Research Institute of Organic Agriculture
Forschungsinstitut für biologischen Landbau
Institut de recherche de l'agriculture biologique

Martina Lori, Sarah Symanczik, Paul Mäder and Andreas Gattinger
Research institute of organic farming, Frick, Switzerland. www.fibl.org

Nitrogen transformations in differently managed soils under projected future rainfall scenarios

Project ECO-SERVE: Background and Objectives

Throughout Europe, climate change induced rainfall variability is projected to increase further, resulting in longer drought periods alternated by heavy rainfall events. *Sustainable provisioning of multiple ecosystem services in agricultural landscapes* (ECO-SERVE) is a European joint research project which aims to analyse ecological intensive and conventional intensive land management systems in regard to their ability to cope with projected future climate change induced rainfall scenarios.

The overarching aim is to accomplish a trait based understanding of the influence of land management on soil biota, fauna and soil organic matter which further allows farmers to manage their ecosystem services in order to adapt to future rainfall variability and particularly to long drought periods and heavy rainfall events in order to secure a sustainable production.

The different ECO-SERVE partners contribute together to a joint experiment and run several local more in depth experiments in their specialized fields whereas FiBL focuses on the nitrogen cycle and the microbial community.

'Joint' Experiment

Compare 'ecologically intensive' versus 'conventionally intensive' managed agricultural, grassland and agroforestry sites regarding their ability to cope with rainfall variability such as drought periods and heavy rainfall events.

Set up

Paired intact soil cores from 'ecological intensive' and 'conventional intensive' land management sites from agricultural (CH), grassland (F) and agroforestry (PT) systems will be incubated under four different rainfall scenarios (Figure 1). Chemical and physical plant/soil traits, faunal and microbial parameters, ecosystem functions and services of the soil cores will be analyzed at the start, midterm and the end.

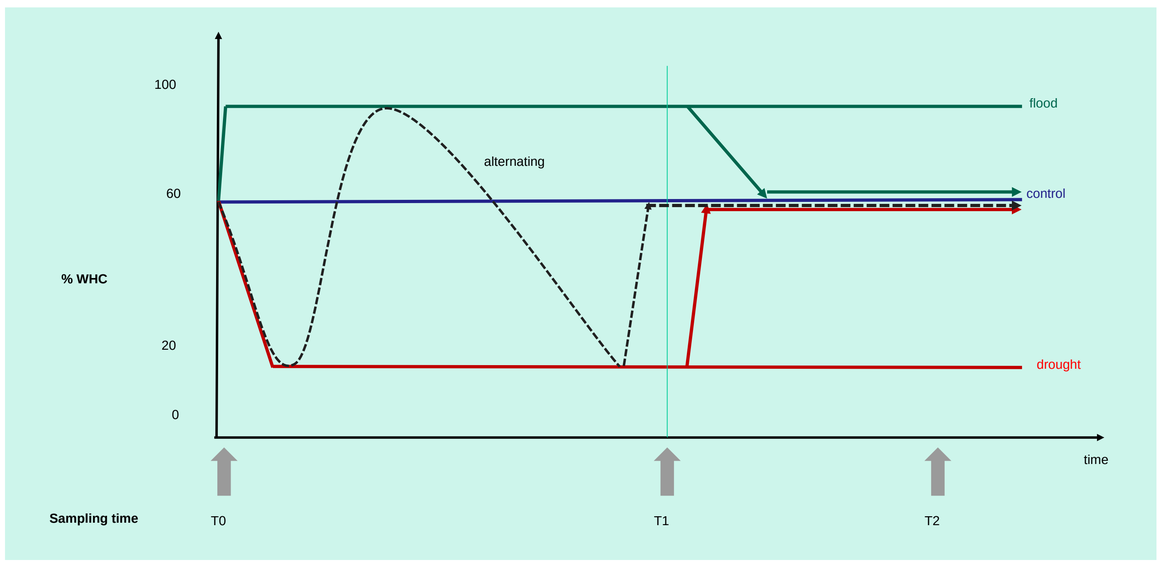

Figure 1: Rain regimes and sampling scheme. A flood rain regime with excess water, a drought regime with limiting water, a control rain regime with optimal water and an alternating rain regime will be applied. Destructive sampling will happen at T_0, T_1 and T_2.

Status Quo

Soil cores from all sites were extracted (Figure 2) and subsequently incubated under different water regimes in Portugal.

Stakeholder interaction

Poster presentation to scientists and farmers

- 25 Jahre Ökolandbau an der Justus-Liebig-Universität Giessen, June 2015
- DOK Flurbegehung, June 2015

Movie about the DOK field trial including ECO-SERVE (www.bioaktuell.ch)

'Local' Experiment

A first overview of the existing literature revealed the availability of multiple studies about the effect of changing moisture regimes or different farming systems on to nitrogen transformations. However, so far only very few studies analyzed the effect of farming systems combined with different moisture regimes which led to the following experiment:

Analysis of the net nitrogen mineralization and the abundance of genes involved in protein hydrolysis in differently farmed soils under normal and drought conditions.

The hydrolysis of proteins into smaller peptides and amino acids is the initial step of the transformation from organically bound nitrogen into mineral and plant available forms. By quantitatively tracing the abundance of genes encoding for extracellular proteases, the potential of predominant microbial groups mineralizing nitrogen can be estimated.

In 2015, Hartman *et al.* discovered a more diverse and species rich microbial community in organically managed systems compared to conventionally managed once and hence we hypothesize:

Figure 2: Soil core extraction. Extraction of intact soil cores happened in France and Switzerland in October 2015.

Hypothesis

Organically managed soils have i) a higher abundance of functional genes involved in protein hydrolysis ii) a higher net nitrogen mineralization iii) a higher microbial activity and abundance compared to conventionally managed soils at optimal moisture conditions as well as under drought conditions.

Set up

Comparable soils from differently managed systems of Switzerland and Germany will be incubated pairwise for 45 days with or without the input of lupine litter under optimal and drought conditions. N_{min} and N_{org} analysis as well as gene abundance (*npr, apr, sub, 16S* according to Bach *et al.* 2001) will be analyzed at start, midterm and end. CO_2 respiration will be measured weekly.

Status Quo

- Different sites are selected, soils collected and analyzed
- Incubation system tested
- Standard plasmids cloned
- qPCR assay under establishment

Outlook

- Literature study about the combined effect of land management and rainfall variability onto nitrogen transformations
- Pot experiment assessing nitrogen use efficiency in differently managed soils under different rainfall variability using ^{15}N tracer
- Pot experiment to identify actively nitrogen metabolizing bacterial communities in soil from differently managed sites under different rainfall variability using ^{15}N-SIP

Acknowledgements
The authors kindly thank the Swiss Nationalfonds (SNF) Nationales Forschungsprojekt (NFP68) «Ressource Boden» for funding. The project *Sustainable provisioning of multiple ecosystem services in agricultural landscapes (ECO-SERVE)* is part of BiodivERsA/FACCE-JPI.

Literatur

- M. Hartmann, B. Frey, J. Mayer, P. Mäder, F. Widmer: Distinct soil microbial diversity under long-term organic and conventional farming. The ISME Journal (2014), 1–18
- H.-J. Bach, M. Schloter, J.C. Munch: Institute:PCR primers and functional probes for amplification and detection of bacterial genes for extracellular peptidases in single strains and in soil. Journal of Microbiological Methods (2001) . 44 173–182

martina.lori@fibl.org