Key messages World Soil Day 2022 (5 December) – Soils, where food begins.

Background

Soils, through their extraordinary capacity to form, store, transform, and recycle the nutrients, produce 95 percent of the food. Healthy soils are the basis for healthy and nutritious food: it all starts in soils… where food begins!

Of the 92 naturally occurring chemical elements on the planet, 18 are essential to plants, and 15 are supplied by soils. **Macronutrients** such as nitrogen, phosphorus, and potassium are needed for plants in large amounts. **Micronutrients** such as boron, copper, iron, manganese, and zinc and are also essential for plants but only needed in small amounts.

To sustain production over time, it is necessary to have a balance between nutrient input (*i.e.* synthetic and mineral fertilizers, organic residues, biological nitrogen fixation, atmospheric deposition,) and output (crop harvest, erosion, loos of soil organic matter, greenhouse gases emissions):

- When soils are nutrient-depleted, they lose their capacity to support crops and produce nutrient-deficient food.
- When the nutrient content of soil is too high, it represents a toxic environment for plants and animals, pollutes the environment (soil, water and atmosphere) and negatively contributes to climate change.

The problem

About **33% of the global soils are already degraded**, and the trend is accelerating. In recent decades, the status of soil fertility has declined due to unsustainable soil management practices, causing a drastic decline in food vitamin and nutrient content. Several factors are responsible for this, including the loss of soil organic carbon and biodiversity, nutrient imbalance, soil erosion, pollution, or salinity and the non-judicious use of fertilizers. In addition, an estimated **24 billion tones of fertile soil are lost due to erosion each year**. The loss of soil fertility leads to low crop yield and crop failure, leading local populations to hunger, malnutrition and poverty. Nutrient imbalance has been identified as one of the top ten soil threats. Hidden hunger (also called micronutrient deficiency) is attributed to nutrient-poor diets and is linked to nutrient-depleted soils. **More than two-thirds of the world's population lacks one or more essential minerals**.

Fertilizer

When the biogeochemical cycles are not respected, the nutrients removed through harvest need to be replaced by fertilizer. Fertilizers are chemical substances or materials from mineral, synthetic, organic, or recycled sources.

- The average yield attributable to synthetic and mineral fertilizer inputs is 40 to 60 percent in temperate climates and often much higher in the tropics.
- Synthetic and mineral Fertilizer use has increased by 500% in the last 50 years, and in the case of N fertilizers, this figure rises to 800%., causing a surplus of reactive nitrogen in the environment that has devastating consequences.

In 2020, 266 million tons of synthetic and mineral fertilizers were used in agriculture globally. In comparison, the estimated quantity of manure used in 2020 is 28 million tons.

Thirty countries use more than 90% of the mineral and synthetic fertilizers in the world, and four countries (China, India, United States of America and Brazil) alone use more than 50% .

Overuse of fertilizers causes soil and water pollution through nutrient leaching, alteration of biogeochemical cycles, eutrophication of water bodies and greenhouse gas (GHGs) emissions.

- In highly fertilized areas, between 50-60 percent of the nutrient inputs become a major source of pollution to groundwater, freshwater, and coastal waters.
- In Europe, 45 percent of Cd contamination of cropland is caused by certain mineral phosphorus fertilizers.
- Globally, there is a nitrogen surplus (the amount of nitrogen added to the soil is greater than the amount of nitrogen removed by crops). As a result, almost half of the applied nitrogen through fertilizers enters the food chain and the rest is lost into the environment. 38% of agricultural emissions come from the release of N2O (a potent GHG with a global warming potential 300 times higher than the one of CO2). On the other hand, nitrogen fertilizers are responsible for feeding 48% of the world's population.

Underuse of fertilizers. In some regions, the use of synthetic and mineral fertilizer is very low compared to the global average.

- The average fertilizer consumption in sub-Saharan Africa is estimated at 17 kg of nutrients per hectare of cropland, which is very low compared to the world's average fertilizer consumption of 135 kg/ha.
- The underuse of fertilizers also has a significant impact on soil health as it means that nutrients are being mined from soils and soil organisms do not have access to essential nutrients to grow and support the nutrient cycle.

