Organic conservation tillage – evidence from more than 15 years of research

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In Europe, the plough is a common machine for soil tillage. Its history is dating back to the early days of agriculture and hence its use is deeply rooted in European culture. With ongoing heavier machines, larger fields and less landscape diversity, ploughing contributed to large-scale soil degradation. The bare soil surface is prone to erosion; the risk of soil fertility decrease is high. Long-term sustainability of current ploughing practices is therefore questioned. In organic farming, ploughing is seen as an important tool for weed control, ley termination and incorporation of organic material. Yet, also organic farming practices can still be improved. The aim was therefore to replace ploughing by less intensive tillage methods and to monitor changes in soil quality and yield performance. At FiBL, research started roughly in 2000 with both scientific and practice oriented trials and collaborations.

The long-term trial in Frick was established in autumn 2002 on a clayey soil with the aim to test continuous organic reduced tillage, in this case, the consequent use of non-inversion tillage to 10 cm and occasional deeper loosening to 15-20 cm with a chisel plough. For ley termination, a shallow plough ("Stoppelhobel") was used to turn the grass sward to ca. 5 cm. After three rotation periods, soil fertility improved substantially, namely humus content and microbial biomass and activity. Belowground biodiversity increased and shifted to more fungal based communities. Earthworms profit from reduced tillage with a higher reproduction. Yield performance was less stable with both higher and lower yields. Crop performance was more dependent on weather situations especially N supply in early spring that is provided by soil mineralisation. Weeds also increased. Problematic were perennial grasses and *Convolvulus* species at this site. Another long-term trial was started in 2010 in Aesch on a loess soil. Soil tillage is similar to Frick except that only chisel ploughs are used in the reduced tillage system to 10 cm. At this site, yields differed only slightly with a tendency to lower yields, also with the observation of slower soil mineralisation in spring in wet and colder years. Soil fertility did not change much within 9 years, presumably to the lower clay content. A compact zone below tillage depth and within the old plough layer in reduced tillage indicate the need of strategic aeration also in this soil. Weeds also increased, but are far less problematic than in Frick.

Both trials were already an important platform to test specific research questions in European collaborations. Two Core Organic projects, TILMAN-ORG (2011-2014) and FertilCrop (2015-2017) were compiling available data on organic conservation tillage in Europe and used the datasets of running trials to address questions like yield performance, weeds and soil fertility on a more global scale. In addition, socioeconomic questions, e.g. farmer's motivations and obstacles in adopting conservation tillage were assessed. A new collaboration within the SOCORT project is measuring soil organic carbon stocks with the same approach to find a more general indication if continuous organic reduced tillage can contribute to climate change mitigation by carbon sequestration.

A farmers network to test reduced tillage and also organic no-till on-farm was set-up at FiBL in 2009 and is still ongoing. Farmers test specific issues like reduced ley termination, green manures or different machinery to advance and gain experiences in organic conservation tillage.

At this stage, it can be concluded that continuous reduced tillage is possible in organic but that management is more difficult and needs to be combined with other strategies like green manures, strategic soil aeration and a more sophisticated weed control. At the conference, a compilation of results from the FiBL long-term and on-farm trials and European collaborations will be presented.