SOIL AND THE ENVIRONMENT

I. Balasooriya

Associate Director, Institute of Fundamental Studies

Primitive man, like all other organisms which inhabited the earth at the time, was a relatively insignificant component of the environment. He had little power over other organisms. He could not substantially change the nature of his own environment. Somewhere through the ages of history man learnt the art of domesticating plants and animals. He changed his life style from a food gatherer to food grower. This was a very important event in the history of the human race. It enabled the formation of large human settlements and laid the foundation for modern civilisation. Man who was dependant directly on plants and other animals for his food and other requirements also became directly dependant on the soil for cultivating his plants.

There is no doubt, whatsoever, about the very important role played by soil in the biosphere. It forms the base of the food pyramid and support the green plants which are the only organisms that could harness the energy from the sun and make it available for the other organisms in the biosphere.

Soil is the medium on which plants grow and provide them with

1. Anchorage, and
2. Most of the nutrients

All organisms including man are directly dependant on plants for much of their requirements and are, therefore, dependant on the soil for their survival. Prosperity of a population that inhabit a particular area is usually directly related to the fertility and productivity of the soils of that area.

There are many recorded instances in the history of mankind where many a prospering civilisation had perished and disappeared due to the inability to those civilisations to manage their soils so as to ensure sustained productivity. Thus there is no doubt as to the need to manage and look after the soil if the future prosperity of the human race is to be ensured.

Soil forms a shallow mantle of particulate matter over the earth's surface and covers the parent bedrock. It varies greatly in depth ranging from several metres to a few millimetres and consists chiefly of,

Inorganic substances
Organic matter, and
living organisms

The inorganic constituents of the soil can be broadly divided into four main groups. These are;
Mineral particles of various sizes, viz, gravel, sand, silt and clay.
Mineral salts both soluble and insoluble in soil water
Soil water
Soil air

Bulk of the soil consists of mineral particles formed by

the weathering or breakdown of the parent bedrock. Weathering of rocks is a very slow process and it takes several decades for the formation of one centimetre of soil. However, several centimetres of soil from a locality may be displaced or lost in a single day due to erosion, if proper precautions are not taken. In fact much of the soil present on the earth's surface today would have been formed over the past millions of years. Much of this valuable legacy could easily get washed away. In natural habitats under natural vegetation the soil is very well protected and erosion does not take place in most instances. This is the reason why streams flowing through natural forests like the Sinharaja contain crystal clear water. In fact the waters in some of the streams in the Sinharaja Forest is believed to be some of the purest natural occurrences of water.

When the soil is covered with vegetation it protects the soil in three ways. Firstly, it prevents the rain drops beating directly on the soil surface and dislodging the soil particles. Secondly, it reduces surface run off by increasing percolation into the soil and also by retaining a part of the rain water in the foliage for a short period of time. Thirdly, it prevents the water flowing along the soil surface from directly coming into contact with the soil and washing away soil particles.

Clearing of natural vegetation exposes soil to erosion and precautionary measures should, therefore, be taken to minimize erosion.

If a soil is to be productive it must also act as a reservoir of plant nutrients, such as water and mineral salts. The mineral salts needed for plant growth reach the soil in four ways under natural

conditions, viz, chemical weathering, mineralisation of organic matter, nitrogen fixation and lightening.

Chemical weathering is a slow process and occurs when various acids and other chemical substances produced as a result of biological activity act on fragments of the parent bedrock converting insoluble complex substances into simple soluble ones. Mineralisation of organic matter is predominantly a biological process and occurs as a result of the activities of various groups of soil organisms, mainly the soil micro-organisms. Nitrogen fixation may occur as a result of the activity of certain free living micro-organisms or those that live in symbiotic associations with the other plants. Lightening converts some of the atmospheric nitrogen to oxides of nitrogen which could eventually reach the soil after dissolving in rain water.

Many of the above processes play a major role in the maintenance of soil fertility which are dependant on the activities of soil organisms. Soil organic matter is formed by the decomposition of dead bodies of plants and animals and dead parts of plants that fall on the earth's surface. They may also be formed from the excretory and secretory products of organisms that reach the soil. Soil organic matter is not only the most important substrate for soil organisms but also acts as a reservoir of plant nutrients. In addition, the decomposing organic matter release certain substances like alginic acid into the soil which help to bind soil particles together, thereby, improving the soil structure. Humus which is a product of the decomposition of organic matter, along with clay, forms the soil colloidal complex which helps to absorb and retain cations in the soil and also improve the moisture retaining

capacity of the soil.

Soil under natural vegetation like the rain forests is rather poor in nutrients but is able to support a very luxurient vegetation. This is because of the presence of an efficient recycling mechanism that operates in such habitats. In these habitats the nutrients that get added into the soil due to weathering, decomposition, natural fixation and through rain water more or less equals the nutrients that get removed from the soil due to absorbtion by plants, leaching by percolating water and denitrification. In other words the nutrients locked up in the biomass of such a system is very efficiently recycled back into the system for regeneration and growth. This becomes possible because the bulk of the biomass remains within the system even after death so that eventually the total biomass is available for recycling.

In an agricultural system the situation is very different. Much of the plant nutrients locked up in the biomass of the natural vegetation gets removed from the area during the preparation of the land for agriculture. Furthermore, with the removal of each crop from the agricultural system a certain amount of plant nutrients is removed from the system. Thus, if the productivity of the soil is to be maintained, a certain amount of plant nutrients, in the form of fertilizer or organic manure will have to be added to the agricultural soils. This must be done very carefully for the excessive use of fertilizer could adversely affect the soil biological processes responsible for the various recycling processes such as decomposition and nitrogen fixation.

The need for manupulating the natural soil biological

processes for increasing the productivity of soils on a long term basis is now being increasingly recognized. Soil is the base on which all life on this planet depends and if the soil is not managed and looked after properly there is the grave danger of the whole world changing into a desert. Many of our activities tend to cause soil erosion, thereby, decreasing drastically the quality of usable soil on the earth's surface. At the same time accumulation of various chemical substances in the soil such as pesticides, industrial affluents etc, tend to poison the soil and decrease the soil biological activity, thus decreasing the quality of usable soil. Even the indiscriminate use of mineral fertilisers in many instances lead to lower the quality of agricultural soils in the long term, by decreasing the organic matter content and by suppressing the activities of certain useful organisms like the nitrogen fixers.

Earlier belief was that the soil is an inactive reservoir of plant nutrients. Fertility could, therefore, be improved by the addition of of plant nutrients in the form of fertilizer. The realisation of the role of soil organisms on soil productivity has focussed the need for, and, the desirability of manipulating the natural processes in the soil for increasing soil productivity. Increased and indiscriminate use of chemical fertilizers tends to reduce microbial activity in the long term and interfere with the sustainable productivity of the soil. Moreover, the excessive use of other types of agrochemicals which are toxic to soil organisms also has a negative effect on soil productivity.

I would like to conclude with the following quotation

"This we know. The earth does not belong to man; man belongs to the earth. This we know. All things are connected. Like the blood which unites one family, all things are connected.

What ever befalls the earth befalls the sons of the earth. Men did not weave the web of life; he is merely a strand in it. Whatever, he does to the web, he does to himself." *

* Red Indian Chief in 1854.