Living soils:

Foundation of better agricultural practices

Editorial

Whether we realise it or not, soil affects each of us in our everyday lives. The food we eat, the farming systems, the foundations of our houses, the roads we walk on – all are affected by the state of the soil. Because it is so fundamental to agriculture, an issue of *LEISA Magazine* has come out every few years, devoted to the topic of soils. This time around, we look at it from the angle of "living soils". This topic particularly focuses on making the most of the soil's living organic matter –how to build it up and increase the availability of nutrients and soil fertility– thereby ensuring a stable base for farming systems. The composition of soil life varies from one land-use system and ecological environment to another. Besides presenting stories on specific experiences about revitalising agricultural soils, this issue highlights social processes that have helped improve soil management strategies.

What do we mean by a living soil?

Soil is often viewed as a physical substrate that performs a wide range of functions that also go beyond agriculture. It regulates water, sustains plant and animal life, recycles organic wastes, cycles nutrients, filters out pollutants, and serves as a physical support for structures. Yet, soil is also a living entity in itself, containing an enormous number of organisms, and vast biodiversity. One gram of good soil contains millions of organisms, including several thousand different species. They range in size from the tiniest one-celled bacteria, algae, fungi and protozoa, to the more complex nematodes and arthropods, and to the visible earthworms, termites, insects, small vertebrates and plants. This community of organisms makes up a "soil food web" densely packed in the upper layers of the soil (see Figure). These organisms can be divided into different levels of producers and consumers that interact and convert energy and nutrients between themselves, as well as in association with plants' roots.

Although much about soil ecosystems is still unknown, what we do know is that soil organisms modify the soil environment, affecting its physical, chemical and biological properties and processes. It is the soil organisms that interact with minerals and organic matter, helping to create soil structure and therefore affecting water infiltration, drainage and holding capacity. For example, earthworms create tunnels and burrows throughout the soil. Activities in the soil determine plants' access to nutrients through decomposition of rocks, organic matter, animals and microbes. Roots absorb these mineral ions if they are readily available in soil solution and not tied up by other elements or by alkaline or acidic environments. Many micro-organisms have symbiotic or parasitic relationships with plants, making nutrients available and contributing to protection against insect pests, microbial parasites and diseases. Furthermore, different microbes degrade pollutants such as pesticides and petroleum derivatives, and fix greenhouse gases like methane and carbon dioxide.

In this issue, we include articles that focus on the role of soil organisms. Research in Burkina Faso looks at the importance of termites and mulch to rehabilitate degraded soils (see Ouédraogo *et al*., p. 28). Another article provides a glimpse of the development of smallholder adoption of soyabeans in Zimbabwe, and explains how different strains have different types of rhizobial relationships to fix nitrogen (see Giller, p. 30). Finally, we hear more and more about the use of "Effective Micro-organism" (or EM) mixtures as a biological input for soil, to increase decomposition processes and make more nutrients available to plants. Experts disagree on the use of this product and its effectiveness, and we therefore present two views on EM on pages 18 and 19.

Feeding soils to build up soil organic matter

Working with the soil's living processes means using practices that build up rather than deplete the soil organic matter. For

