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COMMITTEE ON AGRICULTURE

Twenty-third Session

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Perspectives of Land and Water Resources in a Changing Climate

Executive Summary

The objective of this document is to seek guidance on the role of FAO in the analysis of the state of natural resources for agriculture and their sustainable management in support to national, regional and global assessments.

Agricultural production will have to increase substantially in the period towards 2050. Given the scarcity of land and water resources, sustainable intensification of agricultural production is the primary means to meet the future demand for food. Intensification will occur within a changing climate requiring adaptation and mitigation and will have to be sustainable to safeguard future use of the resources.

Information and analyses at national, regional and global level need to provide a sound basis for policies, investment and interventions required for sustainable agricultural production increases. FAO supports and undertakes assessments and maintains unique databases on natural resources for food and agriculture. It has a long history of work on agro-ecological zoning, on the assessment of land suitability and on yield estimates supporting national and global perspectives studies.

New and updated approaches are developed to estimate agricultural production potentials and variability under different environmental and management scenarios, including climatic conditions, management regimes, water availability and levels of inputs. These also offer opportunities to develop further tools and methodologies for the planning and management of national natural resources.

At regional and global level, FAO seeks to ensure that the natural resource base for agriculture is evaluated and relevant studies are made on its future outlook and sustainable use and supports the preparation of the Global Perspectives studies on world agriculture in the 21st century.

Suggested action by the Committee on Agriculture

The Committee is invited to:

1) Recommend that FAO strive to ensure that sufficient, reliable and impartial information and knowledge on sustainable management of natural resources for food and agriculture is available to Members to support policy decisions and interventions on food and agriculture at national, regional and global level. The Organization should seek to ensure that knowledge is supported by a wide scientific consensus.

2) Recommend that FAO, in cooperation with Members and with relevant national and international institutions give high priority to:
   a) development of tools and methodologies for and, on request, provide technical assistance and advise on, the planning and management of national natural resources for food and agriculture under different climatic and management conditions;
   b) analysis of regional and global perspectives on the status and sustainable use of natural resources for food and agriculture, under different climatic and management scenarios.

3) Recommend that FAO establish a small Coordinating Unit on Regional and Global Perspectives on Natural Resources for Food and Agriculture, with the objective to:
   a) coordinate, in cooperation with Regional and Sub-regional offices, the development of tools and methodologies on the sustainable management and planning of national natural resources based on new approaches to natural resource evaluation, productivity estimates and scenario analysis;
   b) plan and participate in the execution of studies on the regional and global perspectives on the status and sustainable use of natural resources for food and agriculture, under different climatic and management scenarios;
   c) identify the need for the maintenance, updating and full use of relevant FAO databases and information that form the basis of analytical work on natural resource perspectives;
   d) assure the appropriate planning and use of natural resource analysis and data within FAO, including socio-economic Global Perspective Studies on agricultural production.

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I. Introduction

1. Global population increase, urbanization, rising income and changing consumption patterns will continue to be major drivers for change in agriculture over the next decades. To satisfy the increased demand, global food production will need to continue to increase but in a sustainable way. To achieve food security for all, substantial economic, social and technology improvements will have to occur.

2. Change will have to take place within the context of conservation and sustainable management of natural resources for food and agriculture and preservation of the environment. In many places, cropping intensification resulted in soil degradation and in the reduction of water availability and quality. In particular in irrigated agriculture, increasing water scarcity and competition with other water users often constrain production. Another overriding agricultural production factor is climate change requiring adaptation to new climatic conditions, and mitigation reducing the carbon footprint of, and increasing carbon sequestration by agriculture.

3. At national level, FAO Members decide on policy, investment and interventions in agriculture and food security. At regional and global level, they create an enabling environment through international agreements, decisions, and programmes. To be able to do so in a meaningful way, Members need reliable projections on agricultural production, nationally, regionally and globally, under different climatic and management scenarios. A fundamental aspect is information on the availability, status and sustainable productivity of natural resources for agriculture and food security.

