Sustainable management of soils

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Chair of Science 20 (S20)

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S20 (Science 20) is the 7th and youngest engagement group established by the G20 countries to provide their governments with feedback from Academies of Sciences regarding the G20 agenda. Its first summit took place in Halle (Germany) in March 2017 with a discussion topic on global health. The second S20 summit took place in the city of Rosario (Argentina) on July 24 and 25, 2018. The selected topic was the sustainable management of soils within the general topic of food and nutrition security. Delegations of 20 countries were present with more than 400 participants. Recommendations of S20 about the sustainable management of soils are described below. At this summit, the Inter Academy Partnership (IAP), a world association of Academies of Science, Research and Health, presented a set of recommendations on food and nutrition security that are also incorporated to this document.

Improving Soils and Increasing Productivity (S20 Recommendations)

Soils are fragile surface formations that are responsive to human activities. As the World Soil Charter states: *"Soils are fundamental to life on Earth but human pressures on soil resources are reaching critical limits" (FAO, 2015a).* Knowledge and protection of soils is essential to sustain human civilisation.

The list of soil-related issues on the agricultural agenda has increased greatly in recent years. The 2015 *Status of the World's Soil Resources* identifies the main threats to soils as soil erosion, loss of organic carbon, and nutrient imbalances. Other threats include soil salinisation and sodification, loss of soil biodiversity, soil contamination, acidification, and compaction *(FAO, 2015b).* Additionally, high quality soil is being lost to urbanisation and industrial development. According to the *FAO (2015b)*, 33 percent of the world's soils are moderately to highly degraded due to these threats.

Soils, water and energy are essential resources for ensuring food security in the world. *FAO (2015c)* estimates that approximately 95 percent of global food production comes directly or indirectly from soils. At the current population growth rate, and projected changes in diets, it is estimated that the world will need to produce 60 percent more food by 2050, which necessitates prioritisation of the preservation of functional soils for a food-secure world.

The management of soil needs to encompass sustainable agriculture as well as the broader functions of soils for the maintenance of natural ecosystems and for climate regulation. A multidisciplinary concept of global soil sustainability is needed to quantify biophysical, economic, social and policy dimensions.

Soil sustainability requires knowledge, legislation and education in good agricultural practices of a natural resource that is often privately owned and yet is an important public commodity. Broad access to the information generated is imperative.

A diversity of sustainable soil management approaches is described in reports by UN organisations, for example, *FAO (2015b)* and *UNCCD (2017).* These aim to combat soil erosion, increase soil organic matter and promote soil carbon sequestration, limit soil sealing, enhance soil biodiversity, and long-term physical and chemical fertility. They all share the premise that sustainable soil management, using scientific, evidence-based and local knowledge can maintain or increase nutritious food supply, while also contributing to climate mitigation and safeguarding of ecosystem services *(FAO 2015b).*

In this context, the S20 affinity group makes the following specific recommendations aimed at improving the evidence base for the sustainable management of soils and increasing productivity

1. Promoting good soil governance implies soil protection against the threats mentioned above. Priorities should be given to limiting urban sprawl and devising adaptive strategies of soil management to climate change.

Soil monitoring based on benchmark sites and/or permanent observatories is necessary to assess soil restoration programmes, and detect tipping points in soil degradation. Indicators must be defined according to regional and local conditions to generate relevant information for policy makers and stakeholders. Integration of soil, water and crop data into scientifically based models allows for building scenarios and supporting decisions. Science is needed to inform policy actions by governments and civil society, particularly legislation concerning soil conservation and protection. It is necessary to promote education (schools and media) as a means to increase public awareness of the essential role of soils. Programmes aimed at educating farmers in sustainable soil management are strongly needed.

2. Substantial progress in soil knowledge involves integrating soil data into decision tools. Comprehensive 3D high-resolution (30-m) digital mapping is necessary to generate knowledge of soil properties and its relevance to research and management. This effort must be extended to all geographical regions of the world in order to identify soil deficiencies, and to underpin new practices which can improve soils. Integrating 3D digital soil properties with weather monitoring and crop suitability will improve water and fertiliser efficiency, and define best practices adapted to local and regional conditions. These soil and crop suitability maps should be complemented by methods of proximate soil sensing employing real-time big data to hasten digital agriculture. This will reduce inputs and improves environmental outcomes while maintaining or improving productivity.

The research agenda on soils must include the following:

a) Deciphering the mechanistic functions of the soil microbiome and its biodiversity on soil function and on plant and human health, is one of the more interesting challenges in modern biology. Modern high-throughput sequencing will be the basis for quantifying the genetics and enzymatic controls on an array of soil processes fundamental to agriculture, climate and medicine. Although this complex research area is at its infancy, these studies can eventually be useful to increase soil productivity and for decontamination by microbial remediation.

b) Research on the efficiency and the effective recycling of fertilisers, a critical global constraint to achieving yields.

c) The study of the short- and long-term sequestration of carbon, the preservation of soil organic matter and the rehabilitation of degraded soils.

d) Programmes aimed at reducing and eventually avoiding soil contamination should be encouraged, focusing on the toxicology and environmental aspects of agrochemicals and on sustainable practices. Examples include the combat of pests by ecological procedures, the use of less-toxic and rapidly-decomposing pesticides, and highly targeted treatments.

3. Increasing international scientific cooperation programmes in sustainably managing soil. Doctoral and post-doctoral programmes that enhance professionals and scientists of less developed countries should be specifically established and promoted.

Food and Nutrition Security (IAP Analysis)

All countries face the problem of combatting the burden of malnutrition as part of their efforts to achieve the UN Sustainable Development Goals. A project organised by IAP and involving the four regional academy networks has assessed a wide range of science opportunities for tackling food and nutrition security, with the objective of providing access for all to a healthy and affordable diet that is environmentally sustainable and culturally acceptable. The four regional reports have been published *(www.interacademies.org)* and a global report is in course. Emerging points of this global report are:

1. Taking a food systems perspective to deliver health and well-being, with research priorities, for example, in food processing, reduction of food losses and ensuring market resilience.

2. Understanding food production and utilisation issues, covering considerations of efficiency, sustainability and diversity of resources, with research priorities, for example, in evaluating impacts of climate change, issues for new farming structures, and new food sources.

3. Capitalising on opportunities coming within range in the biosciences and rapidly advancing sciences, with research priorities, for example, for novel breeding techniques and precision agriculture.

4. Emphasising transformation to a healthy diet, with research priorities, for example, for understanding consumer behaviour and private sector innovation.

5. Addressing the linkages food-energy-water-health, with research priorities, for example, to assess trade-offs between different ecosystem services.

6. Promoting activity at the science-policy interfaces and reconciling policy disconnects, for example, with regard to the priorities for global capacity building in generating and sharing research, promoting public-private partnerships and developing flexible and proportionate regulation of innovation. F

FAO (2015a), Revised World Soil Charter, Food and Agriculture Organization of the United Nations, FAO (2015b), Status of the World's Soil Resources, Food and Agriculture Organization of the United Nations, FAO (2015c), Healthy soils are the basis for healthy food production, Food and Agriculture Organization of the United Nations, UNCCD (2017), The Global Land Outlook, United Nations Convention to Combat Desertification.

Knowledge and protection of soils is essential to sustain human civilisation

The Science 20 (S20) Summit was in July in Rosario, Argentina and offered recommendations for achieving a sustainable food future