Integrated Farming Topic Sheet no 5 / 2015

Soil Biodiversity and Integrated Farming

Soils – abundance of life!

Whether used for agriculture, forestry, gardening, landscaping or nature conservation purposes for example, soils are home to an abundance of life: In addition to the soil minerals sand, silt and clay, and soil organic matter, literally billions of all kinds of organism can be found under one single footprint alone. This includes bacteria, fungi, algae, protozoa, nematodes, mites, springtails, insect larvae, diplopoda and earthworms. Their combined body weight may amount to a total of 260 to 1,650 grams per square metre of soil – and that is part of the explanation for the importance of soil life in Integrated Farming.

Margarethenhof, Cologne Libur, Germany

"They are my plough", says farmer Bernd Bulich, highly dedicated supporter of Integrated Farming, and points his finger at the earth-worms, easily to be seen in the soil where the non-inversion cultivator just passed. Following first successful trials in 2003/2004, the 460 hectare family farm is consequently managed without plough for ten years now. When a biogas plant was set up in a joint venture with a neighbour in 2008, also maize and other energy crops were added to the cropping sequence which was based on wheat, rye, barley, sugar beets and oilseed rape before. Today, about one quarter of the arable area of the farm is used to grow maize, sorghum, clover-grass mixtures, sunflowers and – as a peculiarity in Germany – a mixture of maize and runner beans. Having learned to question and replace traditions – wherever possible and feasible – with better and more efficient practices during his studies of agronomy in Soest, Germany, the farmer has also started trials with soybeans on his farm.

It is not the economic results alone which prove him right; the first year without plough resulted in savings of about 10,000 litres of diesel fuel – whilst yields remained as high as before. Soils and soil life, however, particularly rewarded his doing without the plough as well as his change to keep straw as residue in the field rather than selling it to other farmers. Soils of the farm are mostly loamy sands or sandy loams, and in the past ten years organic matter content of the soils has risen by about 0.6 percent since ploughing was stopped. "It can easily be seen that these soils have become more vital, more active and more stable. The number of earthworms has increased dramatically, soils 'digest' excess water from heavy rainfalls far better and store more water which then is available for my crops. Reduced or even conservation tillage indeed requires knowledge, experience, and the courage to leave well-known paths for the unknown – but soil fertility and soil life give clear evidence of the advantages which they take", concludes Bernd Bulich with satisfaction.

All these different species are closely linked together in highly complex ecological interactions, making the soil environment one of the most complex biological systems on this planet. Whereas larger wildlife species such as birds, mammals or plants are visible and receive frequent attention, soil organisms live in and below the ground. They are tiny and unremarkable or even invisible unless observed through a microscope. Soil organisms therefore seldom receive the attention that would correspond to their biological functions and importance.

The Vinot Farm at Saint Quentin le Verger, Champagne Region, France

Jean Paul Vinot grows cereals, sugar beet, rapeseed, alfalfa, industrial hemp, as well as ryegrass, orchard grass and peas for seeds. He has been practicing Integrated Farming for decades and no-tillage for 18 years now – and observed a growing number of earthworms in his soils, improvements of the soil structure and thus positive impacts on his crops. "By using no-tillage and leaving the residues of previous crops on the soil surface, I noticed that my soil profiles became deeper, and earthworm tunnels allowed better infiltration of rain water. As a consequence, there is no more accumulation of surplus water on the soil surface. In addition, crop roots use earthworm tunnels, reach down to a depth of 70-80cm and thus use additional nutrients and water", says Jean Paul.

The growing number of earthworms was the first evidence of the stimulation of soil life following no-tillage, but apparently the number of fungi and bacteria are also increasing. 30 hectares of alfalfa are the cornerstone of the rotation. Left in the fields for 3 years, alfalfa creates a symbiotic relation with Rhizobium bacteria around its roots which go down as deep as 2 meters and enrich the soil with nitrogen. "One interesting effect of alfalfa and no-tillage is the preservation of symbiotic root-fungus-bacteria associations. As most of the soil remains undisturbed, mycelia have more time to settle and organise", says Jean Paul.

He is convinced that untilled soils are more resilient, and that earthworms, picking up residues on the soil surface, ensure a natural perforation of compacted areas whilst making their way down into the soil. "When you stop tilling the soil and allow nature to do the job, roots, earthworms, fungi, bacteria and other all kinds of soil life will organise themselves. Let them take over tillage; it will take somewhat longer, but it works. However, every farmer has to adapt his practices to his own site and situation", Jean Paul Vinot concludes.

