

Soil carbon sequestration in Switzerland - the DOK trial

Case Study by Johannes Scholberg^a and Adrian Muller^b

Organic systems, by closing nutrient cycles and making more efficient use of local (on-farm) resources, can contribute to mitigating climate change¹. This is due to the fact that certain farming practices result in storage of carbon (C) in the soil (sequestration), thereby effectively reducing the amount of CO₂ in the atmosphere. The DOK trial, a research project on the mitigation potential of Organic Agriculture has demonstrated this.

DOK trial

The DOK trial was initiated in 1978 to investigate the effect of different organic versus conventional farming practices with different fertilizer, pesticide and energy use, on crop yield, biodiversity, and soil quality². The crop rotation, tillage practices, residue management and manure application rates used were based on the same number of livestock so that the effect of different farming systems - except for the stockless conventional system - on soil C sequestration could be determined. The study was conducted at Therwil in the vicinity of Basel in Switzerland using a 7-year crop rotation. Results for this study were described in detail in a number of scientific papers (2, 3, 4). Some of the main results as related to climate change mitigation are outlined below. It should be noted that the differences between conventional and organic management practices used in these studies are not so pronounced as for example the same stocking rates are used in both systems. In regions where these differences are more pronounced, it would be expected that the benefits of C sequestration in Organic Agriculture would be much greater.

High Sequestration

The storage of CO₂ in the soil between 1977 and 2004 was calculated for the different systems in the study^{3,4}. At the onset of the study the soil carbon content was fairly high. This was probably due to high previous applications of manure and the incorporation of grass-clover pasture before the start of the study. The upper 20 cm of the soil contained about 1.5% C which translates to an initial carbon stock of around 45,000 kg C per hectare. Using computer models it was calculated that annual inputs of 3,000 to 3,500 kg C per hectare would be required to maintain the original (high) soil C level at this study site³.

Averaged across the entire period, plant residues added between 1,360 and 1,640 kg C per hectare annually. Additions from manure ranged from zero (stockless conventional system with only chemical fertilizers) to 890 to 1,170 kg C per hectare (for the other systems) annually. Total C addition from crops and soil amendments ranged from 1,410 (stockless conventional system) to 2,280 to 2,400 (organic systems) and 2,810 (conventional systems with manure). Inputs were thus lower than required to maintain the initially high C stock according to the model calculations. During a period of twenty-seven years, the biodynamic system maintained the original soil C level. In the other manure-based systems soil C dropped by 0.3% per year. Soil organic C dropped by 0.5 to 1% per year when no organic fertilizers were used³. In terms of C sequestration benefits, use of organic amendments resulted in the soil retaining up to 0.25 ton C per hectare per year more (in the biodynamic system) compared to the exclusive use of inorganic fertilizers and pesticides.

^a Agro Eco - Louis Bolk Institute, The Netherlands, j.scholberg@louisbolk.nl

^b FiBL, Switzerland, adrian.mueller@fibl.org

Low Emission

In addition to C sequestration, Mader et al, 2002 found decreased GHG emissions from organic systems due to:²

- Nutrient inputs in organic systems were 34 to 51% lower per hectare than conventional managed systems.
- The amount of energy required per kg product was 20 to 56% lower in organic systems.

Food Secure

The results of this thirty-two-year study demonstrate that organic food production is more secure in periods of high or low rainfall. This was directly associated with more efficient use of nitrogen and greater biodiversity.

- The capacity of organic soils to withstand soil disturbances associated with intense rainfall events (soil stability) was enhanced by 10 to 60% compared to conventional soils. Soils also had a 30 to 40% higher capacity to conduct water, which renders them less prone to erosion and/or flooding²
- Organically managed soils showed more efficient nutrient cycling, due to higher biological activity. Therefore less nitrogen occurred in a form that is prone to leaching losses and that can contribute to emissions of GHG²
- The number of earthworms and beneficial soil organisms favoring inherent soil structure and fertility, were also two to three times higher in organic soils²

Conclusion

The DOK trial showed Organic Agriculture, relative to conventional agriculture, enhances C sequestration and reduces GHG emissions, thereby mitigating climate change. In addition, relative to conventional farming, Organic Agriculture can also improve inherent soil quality and soil fertility. The enhanced biodiversity of the organic system was one of the key factors favoring more efficient use of water, nutrients and energy for crop production. This also renders organically managed systems more able to sustain production under adverse climatic conditions associated with climate change.¹

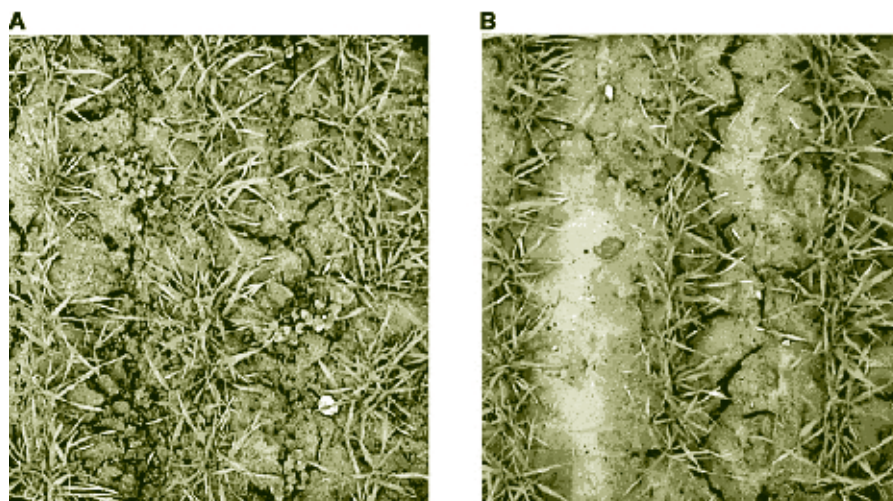


Figure 1: Organic soil management practices (a) result in resilient soils, store more carbon, water and nutrients, and have a better structure compared to conventionally managed soils (b) that sequester less carbon and are prone to soil degradation

- 1 International Trade Centre UNCTAD/WTO. 2007 Organic farming and climate change. ICT, Geneva, Switzerland, 31 pp.
- 2 Mäder P., A. Fließbach, D. Dubois, L. Gunst, P. Fried, U. Niggli. 2002. Soil fertility and biodiversity in organic farming. *Science* 296: 1694-1697.
- 3 Leifeld J., R. Reiser, H. Oberholzer. 2009. Consequences of conventional versus organic farming on soil carbon: Results from a 27-year field experiment. *Agronomy Journal* 101: 1204-1218.
- 4 Fließbach, A., H.R. Oberholzer, L. Gunst, P. Mäder. 2007. Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. *Agriculture, Ecosystems, and Environment* 118: 273-284.