

Hungary study site experiment 2: MONITORING AND ANALYSIS OF SOIL CULTIVATION

The problem

Conventional tillage can result in soil compaction, organic C loss and increased erosion, whilst crop rotations and N fertilisation levels can affect the overall sustainability and quality of soils.

The main objective of this soil cultivation long-term field experiment was to evaluate the effect of crop rotation, levels of nitrogen fertilization and soil cultivation on soil properties and system sustainability.

The proposed solution

This experiment was conducted on an experimental field managed by the researchers jointly with farmers. The experimental field is located in Keszthely in the western part of Hungary at an altitude of about 119 m and covers an area of about 16000 m². The topsoil has a sandy loam texture

The experiment was established in 1972 and was set up in strip-plot -randomized complete block design with four replications. The factors of the experiment are the increasing rate of mineral N fertilization and the different soil cultivation methods in maize wheat biculture. (maize-maize-wheat-wheat).

Experimental design

Treatment no.	Cultivation	N fertilisation
1	Conventional	None
2	Conventional	180kg/ha – maize, 160kg/ha – winter wheat
3	Minimum	None
4	Minimum	180kg/ha – maize, 160kg/ha – winter wheat



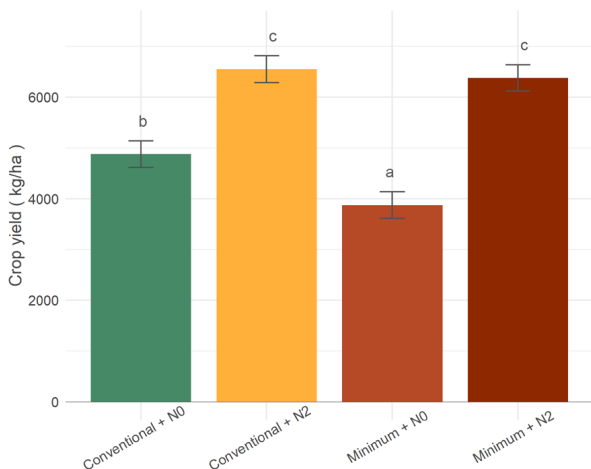
Measurements taken: Saturated hydraulic conductivity, water stable aggregates, bulk density, mineral N, available P, SOC, pH, earthworms, crop yield, microbial biomass carbon, cation exchange capacity.



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Results

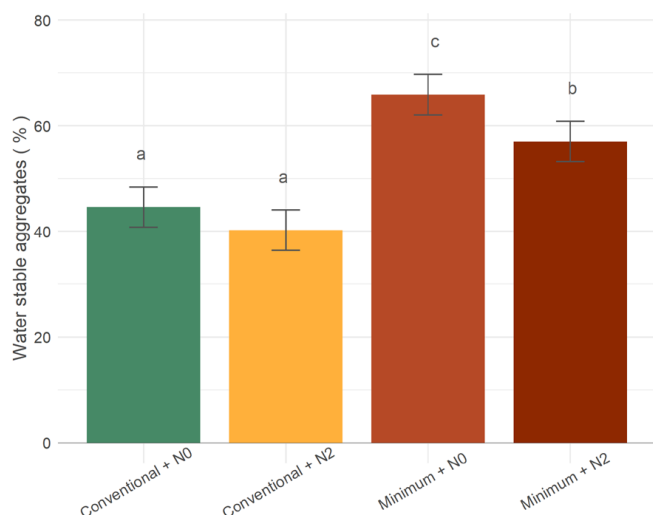
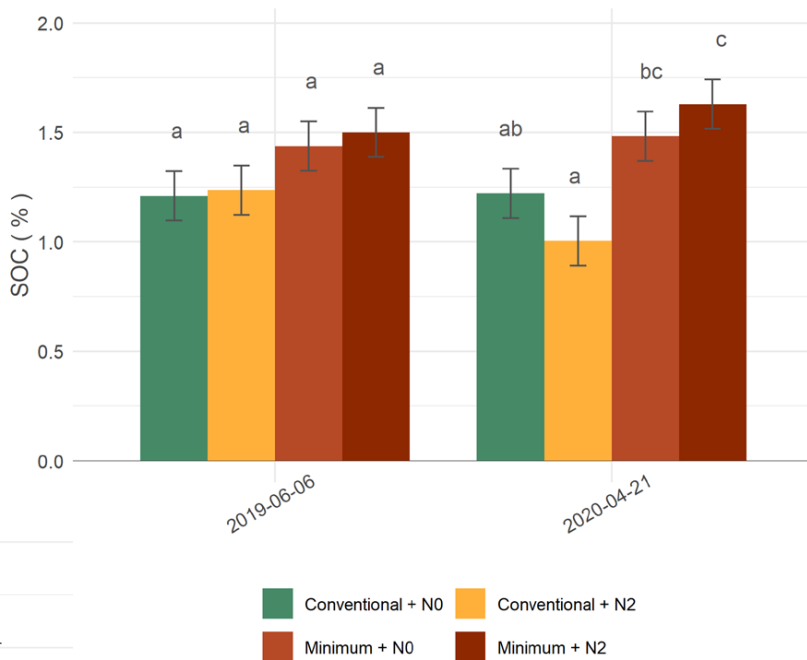
Crop Yield