4. This document covers in particular the provision of information on, and the analysis of longer-term perspectives of, the sustainable management of natural resources for food and agriculture, within an overall framework of food security and poverty reduction. The objective of this agenda item is to seek guidance on the role of FAO in the analysis of information on the state of natural resources for agriculture and their sustainable management in support to national, regional and global assessments.

II. The need for national, regional and global assessments of natural resources for food and agriculture

5. Global population is projected to increase from 7 billion in 2010 to 9.3 billion in 2050 and 10 billion in 2080, according to the medium variant of the UN World Population Prospects[1]. Most of the increase is projected to come from 58 countries, of which the large majority is in sub-Saharan Africa. Recent data indicate that due to population increase and dietary changes, demand for agricultural produce may rise by some 60 percent in the period 2005/7 to 2050 [2]. Globally, it is projected that the increase in demand can be met through further intensification and extension of land under cultivation. It is estimated that around 90 percent of the increase in agricultural production will come from intensification, including extension and better use of irrigation, and the remainder from expansion of the area under cultivation[3].

6. After making ample allowances for forested and protected land and land in other use, globally, some 1.4 billion hectares of uncultivated prime and good agricultural land remain. The uncultivated land with a good agricultural potential is, however, distributed very unevenly. In the Near East, and southern and eastern Asia very little remaining land is suitable, and water availability for irrigation becomes a limiting factor to intensification[4]. In particular, countries with rapidly growing populations, little additional suitable land resources, and a low, mostly agricultural gross domestic product, will

[1] United Nations, Department of Economics and Social Affairs, Population Division. World Population Prospects: The 2010 Revision.
[2] FAO, 2006. World Agriculture towards 2050. Interim Report FAO, Rome, revised by FAO staff in 2011 (publication in preparation).
[3] Piero Conforti, ed. 2011. Looking ahead in world food agriculture: Perspectives to 2050 FAO, Rome
[4] Fisher, G. et al., 2011. Scarcity and abundance of land resources: competing uses and the shrinking land resource base. SOLAW Background Thematic Report, TR02.

have great difficulty making the necessary investment to increase agricultural production and reduce poverty and hunger.

7. Biofuel and livestock production may substantially influence the future perspectives of agricultural demand and production. Biofuel production is driven, in part, by subsidies and mandates, in part, by economic factors and its contribution to future demand is difficult to estimate. Dietary changes, and in particular increased consumption of livestock products will be a critical driver of demand growth while a reduction of post-harvest losses and food waste might reduce the need for an increase in food production. Sustainable diets will be an important element of a shift towards sustainable agriculture development. Predictions on the effects of climate change on agriculture indicate a decline of production at lower latitudes and an increase of production at higher latitudes. Overall, global predictions of reduction in potential yield are not very substantial until 2050, but are larger after that date[5]. However, climate change scenarios predict serious yield reductions in many developing countries; effects will greatly differ among regions and locations and be particularly severe where land and water resources are already scarce.

8. Intensification has been accompanied, in places, by significant degradation of land resources. This is due, in part, to production systems that are not sufficiently adapted to local ecological conditions, which trigger problems such as water and wind erosion, nutrient mining, topsoil compaction, salinization, soil pollution and loss of biodiversity. Globally, only half the nutrients that crops take from the soil are replaced. Soil health is declining in many cropping systems both in developed and developing countries. The worst situations occur in highland rainfed cropping systems; in low input, limited management rainfed cropping and agro-pastoral systems and in a number of intensive agricultural systems. Globally, approximately 25 percent of all land, including croplands, are characterized either by a low 'baseline' level of ecosystem benefits and/or declining ecosystem benefits.

9. Irrigation development and efficiency are vital to raising agricultural productivity worldwide, but negative side effects of intensive irrigated farming on soil and water have been substantial. It is estimated that worldwide, 34 million hectares (11 percent of the irrigated area) are affected by some level of salinity. An additional 60 to 80 million hectares are to some extent affected by water logging and related salinity. Groundwater is pumped intensively and in some coastal areas aquifers are increasingly polluted and salinized[6].

