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Benefits of Conservation Tillage for Soil Erosion Control

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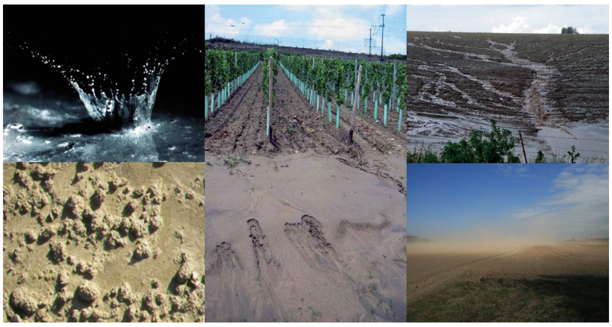
Soil Erosion and Agriculture

Erosion is one of the oldest and largest threats to soils globally, which are in turn one of the most valuable resources on our planet (*Picture 1*). Along with the enormous economic costs, e.g. from reduced productivity, the effects of transported and translocated sediments affect human safety, food security and social development. For centuries, humans have worked the earth's surface for their purposes, leading to unprotected and destabilized soils exposed to the influences of the atmosphere. Today, overgrazing, construction activities, and mainly agricultural land use have tremendously accelerated erosion rates.

The intensive and continuous use of ploughs, especially since the advent of mechanization in agriculture, has above all increased sediment transport. In this respect, tillage erosion is defined as a gravitational net displacement of soil and soil constitutes, where particles are lifted by ploughing and then fall back on average further down the slope than up the slope. This process can represent up to 70 % of the soil loss of a given area, and individual events can exceed 100 t ha^{-1} (*Table 1*).



Picture 1. Forms of water, wind and tillage erosion

Table 1. Soil erosion rates under no-till (NT), conventional tillage (CT) and an erosion-preventing land use for different countries and the European Union

Region	Land use type	Range soil loss *[t ha^{-1} yr^{-1}]*	Mean soil loss *[t ha^{-1} yr^{-1}]*	Reference
Australia	Forest / shrub land	0–5.2	1.0	*Lu et al. 2003*
	Farmland, CT	0.1–100.5	16.1	
	Farmland, NT	–	2.6	*So et al. 2009*
Brazil	Forest, cultivated	–	1.4	*Merten and Minella 2013*
	Sugarcane, CT	–	13.0	
	Farmland, NT	–	<1.0	
China	Forest	0–1.9	0.7	*Guo et al. 2015*
	Farmland, CT	7.7–49.4	24.6	
	Farmland, NT	–	1.9	
EU	Forest	–	<0.1	*Panagos et al. 2015*
	Perm. crops, CT	–	9.5	
	Farmland, NT	–	<1.5	*Pers. comm.*
USA	Native grassland	–	<0.1	*Zhang and Garbrecht 2007*
	CT	–	5.7	
	NT	–	0.3	

Conservation Tillage

In this context, conservation tillage and particularly no-till farming are considered to be major improvements regarding soil erosion control (*Figure 1*). No-till practices reduce soil disturbances to the very moment of planting, maintain vegetation cover and thus effectively mitigate all forms of erosion caused by machinery and climate. Reduced erosion rates are widely observed after adoption of no-till and partly up to one order of magnitude lower than in conventional agriculture (*Table 1*).

The benefits of no-till farming to mitigate erosion occur above all due to remaining plant covers and residues on the soil surface, but also due to improvements in soil functioning. Avoiding intensive soil cultivation stabilizes the soil structure with improved soil aggregation, macroporosity and thus water characteristics. Higher soil water infiltration and hydraulic conductivity are commonly found in no-till and are mostly due to the abundance of macropores. The cohesion between soil particles is determined by soil organic matter, soil rooting and the activity of soil organisms, all three of which are generally elevated in no-till systems. The extent of such soil improvement increases with the duration of conservation practices.

Conclusion and Outlook

The use of conservation tillage, or complete no-till has beyond controversy the most beneficial effect on soil erosion control. It thus contributes a further step towards fulfilling the FAO Sustainable Development Goals. However, reduced tillage often comes with problems in farm management, mainly related to weed control and thus declining crop yields with higher weed infestation. This is particularly evident in organic farming systems, where herbicides are generally not foreseen and farmers are encouraged to periodically use ploughs.

Nevertheless, there is great potential to overcome these barriers and to introduce no-till in farming systems around the world for soil conservation, particularly in regions that currently have low adoption rates. The further acceptance of such practices by farmers is one of the most important measures to successfully tackle the global threat to our soils. This acceptance goes hand in hand with an improvement in comparable methods in order to substantiate scientific findings with robust data and to better understand basic processes.

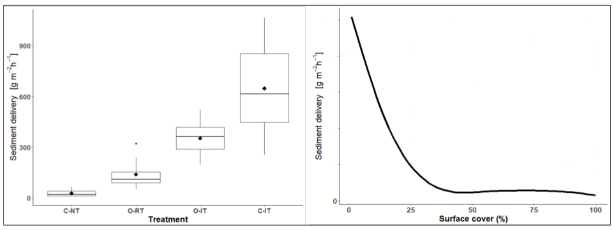


Figure 1. Sediment delivery for different management treatments (left) and soil surface cover (right) in the Agroscope Farming and Tillage Trial.
C-NT: conventional, no-till, O-RT: organic, reduced tillage, O-IT: organic, intensive tillage, C-IT: conventional, intensive tillage

Read More:

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