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Evaluation of the effects of soil erosion on soil quality

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The objective of this long-term field study was to compare different tillage systems with respect to runoff, soil loss, loss and availability of nutrients and impacts on soil physical parameters and crop yield.

Three different tillage systems were compared: 1) conventional tillage system (CT), 2) conservation tillage with cover crop (CS) and 3) direct seeding with cover crop (DS). The field experiments started in 1994 at three sites in Lower Austria on a silty clay loam, a loam and a silt loam. Slopes ranged from 5 to 16 %. A crop rotation of corn - small grains was applied.

Undisturbed soil samples of 100 cm^3 volume and 2,5 cm height were collected eight years after the initiation of the project from four depths in the top 50 cm of the soil. The main physical and chemical soil properties like soil organic matter (SOM), bulk density (BD), total porosity (POR), air capacity (AC), field capacity (FC), permanent wilting point (PWP), plant-available water capacity (PAWC), contents of total nitrogen (Ntot) and phosphorus (Ptot) a.s.o. were determined. Long-term average runoff ranged between 19,4 mm (DS) and 20,4 mm (CT) with no significant difference between the treatments. For single storm events the CT treatment often showed higher values than the reduced tillage systems CS and DS. Although average runoff did not significantly differ between management systems, significant differences in soil loss could be determined. Average annual values were between 9,86 t/ha (CT) and 1,15 (DS) for the silt clay loam, between 4,72 t/ha (CT) and 1,79 t/ ha (DS) for the loam and between 4,25 t/ha (CT) and 0,42 t/ha (DS) for the silt loam.

The loss of nutrients (N, P, Corg) was strongly linked to the soil loss. Overall, CS reduced nitrogen loss by 59% and phosphorus loss by 73%. With DS corresponding reductions of 77% for nitrogen and 84% for phosphorus could be achieved. Reductions

in the loss of organic carbon were 68% for CS and 79% for DS.

The analyses of the physical soil parameters showed no clear trend for the three locations and the investigated treatments. Significant differences between treatments could be observed, if ever, only in top 25 cm.

Due to CS and DS bulk density was increasing whereas POR was decreasing in the corresponding range. Significant differences were observed only in Mistelbach and only in the 0 - 5 cm layer. CS and DS led to an increase of BD and a decrease in porosity. This is mainly explainable due to a reduction in the amount of large pores in the reduced tillage systems. Depending on the soil type the large pores (eq. diam. $>$ 10 mm) ranged from 22 % to 12 % for CT, 20% to 12% for CS and 20% to 10 % for DS.

Conservational tillage and direct seeding increased the field capacity (FC at 300 hPa), whereas a reduction could be seen for AC. The plant available water capacity was highest for DS with 12 - 16%, followed by CS with 10 - 15 % and always the minimum for CT with 11 - 14%. CS and DS showed no effect on the permanent wilting point (PWP).

Overall it can be concluded that for the investigated soils reduced tillage systems (CS and DS) have either no influence on soil physical parameters, or they are improving them towards better air and water storage parameters in comparison to conventional tillage (CT).

At all sites the reduced tillage systems combined with cover crops during the winter period led to higher amounts of organic carbon in the top 30 cm soil depth whereas the amounts of total nitrogen and total phosphorus were only increasing for sitly clay loam and loam, but with no noticeable change for silt loam.

The long term average crop yields increased on two of the investigated sites (loam and silt loam) by about 2 to 6 % due to the reduced tillage practices, but decreased on the silty clay loam within the same range. All these differences are not significant. In the last two growing seasons CS and DS produced higher yields at all three sites, which were characterised by low rainfall amounts. The combination of increase of plant available water and a possibly better availability of nutrients in the fields with reduced tillage intensity seem to be able to improve the crop productivity.

Reduced tillage practices DS and CS are efficient methods to prevent soil erosion and to improve various functions of agriculturally used soils. Nevertheless site specific conditions like soil and climate have to be considered when choosing the proper erosion control measure.