Nitrogen transformations and its underlying microbial communities in differently managed soils under future projected rainfall variability

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Soil microbial communities play a fundamental role in maintaining a broad range of soil functions and ecosystem services. Especially nutrient provisioning to cultivated crops are of prime interest in agricultural contexts in order to maintain the production of food, fibre and fuel for the ever increasing human population. Since Nitrogen (N) is the most limiting nutrient in agroecosystem and it's cycling and availability is highly dependent on microbial driven processes, we investigated the impact of farming systems on related ecosystem processes and herein involved soil microbial communities. Considering global climate change, also the potential to withstand rainfall variability was assessed.

Initially, a systematic literature search followed by a meta-analysis identified differences in microbial abundance and activity in contrasting farming systems. Overall, we identified 32 % to 84 % greater microbial biomass carbon, microbial biomass N, total phospholipid fatty-acids, and dehydrogenase, urease and protease activities in organic compared to conventional farming systems. Categorical analysis identified crop rotation, the inclusion of legumes and organic inputs to be important practices positively affecting soil microbial communities.

Next, in order to test whether distinct microbial communities in soil of organic and conventional farming (DOK long-term trial) lead to distinct functioning when facing future projected drought stress, a plant nutrition experiment using a ^{15}N labelled green manure was performed. We identified 30 % higher amounts of N derived from organic fertilizer in ryegrass grown on organically (BIOORG) compared to conventionally (CONMIN) managed soil, but only when subjected to dry conditions. Concomitant with enhanced N provisioning, enhanced stability of proteolytic (*apr* encoding) microbial community diversity and composition was identified in response to drought stress in BIOORG soil. Our results of the DOK indicate proteolytic microbial communities selected under organic farming (BIOORG) to have a better capacity to maintain plant nutrition of a model crop under dry conditions.

Lastly, the effect of management (ecological intensive vs. conventional intensive) on N-related ecosystem processes (forage N uptake and NO_3 leaching) and herein involved microbial communities was assessed in a more natural scenario. Terrestrial model ecosystems (intact soil cores) originating from forage agroecosystems across Europe (Switzerland, Portugal and France) were subjected to altered rain regimes for 263 days. Across countries, we observed strong impacts of rain regimes on N-related ecosystem processes and soil abiotic indicators, but a high resistance of N-related microbial communities. Furthermore, N-related microbial community structure was affected by management across countries and rain regimes, with a positive cascading effect of eco-intensive management on N-related ecosystem services through N-related microbial community composition. Our results based on long-term trials and farm comparison show that distinct farming systems/management shape soil microbial communities and affect their ability to provide ecosystem functioning when facing future projected rainfall variability.