The misuse of fertilizers also constitute an issue as in the absence of extension services, farmers use fertilizers according to their knowledge or that advice given by agro-dealers. This is done without considering the status of key soil properties and crop requirements. Furthermore, the quality of fertilizers is in many cases unknown.

Fertilizer crisis

Smallholder farmers, particularly from vulnerable countries across Africa, Latin America and Asia, lack access to organic and inorganic fertilizers and are currently facing a 300 percent increase in fertilizer prices, already impacting food production prospects and farmers' livelihoods in many countries. The answer to the crisis is not simply to facilitate the production of more fertilizer, but to increase fertilizer use efficiency and strengthen and promote alternative sources of fertilizer.

Soils and food security

Soils have a key role in all four dimensions of food security: availability, access, utilisation and stability. The chronic lack of micronutrients from soils and diets causes severe and often invisible health problems. Hidden hunger affects over 2 billion people worldwide and about two-thirds of the world's population is at risk of deficiency in one or more essential mineral elements. Higher yields mean that nutrients from the soil must be distributed across a greater volume of crops, diluting the nutrients in fruits and vegetables. The average nutritional value of the main crops has declined since 1950, and some vitamins and minerals have decreased by 15 to 40 percent.

Taking action to prevent and reverse nutrient imbalances in agri-food systems

By 2050, agricultural production must increase by 60 percent globally – and almost 100 percent in developing countries – to meet food demands alone. Sustainable soil management could produce up to 58 percent more food.

- Fighting nutrient imbalances through a sustainable use of fertilizers. The International Code of Conduct for the Sustainable Use and Management of Fertilizers, together with the Voluntary Guidelines for Sustainable Soil Management (VGSSM), provide the framework for implementing locally-adapted sustainable practices. Alternative fertilizer sources should be promoted (such as manures and bio-fertilizers) and the pursuit of new sources and technologies for cheaper, cleaner, and more effective soil nutrition should be sought.
- Improve data and information on key soil characteristics. Soil maps capture the spatial variability of soil resources and allow to identify intervention hotspots and guide localized management decisions. Soil nutrient mapping constitutes a key tool to enhance fertilizers use efficiency.
- Recarbonization of soils. The increase in soil organic carbon stocks through the global RECSOIL Programme can improve physical, chemical, and biological soil properties, boost nutrient content and reduce the dependence on inorganic/synthetic fertilizer.
- Nature based solutions. There is no single solution to all soil fertility problems, but nature offers a portfolio of alternatives to increase nutrients in soils:
    - Soil biodiversity can make a difference in the soil nutrient status. Using nitrogen-fixing and phosphorus-solubilizing microbes and biofertilization techniques increase the availability of nutrients for plant uptake.
    - Improving soil health by adding organic matter and regulating soil pH increase soil fertility and nutrient availability. Livestock manure is a resource of organic material and beneficial microorganisms and often an unexploited nitrogen source.
    - Composting and recycling of food waste can bring back nutrients to soils and contribute to the circular economy.
    - Crop diversification and inclusion of pulses improve nutrient cycling, nutrient use efficiency, and soil nutrient storage while reducing the need for external inputs.
- If you cannot measure it you cannot manage it. Monitoring soil fertility and fertilizer quality through standardized analytical methods is critical to provide reliable and comparable soil information. The Global Soil Laboratory Network (GLOSOLAN) builds and strengthens the capacity of laboratories in soil analysis and the International Network on Fertilizer Analysis works on evaluating the quality and safety of different nutrient sources to avoid health problems and environmental pollution.
- Empowering farmers to embrace sustainable soil management practices. Farmers should be at the center of the plans for the maintenance and enhancement of soil fertility and sustainable nutrient management. Strengthening of national capacities on sustainable soil nutrient management, technical support, and financial incentives are part of the root solutions to soil fertility loss and nutrient imbalances of the Global Soil Doctors Programme.
- Recycled nutrient sources are alternatives to increase soil fertility and contribute to the circular economy. About 3.5 million tons of waste produced daily worldwide could potentially be used to bring back nutrients to soils. Animal manure, urban wastes, wastewater, algae biomass, compost, among other sources, can be returned to the plant nutrient cycle after consumption by humans or animals, as by-products of food processing or as plant residues returned to the soil.

Sustainable soil management is still the most cost-effective solution to increase the content of nutrient in soils and improve crop yields for food security and nutrition.