The year 2015 has been proclaimed as the International Year of the Soils to highlight the contribution of soils in our quest to achieve food security for the teeming millions.

**OBJECTIVES OF THE INTERNATIONAL YEAR OF SOILS**

The International Year of Soils aims to increase awareness and understanding of the importance of soil for food security and essential ecosystem functions. The specific objectives of the IYS 2015 are to:

1. Raise awareness among civil society and decision makers about the profound importance of soil for human life.
2. Educate the public about the crucial role soil plays in food security, climate change adaptation and mitigation, essential ecosystem services, poverty alleviation and sustainable development.
3. Support effective policies and actions for the sustainable management and protection of soil resources.
4. Promote investment in sustainable soil management activities to develop and maintain healthy soils for different land users and population groups.
5. Strengthen initiatives in connection with the SDG process (Sustainable Development Goals) and Post-2015 agenda.
6. Advocate for rapid capacity enhancement for soil information collection and monitoring at all levels (global, regional and national).

When we speak about the importance of sustainable food systems for healthy lives, it must start with soils. Soils form the base of vegetation and agriculture. We need soil for food, feed, fiber, fuel and much more. Forests need it to grow. Soils host at least one quarter of the world’s biodiversity. They are the key in the carbon cycle. They help us to mitigate and adapt to climate change. They play a role in water management and in improving resilience to floods and droughts.

But, it is so sad and alarming that one-third of the soils all over the world have already been degraded. If the current trend continues, the global amount of arable and productive land per person in 2050 will be a quarter of what it was in 1960. The world will have over 9 billion people in 2050, 2 billion more than today. Accordingly, the food production will have to grow by 60% to feed this increased population, demanding intensive agriculture.

The pressure on soils is bound to increase and soils are not easy to fix once they degrade: it can take up to one thousand years to form one centimetre of topsoil. That same topsoil can be quickly washed away by erosion.

So, soils must be managed sustainably. There are many ways to do this. Crop diversification is one of them, which is employed by most of the world’s family farmers. And it is an apt coincidence that the International Year of Soils began to take roots from 2014 which was the International Year of Family Farming.

"SOILS don’t have a voice, and there are only a few people to speak out for them. They are our silent ally in food production..." This was José Graziano da Silva, Director-General of the Food and Agriculture Organization (FAO) speaking on the occasion of the launching ceremony of the International Year of Soils 2015.

The celebrations were officially kicked off at the FAO Headquarters on 5 December 2014, which was also proclaimed as the World Soil Day. Mr. da Silva said that the Year is an event “to highlight the significant contribution of healthy soils to achieve our food security and nutrition goals, to fight climate change and to ensure overall sustainable development”. He also pointed out that soils are often forgotten, though they are vital to and represent a silent ally in food production.

The soils are in danger because of expanding cities, deforestation, unsustainable land use and management practices, pollution, overgrazing and climate change. The current rate of soil degradation threatens the capacity to meet the needs of the future generations. The main goal of the International Year of Soils is, therefore, to raise awareness about the importance of healthy soils and to advocate for sustainable soil management in order to protect this precious natural resource.
What is Soil?

Soils are typically made up of about one-third water, one-third minerals and one-third organic materials. But, if we take these three elements separately and mix them together, we won’t get soil. Soil is much like a living organism. It is a complex and dynamic system that forms habitat for an immense diversity of species, including human beings.

It is composed of living and non-living components. The living component includes from large creatures like earthworms, ants, etc. to microscopic forms like bacteria, fungi, protozoa, and micro-arthropods. The physical and chemical properties of the soil are attributed to the non-living components of the soil. This largely includes the geological part, the solid material, which we often call the ‘soil’.

The nature of the soil varies across different geological landscapes, their formation in turn affected by different climatic, physical and chemical factors. Fertile soil remains as the base for the economic prosperity of a nation through food, fuel and fabrics. Soil could even sustain civilizations. It supplies nutrients for growth of plants which include agricultural crops also.

Soils provide us with the food that sustains life

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It can regulate the infiltration of rainwater from the surface to its deeper layers, and offers micro-filtering to the water that percolates down, creating groundwater of drinking-quality. The quality of drinking water is always determined by the filtering capacity of the soil. As a natural resource, it also contributes to the industrial infrastructure of our social life. And at the same time, it forms the fundamental constituents of all terrestrial ecosystems which influence and which are in turn influenced by systems functioning above the ground.

