Module: Research Projects in Agrosystems
List of potential projects WS 2024-2025

Are you curious about how grazing practices influence water movement in soil and its impact on plant growth? Are you passionate about mitigating climate change and eager to explore the role of grassland plants in carbon storage? Have you thought of analysing the complex interplay of factors determining the productivity and environmental performance of the livestock sector?

If so, you may want to join one of these projects.

1. Does grazing intensity affect hydrological processes?

Description. Grazing intensity can influence soil structure and hydrological processes in grasslands. Heavy livestock traffic often leads to soil compaction, which reduces water infiltration, limits water availability to plants, and hampers nutrient transport. Understanding how different grazing intensities affect these processes is essential for improving grassland management. In this project, you will investigate soil infiltration rates under varying levels of grazing intensity (e.g., heavily grazed areas vs. lightly or ungrazed areas) and assess how livestock impact downward water movement in the soil profile.

Objective: to evaluate how grazing intensities affect soil infiltration rates and compaction in grasslands to inform grazing practices.

As you participate in this project:

- You will develop hands-on skills in measuring soil infiltration rates using easy and accessible field-testing methods.
- You will learn how to use a dynamic cone penetrometer to test soil compaction levels.
- You will explore how changes in soil permeability affect plant water uptake and soil health.

2. Effects of soil aggregate stability on soil carbon storage in grasslands

Stable soil aggregates can physically protect organic carbon from decomposition, making them essential components in climate change mitigation. In this project, you will evaluate how soil aggregate stability relates to soil organic carbon accumulated in grassland soils. You will conduct fieldwork, analysing soil structure and investigating the relationship between aggregate stability and carbon storage potential in grasslands.

Objective: to examine the relationship between soil aggregate stability and soil organic carbon in grasslands.

By participating in this project:

- You will gain experience in soil structure assessment and field data collection.
- You will gain skills in soil sampling, aggregate stability measurement, organic carbon quantification, and laboratory analysis techniques.

3. Soil moisture dynamics and methane fluxes under controlled conditions

Methane emissions are the second most relevant greenhouse gases after CO_2 and have on a 100-year time scale 25 the global warming potential from CO_2. Most CH_4 emissions derive from fossil fuels and agriculture, but a substantial amount is also released from wetlands, making these the largest natural CH_4 source. Soil moisture is a critical driver of the soil methane flux. Anoxic conditions, prevailing in inundated soils, induce a shift from CO_2-production to CH_4-production facilitated by methanogens. How do changes in soil moisture influence the CH_4 emissions? Is there a moisture threshold for the shift between CO_2 and CH_4- production? Does the inundation period affect the emissions? What impact to seasonal floodings have compared to permanent flooding? By addressing these questions, you will explore the complex interactions between soil emissions and moisture dynamics, contributing to our understanding of global climate change.

The objectives are

1. to investigate how soil moisture (low to high) influence methane and CH_4 emissions in soils, looking for thresholds and turning points.
2. to explore the impact of seasonal vs permanent water logging in soils on the C balance.

By working on this project, you will

- learn and improve your laboratory skills (soil incubations, soil sampling + preparation)
- gain experience in GHG measurements with cutting-edge technology
- Understand, analyse and discuss the relationship between soil moisture and methane production.

3. Modelling of livestock systems under global change

Livestock producers are confronted by the need to adapt to a warming climate while ensuring adequate food security for a growing population. Optimisation models based on linear programming (LP) and related methods can explore the implications of changing external environments, e.g. from climate change or public policy, on decision making processes and expected trade-offs for livelihoods or the environment. This project will involve programming a simple optimisation model for a representative livestock farm using available data for a region of interest.

Objectives: 1) to compile key parameters from an existing dataset to study a representative livestock farm, 2) to develop a simple optimisation model involving an objective function and constraints to simulate environmental impacts on producers, identifying optimal practice mixes under the scenarios of interest.

By participating in this project you will:

- Gain experience in key steps involved in building optimisation or simulation models of livestock producers.
- Develop skills in data extraction from farm household surveys or related datasets.
- Gain understanding of environmental change impacts on livestock systems and the potential for agricultural/development policy to improve the livelihoods of farmers.

4. Production systems categorisation of livestock systems under global change

Livestock producers face increasing risks from climate change, including extreme weather (drought, floods), temperature rises, and related (downstream) risks such as rapid price fluctuations in input/output markets. Due to spatial variability in agro-ecology and production characteristics, the adaptive capacity and 'best' adaptation measures are likely to be highly heterogeneous across regions. This project will use classification methods such as Principal Components Analysis (PCA) and clustering to categorize diverse data derived from GIS and survey-based data available for a region of interest. The result will be a production system typology needed to assess expected climate impacts and adaptation measures.

Objectives: 1) to collate diverse data from available open datasets such as GIS-based projections of future climate change (temperature and precipitation) with farm level data, 2) to use data scientific methods (factor analysis and clustering) to categorise production systems and map spatial variability to the identified systems, using GIS methods.

By participating in this project you will:

- Develop skills in the use of GIS and become familiar with common farm and household datasets.
- Develop skills in data extraction from farm household surveys
- Understand climate change impacts in agriculture and methods for their quantification and analysis.