



Long-term Assessment of Water and Nutrient Use Efficiencies of Arable Crops in Central Germany

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Sustainable intensification aims to optimize resource utilization and management through narrowing yield gaps with high resource use efficiency. In this context, it is important to understand the scope to improve water and nutrient use efficiencies in agricultural systems. Long-term experiments monitoring crop performance and soil properties are very beneficial to disentangle the relative contribution of climatic and management factors driving water and nutrient use efficiencies. In this study, long-term data on crop yields and N uptake from the Static Fertilization Experiment of Bad Lauchstädt (1978 - 2016) were analyzed for the main arable crops in Central Germany, namely ware potato, sugar beet, winter wheat, spring barley and silage maize. Yield responses to nutrients across different fertilizer management strategies (mineral and organic) were analyzed in relation to the growing season rainfall. Temporal trends in crop yields, N uptake and soil properties were also investigated to assess the long-term effect of alternative fertilizer management strategies on crop performance.

The results show that application of mineral and organic fertilizers contribute to a more efficient use of growing season rainfall by all crops analyzed. This can be explained by the increases in crop yields observed due to removal of nutrient limitations and build-up of soil fertility over time. There were clear differences in crop yields and N uptake between treatments with and without mineral fertilizer, but these became smaller with increasing amounts of manure applied. Temporal trends reveal that e.g., i) manure application increases crop yields only when no mineral fertilizers are applied, ii) crop yields decline when no mineral and organic fertilizers are applied due to soil nutrient mining in the long-run and iii) N uptake declines when no mineral fertilizer is applied, independently of the manure treatment.