10. The most important water pollution problems related to agriculture intensification are excess nutrients in surface and coastal waters, accumulation of nitrate in groundwater, and pesticides in surface water bodies and groundwater. Agrochemical pollution is widespread. In addition, agriculture may cause other extensive off-site and downstream impacts, including changes in river hydrology and groundwater recharge rates, siltation, and the impact on related ecosystems. Water is also an important vehicle for transport of both pathogens and chemical contaminants from the environment into the food chain, thus impacting on Food Safety and Public Health.

11. Increasing agricultural productivity is the primary means to meet the future demand for food given the constraints on land and water use. To be sustainable, agriculture, including aquaculture and agro-forestry, will need to improve water productivity, increase the efficiency of energy and agricultural chemicals use, protect the environment, restore and preserve soil health, protect and better manage water and biodiversity resources and enhance the use of ecosystem services. Intensification will take place within a changing climate, requiring adaptation and mitigation through technologies and practices that improve the resilience of farming systems in particular those of small farmers in resource-poor countries that are vulnerable to severe climate impacts.

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[5] Fisher, G. How can climate change and the development of bioenergy alter the long-term outlook for food and agriculture? In: Piero Conforti, ed. 2011. Looking ahead in world food agriculture: Perspectives to 2050 FAO, Rome.

[6] FAO 2011. The state of the world's land and water resources for food and agriculture (SOLAW) - Managing risks. FAO, Rome and Earthscan, London.

12. To create conditions for production increases, investment is required to develop innovative systems, practices and technologies and to extend information and best practices to farmers, including climate change adaptation techniques and traditional knowledge. Major investments are required, including in rural infrastructure and support services and building capacity addressing policy, institutions and farmers. Rural employment and access to markets will need to be created. Perspective studies at national, regional and global level are required to provide a sound basis for agricultural policies, strategies and interventions.

13. Within these overall requirements, the Natural Resources Management and Environment Department (NR) is particularly responsible for the development of tools for perspective studies on natural resources and, on request, to support national studies. At regional and global level, the Department needs to ensure that the natural resource base for agriculture is monitored and relevant studies are made on its perspectives and sustainable use. At national and global level the Organization (Economic and Social Development Department) is producing perspective studies that focus on socio-economic and technical projections of future demand and production and the NR Department provides inputs to these studies.

III. The work of FAO on information on natural resources for food and agriculture

14. The objective of the Organization is to ensure that sufficient, reliable information and knowledge on sustainable management of natural resources for food and agriculture is available to Members to support policy decisions and interventions on food and agriculture at national, regional and global level. FAO encourages the availability of such information, seeking to ensure that it reflects a wide scientific consensus and it being reliable and impartial. FAO is a repository, quality controller, standard provider and facilitator for data and information development and undertakes analytical work of its own, drawing on technical work in and outside the Organization.

15. Policy setting and the planning of interventions require in particular perspectives on volume, variability and sustainability of agricultural production, and information on land, water, soil and biodiversity are basic components of these projections. Scenarios may include adaptation to and mitigation of climate change, different agricultural management levels, the agricultural effects of growing crops for biofuel and the effects of the modification of systems and practices, including for instance increases in organic agriculture.

16. FAO supports and undertakes assessments of natural resources for food and agriculture. It has a long history of work on agro-ecological zoning, on the assessment of land suitability and on yield estimates as part of national and global perspectives studies. The Organization cooperates with and draws on the scientific community for advice, co-operation and scientific scrutiny.

17. The Organization participated in the International Soil Science Society initiative of the World Reference Base for Soil Resources and the constant updates of the soil map of the world. This culminated in 2008 in the publication of the Digital Harmonized World Soil Database. It participates in the development of the new digital Global Soil Map of the world and has taken the initiative for the Global Soil Partnership to guide soil knowledge and their sustainable use through regional and national partnerships (see information document COAG/2012/Inf.13).