Soils act as reservoirs of carbon and harbour dead bodies of organisms like animals, plants and microorganisms. Soils can influence the cycling of nutrients and energy in the ecosystems. Soil also plays a major part in the Nitrogen and Sulphur cycles. In a forest land, the soil is always covered by leaf litter composed of dead leaves, twigs and roots of plants. There is a detritus food-chain going on within the soil, where the dead organic matter is decayed by certain micro-organisms in the soil. During decomposition, the organic matter is transformed into inorganic material such as compounds of nitrate, ammonium, and phosphate which supply nutrients for plant growth.

For soils, quality is of prime importance. It means its ability to maintain biological diversity and productivity. In the broader sense, it is the ability to sustain quality of water and air and providing conditions for plants, animals and human populations to live.

The soil environment is constantly under stress from natural and anthropogenic factors. Wind, fire and rainstorm are some of the natural factors while the presence of invasive species and agricultural practices like ploughing and the application of pesticides amount to the anthropogenic factors.

Soil quality is a matter of perfect interplay between the physical, chemical and biological components of the soil. As per...
Coleman and Crossley (1996), the quality and productivity of soil is influenced by the ‘parent material’ (the material that has resulted from the geologic weathering of rock), climate, soil organic matter, soil structure, soil stabilization and the presence of soil biota.

Organic matter present in the soil also determines its quality. A higher content of soil organic matter denotes its higher cation exchange capacity, higher water-holding capacity and higher infiltration capacity. When a soil naturally possesses better aeration and increased soil particle aggregation, it can lessen soil erosion due to reduced runoff of nutrients and improved moisture infiltration and retention. Cation Exchange Capacity is the ability of a soil to store nutrients like Calcium, Magnesium and Potassium for future plant uptake.

The ability of the soil to maintain its structural integrity is also important which is called the Soil Stabilization Capacity. Soils could defend natural and anthropogenic stress when there is a high degree of aggregation between the soil particles. This makes the soils more resistant to soil degradation due to erosion, loss of fertility, buffering capacity and filtering capacity.

Effects of Erosion of the Soil
Erosion is an inevitable action which implies the removal of the surface of the earth by abrasive actions of wind, water, waves, or glaciers. Based on the reason and factors, erosion can be of two types: Geological and Accelerated.

Geologic erosion is a slow process, typically occurring at a rate that is much slower than the rate of soil formation. This rate would depend on protection offered by vegetation. The roots of plants can intertwine with each other and hold the soil particles together. The vegetation over-ground such as grasses and certain other plants, which have even gained the name ‘sand-binders’, can protect the soil from washing away while the trees can reduce the wind speed so that the loose soil is not flown away.

The opposite happens in the case of accelerated soil erosion. Here the rate of soil loss is faster than the rate of soil formation. When there is a violent influx of wind or water, the individual particles of the soil become detached from the aggregates and are washed away or blown away for great distances. They are deposited somewhere else as dust or form new soils that are washed into streams, rivers, and oceans. The extent of accelerated soil erosion depends on natural conditions like climate, slope, vegetation cover, soil and the nature of land exploitation patterns.

Generally, both types of erosion result in deterioration of the fertility and productivity of the soil. There can be other consequences also such as flooding, mudslides, and loss of water and air quality. Erosion is the primary factor for soil degradation all over the world. More than one-half the global soil degradation is estimated to be happening due to water, followed by wind and chemicals and then by various physical factors. The prime danger is that an eroded land loses the capacity to remain as productive and is then abandoned.

Intensive agricultural practices also lead to soil erosion, salinization, and even desertification leading to permanent loss of the land, suitable for agricultural production. As per a recent estimate, about 25 billion metric tons of soil erodes each year from agricultural land which includes 17 tons per cultivated hectare and 4.5 tons per person.

Due to erosion, the chemical nature of the soil is altered by salinization,
Organic matter present in the soil also determines its quality. A higher content of soil organic matter denotes its higher cation exchange capacity, higher water-holding capacity and higher infiltration capacity.

Acidification, atmospheric nitrogen deposition, and presence of pollutants, excessive fertilizers, pesticides and manures. The physical processes becoming detrimental to the soil environment include water logging, soil compaction and subsidence.

The climatic condition of a region has a major part to play. In the arid and semiarid regions of the world (e.g., Northwest China, parts of Asia, Australia, southern South America, and North America and North Africa), wind erosion is a far more serious problem for agricultural lands.

Irrigation can also contribute to soil erosion by inducing salinization, the increased concentration of salts in the topsoil. It happens in almost all irrigated lands of the world due to increased evaporation, invasion of seawater and susceptibility of soils to salty groundwater. This gradually leads to soil degradation and eventually decreases the availability of productive land suitable for food, fiber, and fuel production.

