization (FADO) refers to a combination of methodology that helps to identify, analyze and prioritize the climate related vulnerabilities and risks and optimize the adaptation practices to effectively respond to climate variability and change. The approach combines the historical climate data and modern data transmission and information sources for real-time analysis of impacts. It provides opportunities to generate viable options for farm decision making to manage the risks and opportunities at the farm level. The four major components of the FADO methodology are: exploring knowledge on local situation of farmers' decision problems, analysing the vulnerability and climate risks to optimize the management options, decide appropriate

adaptation practices relevant to local situation and facilitate local action by communicating climate information and suitable adaptation practices to farmers.
Additional information as: www.fao.org/nr/climpag/aw_5_en.asp

FAO-Rain Fall Estimate Routine

FAO Rain Fall Estimate (FAO-RFE) for Africa is a new independent method to estimate the rainfall amount, particularly, for certain regions where the coverage of the weather stations is scarce. FAO RFE is based on the Meteosat Second Generation IR channel combined with data coming from ECMWF global forecast model and EUMETSAT MPE. A local calibration is performed using the ground gauges, directly received as SYNOP messages and after a data validation. FAO-RFE offers 10-day and monthly rainfall totals for whole of Africa and for four regions. The importance of the FAO-RFE is that it can be implemented at national level to improve rainfall estimate provided by National Meteorological Services.
FAO is now supporting the transfer of the methodology to Sudan Meteorological Authority.
Additional information as: http://geonetwork3.fao.org/climpag/FAO-RFE.php

CLIMPAG

CLIMPAG (Climate impact on agriculture) is a web portal bringing together the various aspects and interactions between weather, climate and agriculture in the context of food security. CLIMPAG contains data, maps, methodologies and tools for better understanding and analysis of the effect of the variability of weather and climate on agriculture. The web portal covers six major thematic areas: advice and warnings, climate change, climate indicators, data and maps, hotspots and natural disasters. User friendly drop-down menu provides access to all publications, tools and methods relevant to all the thematic areas.
The portal can be accessed at: www.fao.org/nr/climpag/

FAO-ASIS (for Agricultural Stress Index System)

This new tool is developed for monitoring agriculture drought with remote sensing data. ASIS detect agricultural areas with a high likelihood of water stress (drought) at global, regional and country level. The ASIS is based on 10-day (decadal) satellite data of vegetation and land surface temperature from the METOP-AVHRR sensor at 1 km resolution. The global ASIS will strengthen the crop and vegetation monitoring work of FAO's Global Information and Early Warning System (GIEWS). The standalone version of ASIS will support national food security early warning systems.
Details at: www.fao.org/climatechange/asis/en/

Remote sensing-based index for crop insurance

The FAO-Agriculture Stress Index System (ASIS) proposed a method that could prove helpful in developing remote sensing index-based insurance for food security in developing countries. It is based on per pixel analysis of drought indicators that takes into account both the temporal and spatial integration of drought. The proposed remote sensing index will work better in countries with semi-arid conditions where water stress is the main limiting factor of agriculture production. With respect to weather station-based indices, a remote sensing-based index presents the advantage of exhaustive ground coverage. On the other hand, rainfall estimates derived from remote sensing or general circulation models present the disadvantage of over/underestimating rainfall; in this case, we prefer to consider the NDVI as a proxy for assessing the crop condition (which itself depends on the water available to the crop).
Details at: www.fao.org/climatechange/asis/en/

GAEZ (Global Agro-Ecological Zones)

GAEZ programme aims at developing global assessments on the world's agriculture and natural resources potentials to support strategy, management, planning, rational use and sustainable development goals addressing food security – facilitating access to data, information and knowledge to Members. The GAEZ database provides the agronomic backbone for various applications including the quantification of land productivity. Results are commonly aggregated for current major land use/cover patterns and by administrative units, land protection

status, or broad classes reflecting infrastructure availability and market access conditions. The database contains 5 main thematic areas: 1. land and water resources; 2. agro-climatic resources; 3. suitability and potential yields for up to 280 crops/land utilization types under alternative input and management levels for historical, current and future climate conditions; 4. downscaled actual yields and production of main crop commodities; and 5. yield and production gaps.
Details at: www.fao.org/nr/GEAZ

Climate change for forest policy-makers: an approach for integrating climate change into national forest programmes in support of sustainable forest management.
This publication seeks to provide a practical approach for integrating climate change into national forest programmes, or countries' forest policy frameworks to support sustainable forest management at country level.
Details at: www.fao.org/docrep/015/i2429e/i2429e00.pdf

Climate change guidelines for forest managers.
These guidelines seek to assist forest managers to better assess and respond to climate change challenges and opportunities at the forest management unit level.
Details at: www.fao.org/forestry/climatechange/53620/en/

Annex II: Commission on Genetic Resources for Food and Agriculture

The conservation, development and use of suitable genetic resources for food and agriculture, be them animal, plants, micro-organisms from wither terrestrial or aquatic environments, play a crucial role in world food security. The FAO Commission on Genetic Resources for Food and Agriculture aims with its Programme of Work on climate change and genetic resources[1] to:

A. Promote the understanding of the roles and importance of genetic resources for food and agriculture in food security and nutrition and in ecosystem function and system resilience in light of climate change.
B. Provide technical information to enable countries to understand the role of genetic resources for food and agriculture in climate change mitigation and adaptation.

The Commission aims to identify and promote the potential role of genetic resources for food and agriculture to support the planning, prioritization and implementation of adaptation actions, at different levels. It is currently conducting a survey to gather lessons learned about ways and means to use agricultural biodiversity to build resilience to climate change in food and agriculture systems. Based on the lessons learned, technical material and guidelines for the integration of genetic-diversity considerations into climate change adaptation planning will be developed. The Commission already conducted sectoral studies on climate change and genetic resources for food and agriculture looking at the state of knowledge, risks and opportunities (see Background Study Papers: www.fao.org/nr/cgrfa/climatechange).

In 2014, the Commission foresees to compile information on hotspots of biodiversity for food and agriculture under particular threat from climate change. To some degree monitoring of the impacts of climate change on genetic resources for food and agriculture is also possible through periodic global assessments on genetic resources for food and agriculture, the State of the World reports. Existing reports cover plant, animal and forest genetic resources, while reports on the state of aquatic genetic resources and on the world's biodiversity for food and agriculture are under preparation and due in 2016-2017. Member countries of the Commission also agree on priority areas and develop specific Global Plans of Action for genetic resources, which provide the frameworks to guide the implementation of actions addressing genetic resources, including climate change considerations.

More about the Commission's work at www.fao.org/nr/cgrfa.

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[1] CGRFA-14/13/Report, Appendix D