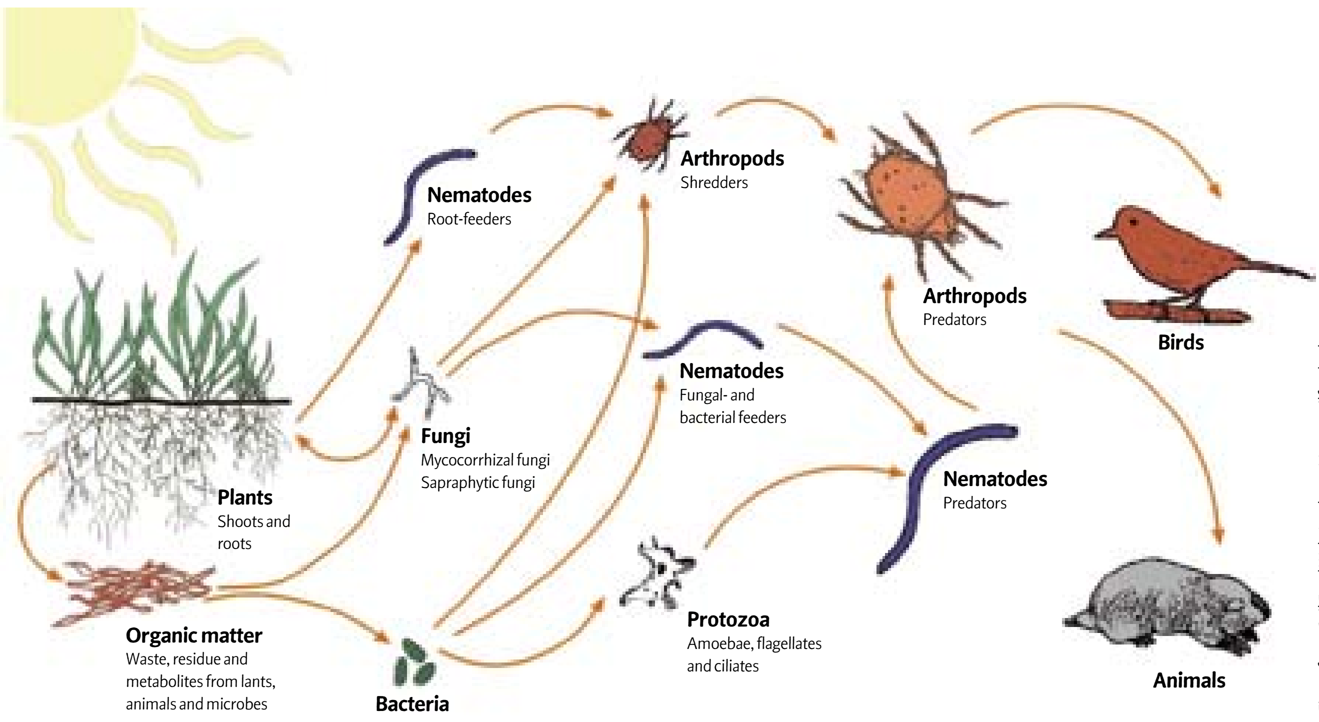

Figure from: Soil Food Web, Inc. http://www.soilfoodweb.com

Figure 1: Soil food web.

instance, continuous use of agro-chemicals to improve the availability of nutrients, without applying organic materials like compost or residues, can deplete the organic matter. Also, while farmers commonly till the soil to loosen it, prepare the seedbed, and control weeds and pests, tillage also breaks up the soil structure, destroys the habitat of helpful organisms, speeds up decomposition, and increases the threats of erosion and compaction. Practices such as burning and deforestation without replenishing the soil also lead to degradation. With time, farmers notice that their soils get "tired", their yields decline, and erosive processes become accelerated. These soils are more vulnerable to environmental forces such as wind erosion and flooding, with a greater risk of desertification.

Ecological approaches to agriculture consider the soil's living dimensions and build up organic matter. Conservation agriculture (CA) is rapidly spreading throughout the world, and is based on three principles that work towards building the living soil organic matter layer: no mechanical disturbance of the soil; maintenance of a permanent soil cover; and use of crop rotations. Practices that enhance building up soil organic matter follow one or more of the CA principles, including:

- reducing tillage (or no-till)
- diversifying cropping systems
- (re)planting trees (e.g. using buffer or contour strips, crop rotations, agroforestry)
- mulching
- using cover crops and green manures
- using crop rotations
- applying manure or compost
- using nitrogen-fixing crops
- eliminating use of herbicides
- rehabilitating degraded land

Examples of experiences with these soil-enhancing practices are described throughout this issue of *LEISA Magazine*. For example, one article details how Mexican farmers have benefited from adopting CA because their costs are reduced, as well as seeing less erosion, and higher moisture and fertility in their soils. On the other hand, they also have problems such as increased weed infestations which they responded to with herbicides. After about three years, however, farmers find that pest problems diminish and they spend less money on inputs. (see Pulleman *et al*., p. 6).