Multiple biological processes and functions

Individual soil organisms contribute to a broad range of specific processes in soils, whereas soil life in sum allows for diverse functions and soil fertility as complex interaction between all organisms, soil organic matter and minerals present. When looking at these processes at species-level, bacteria for example are the most important organisms involved in the decomposition of organic matter – as one essential element of natural nutrient cycles. Certain bacteria of the genus Rhizobium live in symbiosis with plant roots as in legumes, for example, thus contributing to natural nitrogen fixation in soils. Fungi are equally involved in the decomposition of organic matter and may also live in symbiosis with plant roots, as can be observed with mycorrhizal fungi. Both bacteria and fungi also contribute to the biological engineering and stabilisation of mineral soil particles.

Various insect species live in soils during their larval or adult stages, and may be feeding on dead material, may be plant pests and also predators of pest species. Earthworms largely contribute to bioturbation, i.e. the natural process of moving and mixing soil and organic matter particles as well as microorganisms in the soil. Through this process of biological stabilisation of soil particles and the formation of stable soil aggregates, earthworms contribute decisively to the structure and workability of soils. In addition, worm channels are important pathways for air and water: whilst excess water can quickly be drained to deeper soil zones after heavy showers, usually air-filled channels also ensure the supply of oxygen to deeper soil zones in general and to organisms living in these zones in particular.

Arable Farmer Kenneth Verbeek, The Netherlands

The farm of Kenneth Verbeek is situated in the Noordoostpolder. This region was reclaimed in 1940 and is known as the ideal area for agriculture, because of modern farms, good infrastructure, high level of knowledge, and the fertile, easy cultivatable soils. Kenneth Verbeek grows potatoes, onions, sugar beets and winter wheat – and keeping his soils in good condition is a continuous challenge for the entrepreneur who considers the holistic Integrated Farming approach an excellent strategy to achieve ecologic as well as economic benefits for his business.

Maintaining and enhancing the vitality of the soils by focussing on soil life is one of the main goals for Kenneth. “In every farming operation, farmers will ask themselves ‘What is best for soil life?’ – and the more farmers know about their soils and soil life, the more they can do to keep soils healthy and vital”, emphasises Kenneth.

For him, taking care of his soils includes that every crop is followed by cover crops / green manure. The input of chemical fertilizers and crop protection follows the rule ‘as much as needed but as little as possible’, whereas organic manure is applied to the maximum. Kenneth prefers solid organic manure, which is applied in fall and in spring / summer, rather than compost.

A few years ago, Kenneth also experimented with applying earthworms to the soil. He believes that in a healthy soil, there must be different types of earthworms, as a visible indicator for the diversity of soil life. The earthworms settled and stayed in the fields, but the experiment was too expensive to repeat. Feeding soil life sufficiently and making sure that the conditions are optimal thus are key management tools for the farmer.

In sum, soil organisms are indispensable for nutrient cycles, for soil structure as well as air and water balances in soils – and thus for soil fertility at large. Any growth of plants on soils – and particularly any efficient production of plants in agriculture – depends on the presence and activity of these billions of busy and effective ‘little helpers’. That is why soil

organisms deserve and need particular attention, and again that is why soil management plays an important role in the holistic Integrated Farming (IF) Framework.

Protecting and enhancing soil life in Integrated Farming

In agriculture, good soil management is essential for maintaining soil fertility. That is why the chapter "Organisation & Planning" of the EISA IF Framework[1]. covers a "Whole Farm Management Plan" and an "Operating Resources Plan". According to the holistic IF approach, all management practices and all activities on a farm are closely interlinked.

Following this holistic approach, references to soil and soil fertility have to be considered throughout the entire farm management. In the EISA Framework, that is highlighted by the fact that "Soil Management" for example includes aspects such as "Long Term Crop Rotation Plan", "Soil Management Plan", supply of 'soil organic matter', 'soil examination' and 'assessment of field conditions', 'soil cover index' and 'choice of appropriate tillage operations' as well as 'measures to avoid soil compaction'. Also other on-farm measures such as "crop nutrition", "crop protection", "landscape & nature conservation" as well as "waste management & pollution control" refer directly and / or indirectly to soil health, soil fertility and thus biodiversity on and in soils. All these strategies, elements and measures of Integrated Farming aim at maintaining agricultural soils – and soil life therein – healthy, strong, and lastingly capable of providing the food, feed, fibre and fuel we need.

[1] http://sustainable-agriculture.org/wp-content/uploads/2012/08/EISA_Framework_english_new_wheel_170212.pdf