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Erosion and runoff reduction by conservation tillage: scale effects

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Despite extensive research on the effect of conservation agriculture, it remains hard to quantify the effect of tillage technique on runoff and soil loss. One of the reasons is that the most frequently used scale of measurement (small rainfall simulator plots and/or intermediate size field monitoring plots) is not entirely comparable with the scale on which assessments ought to be made (field or catchment).

We set up an extensive experimental program to assess the effect of conservation tillage on runoff and soil loss at various scales. During the last six years we carried out more than 250 rainfall simulation experiments were carried out on small scale plots ($\sim$0.8m^2) while field plots ($\sim$180m^2) were installed to monitor the effect of tillage under natural rainfall conditions and erosion surveys were conducted to assess the erosion response to conservation tillage at the field scale. The results of these measurements indeed show a clear scale effect: for the rainfall simulations a median soil loss reduction of 59 % was reported, whereas for the field plots and erosion surveys a median reduction of 71 and 88 % was noted, respectively. We hypothesize that runoff transmission losses may contribute significantly to explaining the increasing effectiveness of conservation tillage with increasing scale.

In order to investigate the importance of transmission losses experiments under laboratory conditions were conducted. In a 2.3 m long soil tray, filled with a silty loam soil, a seedbed was simulated and covered with different amounts of straw/maize residues. Residues were put on the surface on one hand, and incorporated in the topsoil on the other hand. At the top of the tray, five increasing discharges were applied in sequence and transmission losses were measured. Runoff at the downslope end of the soil tray was clearly influenced by the occurrence of transmission losses, which are

highly dependent of cover percentage, applied discharge and residue type. The effect of incorporation of the residues was negligible. A simple model was used to simulate the runoff generation along a hillslope of 100 m. Simulations show that for a runoff production rate of 7 mm.hour^{-1} the final predicted outflow at the bottom of a 100 m long field would be ca. 50 % lower when a residue cover (30 %) is present compared to a situation without residues. Runoff amounts along the hillslope do not increase linearly but show a degressive increase. In erosion modelling often a linear increase of runoff generation is supposed; taking into account transmission losses can contribute to a better estimation of soil losses