3.2.15. Measures to increase soil water holding capacity.

3.2.15.1. Description.

Water retention capacity (WRC) of agricultural soils is closely linked to soil structure, soil porosity and thus also to organic carbon content. Storage capacity within the topsoil is by far the largest available space within landscape – orders of magnitude greater than all other technical measures. For this reason, even a moderate increase in WRC might contribute significantly to improved soil water use by the crop.

Healthy soils, with high content of organic carbon and rich soil micro-fauna and flora usually generate good structure, indicated by high WRC, in the range of 115 to 265 mm of water to a soil depth of a meter in well-structured soils or 92 to 185 in structureless soils (William 1983). In addition they have high hydraulic conductivity and stable soil structure. However, too high a porosity can cause lowering of water holding capacity due to rapid water drainage. Highly porous soils also tend to have lower nutrient retention capacity.

The care of soil structure and overall soil health requires a continuous effort, based on:

* The minimization of soil compaction by mechanization;
* Soil management oriented towards high soil organic carbon content;
* Well-balanced nutrient content for soil micro-fauna and flora; and
* Optimization of vegetation cover at the field.

The potential impact of caring for soil structure is very high. For instance, an increment of soil porosity of 5 % within 0.4 m of top soil layer can provide up to additional 20 mm of water storage capacity, equating to 200 m³ per hectare.

This measure is effective for reduction of surface runoff, improvement of soil water balance for crops, and reduction of water erosion, Table 3.2.15.1

<table>
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<tr>
<th>Effect</th>
<th>Mechanism</th>
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<tr>
<td>Surface runoff reduction.</td>
<td>Due to better soil structure higher porosity and hydraulic conductivity, a higher proportion of rainfall event can be stored within soil profile reducing surface runoff.</td>
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<tr>
<td>Improvement of water balance.</td>
<td>Due to increase in infiltration during rainfall events and better soil storage more water is available to crops.</td>
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<tr>
<td>Soil erosion control.</td>
<td>Stable soil aggregates resist raindrop impact and overland flow reducing the availability of soil particles for transport. Additionally, surface runoff is significantly reduced due to higher porosity and hydraulic conductivity, reducing the potential for erosion.</td>
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</table>
3.2.15.2. Types of measures to increase soil water holding capacity.

Increasing soil organic matter content.

Organic matter in the soil is necessary for soil aggregation: key to a good soil structure. Organic matter alone is not sufficient, crucially it is the combination with soil fauna that transforms organic material into humus that leads to aggregate formation. To initiate and maintain aggregation, it is necessary to ensure that a sufficient amount of organic material is returned to the soil e.g. as crop residues. In addition proper nutrient balance in the soil, healthy soil fauna, and appropriate soil air, temperature and moisture conditions are also important for maintaining a good soil structure.

Compost applications.

Compost application has a positive effect on soil structure by introducing significant amounts of organic material helping to support soil life. The measure can be very effective, however, studies indicate that amount of compost necessary to be applied on soil surface to significantly improve soil properties are high (up to 150 t ha⁻¹). These high application rates can be expensive for many crops, and also represent a technological challenge for processing and incorporating into the soil surface (Adunga, 2018, Koopmans and Bloem, 2018). Nevertheless, rates below the optimum can have a positive effect on priming soil fauna and soil conditions for establishing vegetation in degraded or very degraded soils. For these reason, the use of compost use should be considered, particularly on degraded soils where the soil ability for self-restoration might be limited.

Biochar application.

Biochar application has been developed and recommended for application in agriculture because of synergies of positive effects on soil quality, fertility and generally soil health and also carbon sequestration. However, although positive effects prevail, nutrients leaching, soil water repellency effects and other negative effects have also been documented. Its main limitation is related to the fact, that charcoal is produced by pyrolysis of biomass in no-oxygen environment. Therefore, amount available is not sufficient for massive application on agricultural land to improve their properties in large scale (Verheijen et al., 2009).

Crops residues.

Crop residues left on the soil surface after harvesting can help soil structure and protect the soil surface from raindrop impact and it is one of the pillars of conservation agriculture, see section 3.3.9.1. It is best to be combined with adequate support of other nutrients and, occasionally, mechanical cultivation, to initiate humus content increase. This measure is generally accepted as fulfilling Good Agricultural and Environmental Conditions (GAECs) regarding soil erosion control, as crops residues cover the soil surface and protect it against rain splash and runoff erosion.
3.2.15.2. Types of measures to increase soil water holding capacity.

Figure 3.2.15.1. Well-structured soil in Lower Austria (Photo T. Dostal).

Figure 3.2.15.2. Structure-less severely degrade soil showing the C horizon below (Photo J.A. Gómez).
3.2.15.4. Selected References.


Koopmans C.J., Bloem J; Soil quality effects of compost and manure in arable cropping; Louis Bolk Institute, Publication No. 2018-001 LbP; Bunnik, 2018. Accessible at: http://www.louisbolk.org/publications/publication/?pubID=3331