Cereal yields were significantly lower under minimum tillage on N0 plots. Significant yield increases were achieved where mineral N fertilizers were applied under both tillage variants, with no significant difference between conventional and reduced tillage. In 2020, wheat yielded less than in 2019. In the previous year of the rotation, maize yields were higher in the minimum tillage variant. When averaged over the rotation period, minimum tillage resulted in slightly higher yields than conventional tillage.

Soil Organic Carbon (SOC)

Minimum tillage resulted in higher SOC due to less soil disturbance and consequently less intensive mineralisation both in N0 and N2 variants. In 2020, this effect was significant on N2 plots.



Water Stable Aggregates (WSA)

Aggregate stability was significantly increased by minimum tillage. The highest values of WSA were measured in the minimum tillage variant when no mineral N fertilizer was applied (N0). Application of mineral N fertilizer (Calcium Ammonium-Nitrate) resulted in a significant WSA decrease.

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Economic results

	AMT control	AMT SICS
Agricultural management technique	Conventional tillage	Reduced tillage
Investment costs	0	0
Maintenance costs	14	9
Production costs	178.5	220.3
Benefits	1050	1170
Summary = benefits - costs	858	941
Percentage change	-9%	

AMT means agricultural management practice

When compared against conventional tillage, reduced tillage resulted in similar wheat yields and higher maize yields.

Economic analysis was carried out on yield values averaged over maize and wheat as rotated in the experiment. The economical benefit of AMT SICS (reduced tillage) was 9 % higher than AMT control.

Stakeholder feedback

- Stakeholders stated that the results of this experiment were plausible but reiterated the importance of maximising profitability and financial sustainability
- The difficulties in obtaining organic manures was referred to by farmers who do not have livestock within their farming systems. Alternative ways of procuring manures (both FYM and green) need to be considered.
- Benefits of the SoilCare project appear to be that it has helped stakeholders recognise the benefits of non-inversion tillage, cover crop production and mulching with straw for managing pests and conserving soil and its biodiversity. Some farmers are now considering making changes to their farming systems as a result.



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Socio-cultural findings

Reduced tillage proved to be advantageous and led to better results than conventional tillage. The only socio-cultural disadvantage of reduced tillage was the increased probability of weed infestation.

Key findings

Minimum tillage led to reduced cereal yields. However, applying N fertiliser compensated for this reduction. When mineral N was applied, there were no significant differences in yields based on tillage practices. When maize yield is also involved in the analysis and yield data is averaged over the rotation, the SICS (reduced tillage) performed slightly better.

Minimum tillage had a positive effect on several soil properties including SOC, WSA, CEC and Microbial Biomass Carbon.

In addition, minimum tillage reduces labour costs. However, the lack of mechanical weed control can result in higher pest burdens than under conventional tillage. Consequently, minimum tillage may require more chemical weed control.

Conclusions

Minimum tillage proved to be an effective alternative to conventional tillage, providing similar or even higher yields through better water conservation, positively influencing other soil properties as microbial biomass carbon, SOC and WSA, providing better conditions for conserving soil against degradation.

Summarizing the advantages and disadvantages of minimum tillage, it can be concluded that the production level of AMT Control and SICS are not drastically different. In addition, minimum tillage results in many positive effects on soil properties, providing better soil physical and biological status. These advantages may compensate for the negative impacts such as increased weed burdens and the resulting need to use chemical control.

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