Farmers then look out for new lands. It can affect ecosystems such as forests, grasslands or wetlands which have specific functions to play in the living world. It is estimated that during the past three centuries, 2.2 billion hectares of forests have been converted to agricultural lands, which, if not happened would have sustained about 4–6.2 billion hectares of forestland worldwide. Forests can also function as a reservoir of carbon which can amount to billions of tons. The carbon is stored in trees and soils. When forests are converted to croplands, apart from the loss of biodiversity, huge amount of carbon dioxide is released into the atmosphere, contributing to global warming.

Pollution of Soil
A continuous struggle is going on between those who are polluting the soil and those who are trying to remediate its aftermaths. Industrial revolution and intensive agricultural practices have made pollution of the soil an incurable epidemic. People may have been aware of the effects of water-pollution, but nobody spoke about the effects of pollution on the soil. May be because it was not obvious as in the case of water and air pollution, but the consequences were far more fearsome.

There was not even a single law relating to the regulation of soil-pollution over the past hundred years and this is true even in the highly civilized and economically developed countries. All the heavily industrialised cities of the world have a very pathetic condition pertaining to the health of their soil environment.

Only recently, ‘soil-health’ has been slowly grabbing public attention, largely due to the efforts of voluntary organisations and environmental protection agencies. However, once polluted, it takes decades and billions of money to get the soil cleaned and brought back to life.

Soil can be polluted in many ways. Soil can be directly affected when pollutants are dumped on to the soil surface. It has become a common practice to dump municipal waste including human excreta into large pits, made temporarily for the purpose or as a permanent measure. This can produce soil directly or can lead to the production of ‘leachates’ which can pollute the adjoining water-bodies. Sometimes rainwater or flash floods can carry these leachates to faraway places and pollute even the deeper layers of the soil.

A few legislations relating to this still hold good, such as the Resource Conservation and Recovery Act (RCRA), passed by the U.S. Congress in 1976 which made all dumping actions to be sanitary. According to this Act, all landfill sites must be engineered to prevent leakage to restrict the generation of ‘leachates’.

Industries are the major source of soil pollutants which include spills and leaks from manufacturing. Leaks may happen during transportation and storage. Disposal systems when not closely monitored can create more harm than good, when the underground storage tanks, disposal wells, and septic systems become faulty and start leaking to the surrounding soil wall.

Pesticide residues in the soil belong to ‘Non-Pointsource-Pollutants’ which means, they do not have any identifiable source. Pesticides may come to the soil from the air, when sprayed onto the soil surface or mixed into the soil.

Air polluting pesticide particles may settle down on the soil surface due to gravity or by way of precipitation. Fertilizers, household chemicals, detergents, construction materials, dust, etc. can also reach the soil. Pollutants that are soluble in water have the highest mobility. They are readily carried by rainwater or flood water, cleaning the soil for a while, but eventually affecting the groundwater.

On the other hand, most ‘heavy metals’ and other chemically stable substances do not directly dissolve in


Biodiversity in the Soils

Scientists believe that soils developed into their present form along with the original land plants, which happened about 425 million years ago, in the early Devonian era. Some microorganisms present in the soil, such as the Cyanobacteria, however, originated about 3 billion years ago. There exist different ‘Spheres of Influence’ for the organisms present in the soil, such as the shredders of organic matter, the soil bioturbators and the root biota.

These organisms influence the ecosystem processes through their interactions with the plants which represent the key soil biota. Though there are plenty of mites and eight-legged arthropods in a forest floor, the organisms at utmost risk include the specialized bacteria such as nitrifiers and nitrogen fixers. Other endangered micro-flora include the mycorrhiza, the symbiotic association between a plant and a fungus. Today, the macrofaunal shredders of organic matter such as millipedes and bioturbators of soils such as earthworms and termites have also become scarce.

Another group is ‘wingless insects’, called Collembolans. Collembolans are ubiquitous members of the soil fauna, often reaching about 100,000 or more in number per square meter. They feed on decaying vegetation and microbes like fungi. They may sometimes eat nematodes when they become abundant. Some feed on plant roots or other parts of the plants. There are eight families of Collembolans that occur in the soil. There are also mites in the soil, which are Chelicerate Arthropods related to spiders. They are the most abundant arthropods in the soil.

Oribatid mites are the most numerous and they are the true Soil Mites. They lead a fungivorous or detritivorous life. Termites are the other major faunal group in the soil. They areIsoptera insects which function as ‘Ecosystem Engineers’ particularly in the tropics. Their ability to digest wood has made them one among the major economic pests. Many species of termites construct mounds and in doing so provide aeration to the soil by making root channels. Termites are often considered as the tropical analogs of earthworms as they are most abundantly found in the tropics.

