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Crop response to deep tillage – a meta-analysis

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Subsoil, i.e. the soil layer below the topsoil, stores tremendous stocks of nutrients and can keep water even under drought conditions. Deep tillage may be a method to enhance the plant-availability of subsoil resources. However, in field trials, deep tillage effects on crop yields were inconsistent. Therefore, we conducted a meta-analysis of crop yield response to subsoiling, deep ploughing and deep mixing of soil profiles. Our search resulted in 1530 yield comparisons following deep and conventional control tillage on 67 experimental cropping sites. The vast majority of the data derived from temperate latitudes, from trials conducted in the USA (679 observations) and Germany (630 observations). On average, crop yield response to deep tillage was slightly positive (6% increase). However, individual deep tillage effects were highly scattered including about 40% yield depressions after deep tillage. Deep tillage on soils with root restrictive layers increased crop yields about 20%, while soils containing >70% silt increased the risk of yield depressions following deep tillage. Generally, deep tillage effects increased with drought intensity indicating deep tillage as climate adaptation measure at certain sites. Our results suggest that deep tillage can facilitate the plant-availability of subsoil nutrients, which increases crop yields if (i) nutrients in the topsoil are growth limiting, and (ii) deep tillage does not come at the cost of impairing topsoil fertility. On sites with root restrictive soil layers, deep tillage can be an effective measure to mitigate drought stress and improve the resilience of crops. However, deep tillage should only be performed on soils with a stable structure, i.e. <70% silt content. We will discuss the contribution of deep tillage options to enhance the sustainability of agricultural production by facilitating the uptake of nutrients and water from the subsoil.