18. FAO supports the availability of global information on land cover and land cover change through the Global Land Cover Network project. It prepares various national and regional land cover and land cover change databases, including the AFRICOVER East Africa module, and provides methodologies, tools and training to national experts. Quantitative information on actual land use at sub-national level is assembled and shared through the Agro-MAPS programme, a global spatial database of agricultural land use, which is widely used by partners. In this framework, FAO also executed Land Degradation Assessments in Drylands, a Global Environment Facility (GEF) financed project related to the United Nations Convention to Combat Desertification. In this project, the decline in ecosystem services including soil degradation was assessed. The project made use of the

Organization's knowledge on soils and land cover. It provided a leading role in assessing land degradation globally, nationally and locally.

19. Global, regional and national information on crop and livestock production, forestry, input use, and a suite of agro-environmental indicators is routinely collected and distributed through FAOSTAT. FAOSTAT data and spatial datasets are commonly used by the scientific community whenever global country-level information on agriculture activity data is necessary.

20. Global, regional and national information on water is routinely collected and distributed through AQUASTAT. This unique database provides quantitative details on the availability and use of the world's water resources on a country basis, with emphasis on countries in Africa, Asia, Latin America and the Caribbean. Additional information is available related to irrigation, water management and wastewater. AQUASTAT data and spatial datasets have probably been used for all global assessments within and outside of FAO that include water use for agriculture.

21. The Organization maintains time series of data from meteorological stations that cover monthly data for 28,100 stations. Interpolation procedures provide estimates of average climatic conditions at locations for which no observations are available. In addition, to support the monitoring of crop growth conditions over parts of Africa, FAO is operating a new independent method to estimate the rainfall amount, particularly for regions where the coverage by weather stations is scarce. The information is routinely used for yield forecasts, in particular for early warning systems for food security including the FAO Global Information and Early Warning System.

22. Crop models that generate guidance on actual and potential yields and water requirements are developed and maintained as tools for formulating strategies and policies for sustainable crop production. Crop models are at the core of FAO's work on Agro-ecological Zoning (AEZ). A more elaborate crop model, AquaCrop, has now been developed; it allows for more accurate simulation of crop growth and water requirements, yield and water productivity, effects of management practices and impacts of climate change. In addition to globally important crops, new parameters on crop growth are being developed for locally important crops that may have a high relevance for food security and resilience of the cropping system to climate change. Furthermore, the Organization coordinates assessments of the state of the world's genetic resources for food and agriculture.

23. The combination of FAO's collection of data on soil, water and climate, its crop models, its information on crops, and its long-term statistical time series, are used in global agro-ecological zoning and land suitability analysis and in projections on future production. The International Institute for Applied Systems Analysis (IIASA)/FAO Global Agro-Ecological Zoning (GAEZ) is a unique, multi-sectoral analytical programme. It has been used to evaluate different climate change scenarios and levels of inputs. The programme, and its database, is currently being transferred from the IIASA to FAO Rome.

24. FAO assisted a number of countries in evaluating the effects of climate change on yields and on the suitability of land for crops. Within the framework of the German-supported Bioenergy and Food Security project the suitability of land for bioenergy and food crops was assessed in Peru, United Republic of Tanzania and Thailand. FAO also executed projects on land cover and potential land use in Libya using this methodology. A specific modelling system for the assessment of agricultural impacts of climate change was recently developed and tested in Morocco.

25. Many of the datasets resulting from FAO's work are of a spatial nature and are maintained as part of a core geospatial dataset on natural resources and published through the GeoNetwork, FAO's spatial data portal on the internet.

26. All above activities are funded by a mixture of Regular Programme and extra-budgetary funding. Opportunities for extra-budgetary funding often drive parts of the programme. The consequence is that there may be a discontinuation of valuable programme elements after the funding ends. Whatever the vagaries of funding, the Organization has over a long period been able to maintain a coherent vision on activities in relation to soil, water and climate, which are well recognized outside the Organization. FAO's Independent External Evaluation recognized the importance of FAO's global

information system on natural resources and advocated that approaches and methods needed to be transferred to member countries for application at national level.

