# Soil quality changes after 20 years of conservation tillage

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## Introduction

Effects of conservation soil management on soil quality were studied in the long term field experiment in Moškanjci, Slovenia, which was established in 1999 and shifted from conventional to **organic farming** in 2014.

Long term conservation (minimum) tillage using 4-row Variodisk Evers Agro, 10 cm deep (MT) resulted in stratification of soil organic carbon (SOC) with the highest concentrations in the very topsoil (Fig. 1), as opposed to conventional tillage with mouldboard ploughing, 22 cm deep (CT), which maintained rather uniform distribution down to the ploughing depth.

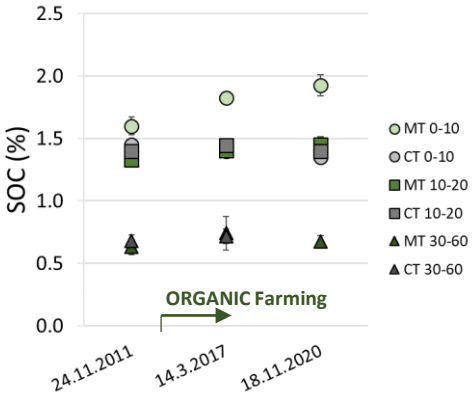


Figure 1. Soil organic carbon (SOC) in Moškanjci under minimum (MT) and conventional tillage (CT). Averages and standard errors are shown.

Similarly, also several other soil properties, such as aggregate stability and water holding capacity, were improved in the upper soil layer of MT in comparison to CT (Table 2, Fig. 2).

Table 2. Water holding capacity in 2011, after 12 years of minimum (MT) and conventional tillage (CT). Averages and standard errors are shown. Different letters indicate significance according to Duncan´s test ($p < 0.05$).

| Tillage | Depth [cm] | Infiltration [mm/h] | Field capacity [%] | Wilting point [%] | Plant available water [%] |
|---|---|---|---|---|---|
| MT | 0 - 10 | 166 ± 37 | 24.8 ± 0.5 a | 11.3 ± 0.3 a | 13.4 ± 0.7 a |
| | 10-20 | | 23.3 ± 0.3 ab | 11.4 ± 0.2 a | 11.9 ± 0.3 ab |
| CT | 0 - 10 | 150 ± 27 | 22.2 ± 0.2 b | 11.9 ± 0.2 a | 10.3 ± 0.1 b |
| | 10-20 | | 24.2 ± 0.6 a | 11.3 ± 0.2 a | 12.9 ± 0.7 a |

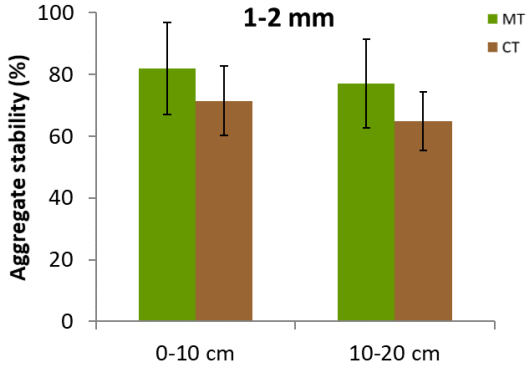


Figure 2. Aggregate stability in Moškanjci (2011) under minimum (MT) and conventional tillage (CT). Averages and standard errors are shown.

Table 1. Crop yields (dry grain or biomass yields) in Moškanjci under minimum (MT) and conventional tillage (CT), from the beginning of experiment till 2020. Averages and standard deviations are shown.

| Year | Crop | MT (t ha$^{-1}$) Average SD | CT (t ha$^{-1}$) Average SD |
|---|---|---|---|
| 2000 | Winter wheat | 6.5 ± 0.6 | 7.8 ± 0.3 |
| 2001 | Winter Barley | 5.0 ± 0.5 | 6.3 ± 0.1 |
| 2002 | Maize | 7.9 ± 0.4 | 10.1 ± 0.5 |
| 2003 | Maize | 2.9 ± 0.1 | 2.2 ± 0.3 |
| 2004 | Sugar beat (biological sugar) | 15.6 ± 1.8 | 15.2 ± 1.4 |
| 2005 | Winter wheat | 5.0 ± 0.3 | 5.3 ± 0.1 |
| 2006 | Maize | 8.0 ± 0.2 | 8.2 ± 0.2 |
| 2010 | Canola (oil rape) | 4.4 ± 0.0 | 3.6 ± 0.1 |
| 2011 | Maize | 7.4 ± 0.4 | 7.6 ± 0.5 |
| 2012 | Sunflower | 1.6 ± 0.0 | 1.6 ± 0.0 |
| 2013 | Winter Rye | 4.7 ± 0.2 | 5.4 ± 0.3 |
| 2014 | Legume-grass mixture | Yield not measured | |
| 2015 | Winter Barley | 3.9 ± 0.5 | 3.5 ± 0.2 |
| 2016 | Soy bean | Yield not measured | |
| 2017 | Winter Rye | 2.9 ± 0.1 | 3.1 ± 0.5 |
| 2018 | Cover crop mixture | Yield not measured | |
| 2019 | Winter Rye (Whole Biomass) | 9.4 ± 2.4 | 9.5 ± 1.5 |
| | Faba bean (whole biomass) | 2.2 ± 0.2 | 2.4 ± 0.2 |
| | Weeds (whole biomass) | 2.6 ± 0.6 | 2.6 ± 0.6 |
| 2020 | Winter Rye | 1.7 ± 0.2 | 2.1 ± 0.5 |
| | Maize | 2.8 ± 0.7 | 4.4 ± 0.5 |
| | Canola (oil rape) | Yield not measured | |
| | Weeds (whole biomass) | 2.9 ± 1.1 | 3.2 ± 0.2 |
| Sum | Relative share (MT/CTx100) | 93.5 | 100 |

ORGANIC Farming

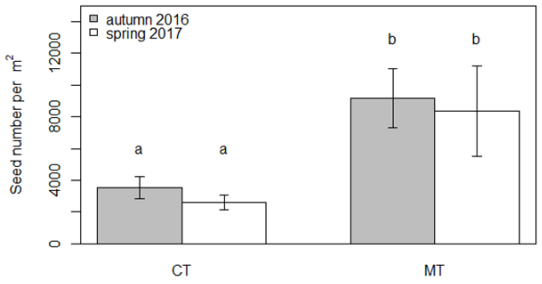


Figure 3. Weed seed bank in soil. Significant effects of tillage (minimum (MT) and conventional tillage (CT)) on (top)soil seed bank quantity (seed number per m$^2$) in spring and autumn sampling. Averages and standard errors are shown. The letters above indicate statistical differences between treatments ($p < 0.05$).

## Conclusions

- Conservation tillage causes vertical soil stratification and significantly **improves** the quality of the soil **surface layer** (organic matter content, aggregate stability, water infiltration and retention).
- Transition to organic agriculture in **minimum tillage** resulted in higher organic stratification in the upper soil layer.
- **Weed suppression is critical** in the transition period from conventional to organic farming system, specially under minimum tillage.