Earthworms have an important role in the fragmentation, breakdown, and incorporation of soil organic matter, aptly yearning the name ‘Friends of Farmers’. It is estimated that there are about 3650 species of earthworms but it is believed that more than 8000 still remain unexplored.

The vegetation over-ground such as grasses and certain other plants, which have even gained the name ‘sand-binders’, can protect the soil from washing away while the trees can reduce the wind speed so that the loose soil is not blown away.

Soil can get polluted by industrial emissions or pesticide residues

There are certain kinds of pesticides that can kill the soil-microflora. These pesticides can remain active in the soil for decades when they are said to be ‘persistent’.

Conservation of Soil

Conservation of soil is the need of the hour. Although chemical fertilizers replenish the nutrient pool necessary for plant growth, they do not regenerate the organic matter present in the soil quantitatively or qualitatively. They also fail to maintain the heterogeneity of the organic materials found in the soil. Only the slower decomposition of organic materials could replenish the fertility of the soil.

Many people cannot differentiate between a forest land and agricultural land, because, as per them, both provide greenery and all the benefits of vegetation. But, after harvest, the soil in the crop field is left bare and exposed to the effects of soil-erosion. So, whatever that is present as natural in the soil must be conserved for maximum sustainable usage.

Our land-management practices must be re-evaluated for the effective conservation of soil structure and the
Methods for soil conservation include reduced tillage, conservation tillage, minimum tillage or zero tillage. It can be achieved through specially designed machines or herbicides with minimal impact on the soil. The other methods are crop-diversification or polycultures, crop rotations, contour farming, terracing and timing of ploughing. These can be used alone or in combination.

**Reduced Tillage:** Tillage is an important factor that decreases soil quality. Reduced tillage practices could increase Soil Organic Matter and moisture content of the soil, and also improve the soil food web. However, there is a great disadvantage in reduced tillage that it requires a greater use of herbicides due to the increased spread of weeds and soil pathogens. If this is not taken into account, it may affect the crop yields due to the increased prevalence of pathogens, pests, diseases and weeds.

Reduced tillage often leads to retention of soil residues and reduction in the emission of carbon dioxide to the atmosphere. This can sustain the soil biota in a healthy state and also maintains the physical and chemical properties of the soil.

**Diversified Cropping:** Also termed as multiple cropping, growing of cover crops could ensure conservation of soil. Cover crops can reduce the leaching of soil nitrogen through immobilizing them as nitrates within the plant biomass. They can compete with weeds in establishing over a particular area and could effectively reduce the effects of soil erosion.

Normally legumes are selected as cover crops due to their capacity to fix atmospheric Nitrogen. There may be other factors for selecting the cover crop such as depth of roots and type of organic matter produced by them, their effect on pathogens and their economic benefit. Crop diversification can also maintain soil quality and increase soil productivity. Multiple cropping systems are also used as an experimental tool in modern agriculture.

**Organic Amendments:** Green manures, chicken and cow manure, pig slurry, grass cuttings, garden composts, kitchen wastes, etc. are examples of organic amendments or mulches. They can maintain the soils with higher organic content, making them fit for long-term agricultural production. Organic amendments can also improve soil aggregation, soil aeration, water-holding capacity, and cation exchange capacity of the soil.

Composts derived from municipal and industrial wastes can improve soil quality and could prevent the ill-effects of land being converted permanently to landfills. There is an economic aspect also behind composting as they are less priced than synthetic fertilizers. Increased consumer interest in the purchase of organically grown food products also increases the use of composted organic materials.

**Bioremediation of Pollutants:** Chemicals present in the soil may be those that are purposefully applied to the soil such as pesticides and fertilizers or those that make an accidental entrance to the soil. Microorganisms present in the soil may use the pollutant as a source of energy for their metabolism or would make it less harmful by changing its composition.

But when certain microorganisms are employed exclusively for this purpose, it is called bioremediation. It can be enhanced through the addition of nutrients to soil to stimulate the growth of indigenous microflora (biostimulation), addition of gases such as oxygen or methane to stimulate activity of microflora (bioventing), inoculation of soil with exogenous microorganisms (bioaugmentation), mixing toxic soil with healthy soil (landfarming) and use of plants (phytoremediation).

Let’s play our part to raise awareness about the importance of healthy soils. In the coming future, healthy soils will have to sustain food production to meet the needs of the increasing population.

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