IV. Approaches to estimate future agricultural production, system resilience and sustainable management

27. The methodology to estimate the productivity of natural resources for food and agriculture depends on the purpose of the estimates. The understanding of the causes for a gap between 'attainable' and 'actual' production provides the basis for establishing a sound decision-making process. These decisions may address financial investment, operational management, and scenario analyses, the latter to test alternatives to the current status of production. Decision-making will occur at different levels and vary from planning to management. The methodology for production estimates may reflect that difference: relatively coarse-spatial assessments for investment-related planning to higher-resolution assessments for operational management. Similarly, strategic decisions require long-term assessments while for tactical decisions short-term assessments will suffice.

28. Agro-ecological zoning analysis offers assessments based on land-suitability and potential-productivity criteria, the origin of which dates back to the 1970s. To respond to emerging needs, and provide meaningful answers to member countries' requests, FAO is now gradually renewing this assessment capacity by updating tools, methods and the database. New approaches to agricultural production estimates and scenarios for different conditions are being developed; in particular, the AquaCrop crop model for yield and water-productivity analysis is developed further and the use of Remote Sensing approaches for land and water productivity appraisals at various spatial and temporal scales is being investigated. The recently established Global Soil Partnership is a suitable vehicle for a renewal of the land planning/suitability criteria.

29. Studies and evaluations of natural resources for food and agriculture will be undertaken at regional and global level to understand production potentials and variability under different climatic conditions, different management regimes, different allocation of water and different levels of inputs, including assessment of systems at risk and necessary climate response strategies. These studies will thus provide the natural resources information inputs needed for FAO's global agricultural and socio-economic perspective studies, as well as for short-term advice on food security. In return, assessment of available natural capital and systems response capacity will need to increasingly reflect the information and constraints highlighted through the socio-economic and food security perspective studies, leading to more fully integrated and consistent natural resource and socio-economic assessments. At the request of Members, FAO may assist with the use of these methodologies at national level to produce national agricultural outlooks and perspectives under varying conditions. The Organization will continue to seek partnerships with other Organizations and with the scientific community to ensure sound outcomes.

30. To guide further work, the Organization has commissioned a study during 2012 to further define the appropriate scope of FAO's engagement, to assess the demand for FAO insights and contributions and to assure the feasibility of FAO studies through their alignment with relevant work undertaken by other Organizations and experts.

V. Guidance sought from COAG

31. The Committee may wish to:

1) Recognize the need to assess the sustainability of agricultural production, current and future, including sustainable intensification and expansion of agricultural systems.
2) Recognize that the need for adaptation to climate change and opportunities for mitigation will influence demands on natural resources and will require adequate planning and intervention at sub-national, national, regional and global levels.
3) Recognize the need for information on, and analytical studies of the status, conservation and use of natural resources for food and agriculture as a prerequisite for the planning of efficient,

sustainable land and water use and agricultural management and for the formulation of appropriate interventions to address degradation, depletion and scarcity of natural resources.

4) Recommend that FAO strive to ensure that sufficient, reliable and impartial information and knowledge on sustainable management of natural resources for food and agriculture is available to Members to support policy decisions and interventions on food and agriculture at national, regional and global level. The Organization should seek to ensure that knowledge is developed on a broad scientific basis.
5) Recommend that FAO, in cooperation with Members and with relevant national and international Institutions give high priority to:
   a) development of tools and methodologies for, and on request, provide technical assistance and advise on, the planning and management of national natural resources for food and agriculture under different climatic and management conditions;
   b) analysis of regional and global perspectives on the status and sustainable use of natural resources for food and agriculture, under different climatic and management scenarios.
6) Recommend that FAO establish a small Coordinating Unit on Regional and Global Perspectives on Natural Resources for Food and Agriculture, with the objective to:
   a) coordinate, in cooperation with Regional and Sub-regional offices, the development of tools and methodologies on the sustainable management and planning of national natural resources based on new approaches to natural resource evaluation, productivity estimates and scenario analysis;
   b) plan and participate in the execution of studies on the regional and global perspectives on the status and sustainable use of natural resources for food and agriculture, under different climatic and management scenarios;
   c) identify the need for the maintenance, updating and full use of relevant FAO databases and information that form the basis of analytical work on natural resource perspectives;
   d) assure the appropriate planning and use of natural resource analysis and data within FAO, including socio-economic Global Perspective Studies on agricultural production.