Living soils, living people

Although soils can be greatly improved through these practices, farmers are not always quick to adopt them. Attitude and behaviours may need to change, as ecological practices require different labour patterns (for example, in applying compost or mulch in different fields) as well as initial investments. Farmers may be more motivated if they can immediately see other benefits, such as higher yields or multiple benefits of growing trees to meet fodder needs while also halting erosion (see Orange *et al*., p. 12). Strategies must also look beyond the physical farming system, to the social, economic and political environment. For instance, farmers in Zimbabwe were encouraged to adopt new (soil-enhancing) crops because they were actively linked to transport, local input and market outlets (see Giller, p. 30).

Better understanding of what lies behind farmers' decision-making also helps when seeking to improve practices. In many societies, soil is regarded as "sacred", and farmers feel a connection with, and respect for, the earth and the soil. In the world of industrialised agriculture, soil is viewed more in terms of inputs-outputs, and less as a living entity. We did not receive articles on this traditionally important aspect of sustainable soil management for this issue of *LEISA Magazine*, unfortunately.

Importance of soil organic carbon

The soil's organic carbon (SOC) content comprises an important part of soil organic matter. SOC is valued by agrarians as a natural buffer for "living soil", insulating it from extreme changes in temperature, reinforcing soil structure, reducing compaction, improving water-holding and drainage, storing nutrients and providing energy for soil biological communities.

Soil organic matter holds a great proportion of organic compounds, nutrients, cations and trace elements that are necessary for plant growth. Plants absorb carbon from the atmosphere. They then transfer it to the soil through their roots, or as decomposing plant residues. Soil carbon may be returned to the atmosphere from the soil, when the organic material in which it is held is oxidised by decomposition or burning. Different agricultural practices that build up rather than deplete soil organic matter (and therefore carbon) are outlined in this issue of the *LEISA Magazine*.

SOC has lately become even more widely appreciated, especially on the international stage, as a potential reservoir for carbon dioxide (CO_2), a greenhouse gas. The amount of carbon in the soil is much larger than in the atmosphere (3.3 times) and in vegetation (4.5 times). As a result, soil carbon is seen as one of the major reservoirs for the global carbon pool. How land is used and managed determines whether the soil can be a "source" or "sink" for atmospheric CO_2. Building the SOC pool appears to be the most promising low-cost strategy to not only mitigate greenhouse gas emissions, but also to insure against otherwise devastating consequences of water shortages, drought, nutrient depletion, and salinity.

Caron Gala. Policy Programs Co-ordinator, Soil Science Society of America, 900 2nd St., NE, Suite 205, Washington, D.C. 20002 U.S.A.; E-mail: cgala@agronomy.org ; http://www.soils.org

Nevertheless, the need for greater interaction between farmers, researchers and extensionists is touched upon. For example, approaches such as "Integrated Soil Fertility Management" (ISFM) depend on a better understanding of soil and nutrient cycling processes. Tittonnell *et al*. (p. 9) describe how farmers and researchers in Kenya managed to find a way to learn together about ISFM through Farmer Field School discussions. They found that farmers were interested in discussing basic processes governing soil fertility and their decision-making with scientists, all going towards improving their practices. In South Africa, Kruger *et al*. (p. 20) describe how the formation of learning groups composed of farmers, extensionists and researchers, led to farmers adopting and experimenting more with soil-improvement technologies. Lastly, a supportive policy environment would help to stimulate farmers to invest more in ecological practices.

On our back cover, Janice Jiggins describes a landmark international agricultural report, which urges policy-makers and scientists to move in the direction of sustainable methods to offset large-scale land degradation and to meet global food needs. At the same time, international climate change experts point to the soil as an important potential reservoir for carbon dioxide, a greenhouse gas (see Box; we will delve more deeply into this topic in our December issue on *Climate change and resilience* – see Call for Articles, p. 23).

These developments all point to the need to respect the soil's living processes even more. As this issue shows, farmers practising low external input and sustainable agriculture are nurturing and building living soils in many practical ways. With the growing recognition that farmers have valuable knowledge and skills to share, we need to work hard to keep documenting and learning from LEISA farmers, while at the same time supporting them in their daily efforts.

■