ARGENTINA 2018
SCIENCE 20

Food and Nutrition Security: Improving Soils and Increasing Productivity

Executive Summary

Soils, water and energy are essential resources for ensuring food security in the world. Human pressures on soil resources are reaching critical limits. Main threats are erosion, loss of organic carbon, nutrient imbalances, salinization and sodification, loss of biodiversity, contamination, acidification, compaction and urbanization. In this context, the S20 affinity group makes the following specific recommendations for the sustainable management of soils:

1. Promoting good soil governance. 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 programs and detect tipping points in soil degradation. 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. Programs aimed at educating farmers in sustainable soil management are strongly needed.

2. Promoting soil knowledge in specific areas. Comprehensive 3D high-resolution (30-m) digital mapping is necessary to generate knowledge of soil properties and its relevance to research and management. Integrating 3D digital soil properties with weather monitoring and crop suitability will improve water and fertilizer 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. 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; b) Studying the efficiency and the effective recycling of fertilizers, a critical global constraint to achieving yields; c) Studying the short- and long-term sequestration of carbon, the preservation of soil organic matter and the rehabilitation of degraded soils; d) Developing strategies to decrease the toxicological aspects of agrochemicals including combatting pests by ecological procedures, using less-toxic and rapidly-decomposing pesticides, and applying highly targeted treatments.

3. Increasing international scientific cooperation programs in the sustainable management of soil. Doctoral and post-doctoral programs that enhance professionals and scientists of less developed countries should be specifically established and promoted.

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 civilization.

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 salinization and sodification, loss of soil biodiversity, soil contamination, acidification, and compaction (FAO, 2015b). Additionally, high quality soil is being lost to urbanization 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 prioritization 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 organizations, 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 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 programs, 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.

Programs 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 fertilizer 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 fertilizers, 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) Programs 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 programs in sustainably managing soil. Doctoral and post-doctoral programs that enhance professionals and scientists of less developed countries should be specifically established and promoted.

References

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ARGENTINA 2018
SCIENCE 20

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S20
ARGENTINA 2018
SCIENCE 20

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S20
ARGENTINA 2018
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