ORGANIC AND CONSERVATION AGRICULTURE, THE BEST OF BOTH WORLDS?

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Plant use solar energy, carbondioxide, water and nutrients to make long chains of carbon. These carbon chains are used for the production of carbon hydrates proteins, fats and other organic substances. We use these for our human and animal food, for fibers, building materials and as an energy resource. Part of this organic material is returned back to the soil to make it capable of growing these same plants.
In millions of years huge amounts of organic matter were stored in the soil as organic matter or fossil energy carriers as oil, gas and coal. We make use of these stocks to supply us with energy and to be able to grow plants for our needs. However what has been stored in our soils for millions of years we now are depleting in a few hundred years. Thus blowing the stored carbon back in the air as CO_2 which is generally considered to be the main cause of climate change. The amount of organic matter we return back to the soil is in general too low to maintain its capacity for plant production on the long term. Various studies show there is a decrease of organic matter in arable soils all over the world. The depletion of organic matter in our soils and the way we cultivate it, is causing susceptibility to physical influences such as erosion and run off and is disturbing the water household.
There are different strategies to cope with this decrease of soil organic matter. They come down to returning more organic matter to the soil or decreasing the speed of respiration of organic matter. Thus preserving soil organic matter at a level on which the soil can fulfill its various beneficial functions. But what level of soil organic matter should we strive for, considering the different functions to be fulfilled? What is the minimum necessary, what is the maximum? Too high organic matter levels can also have adverse effects like leaching of nutrients and emissions of methane or laughing gas emissions. Agricultural science has until now not given very clear answers to these questions.

Winning energy from organic substances as plant oils, wood, organic waste material and crop residues is considered to be partly an alternative for the use of fossil energy. Here the discussion arises if we should win energy from organic materials or we had better use them as food, fibers or building materials or use it to maintain our soils. The authors' opinion is that in general we should focus on developing other sources of energy for our daily needs. The world will already have enough trouble to feed itself in the future and moreover the plant is not very efficient in storing the energy of the sun. We should rather use organic substances dominantly to feed us, to give us clothes and building materials. Only the residues that serve no other purpose could be used to win energy from. Agriculture should rather use its space for winning energy in another way. By placing windmills or solar panels on the roofs, to at least provide in its own energy needs. In due course also tractors could run on home made electricity instead of on fossil or plant derived fuels. The developments in storage of electricity in batteries and in electro traction are going fast.
Should organic residues be returned back to the soil instead of winning energy from it? Another question on which research could try to give answers is for example what should we do better, compost organic residues and manure or should we turn it back directly to the soil or maybe first win energy from it and turn the leftovers back to the

soil? For example, compost is considered a very valuable soil improver. However composting is a process where organic matter partly breaks down. In this process warmth is produced and mostly lost. Also a part of the organic nitrogen is turned into gaseous nitrogen compounds and is lost. Shouldn't we rather use the energy that is lost in the composting process? Or should we better use closed anaerobic fermentation in which the produced methane is used for energy and the nitrogen is not lost. And what is the value of residue of fermentation (digestate) for soil improvement? Research on this topic has only recently started but there is no clear answer yet. There are many reports on the positive value of compost although not often compared with adding the same material directly to the soil before the composting process. Also the effect of using the digestate as a fertilizer and soil improver hasn't been very well compared and evaluated. From digestate the fluid fraction has a high content of nitrates which can be used in a similar way as a chemical nitrogen fertilizer. The solid fraction contains a quite stable form of organic matter. At least it would be worth while to consider fermentation of organic matter instead of composting.

I would like to go back to strategies to cope with the degradation of our soils. Two major strategies are conservation agriculture and organic agriculture. From both strategies there is a great deal of evidence that they are able to maintain or improve soil quality.
Conservation agriculture focuses on minimal soil mechanization and on returning fresh crop residues to the top soil or to the soil surface. The rejection of intensive soil cultivation also reduces the use of fossil energy.
Organic agriculture has it focus more on (re-)using organic materials such as compost and manure for fertilization and soil improvement. In most cases this manure and compost is incorporated in the soil with a mechanical soil treatment. Also the rejection of the use of synthetic pesticides and fertilizers is considered to be beneficial for the soil. Another important effect of the rejection of synthetic nitrogen fertilizer is a strong reduction of fossil energy use and emission of laughing gas, both caused by the production of synthetic nitrogen fertilizers.
Both strategies have in common the focus on the use of cover crops and green manures thus cover crops serve as protection of the soil and as input of organic matter in the soil.
The claims of both strategies for a higher soil organic matter level in the soil have been proven to be right in many experiments and studies. Although in some case studies no differences were found between organic and conventional or conservation and conventional systems. The result of the strategy strongly depends on the way it is applied and on the environmental circumstances and soil status. But in general, both strategies showed to have positive effects on the soil quality.
There are also claims from both strategies to reduce laughing gas emissions although the evidence for these claims is fragmented and sometimes contradicting.
So what if both strategies could be combined? Is this possible and would this give an additional positive effect? Theoretically there could certainly be additive effects. A lower energy use for soil cultivation would be additional for organic agriculture. The decrease of energy use and laughing gas emissions because of the zero input of synthetic nitrogen fertilizer would be additional for conservation agriculture, but what about soil organic matter? None or very few long term experimental results are available for this combination.

Several organic and conservation farmers already are using part of each others strategies. Organic farmers tend to reduce their intensity of soil cultivation. There are also farmers who are successfully combining conservation and organic agriculture. Most examples however, deal with systems with only mowing crops in the rotation. The main challenges for the combination of the organic and conservation strategy are in growing root crops, in the control of weeds, in preventing a decrease of soil structure by compaction and in a sufficient soil temperature in spring. Part of the solution might lie in the application of modern techniques, like GPS for controlled traffic systems and to be able to mechanically control weeds very close to the plant, sensors to recognize weeds from culture plants followed by mechanical removal of the weed.

There are also a lot of other effects of the combination we don't know of. What about yields, pests and diseases, biodiversity etc?

Considering the possible additive effects of combining both strategies it would be worth while to explore this combination under different conditions, with different crops and making use of what modern techniques have to offer. The first step would be to bring the organic and conservation movement together and to exchange knowledge, experiences and ideas.