Nitrogen is one of the most essential nutrients to sustain plant growth. As a result, Nitrogen fertilizers are often applied at an increased rate to maximize crop yield. Nitrogen naturally cycles through agricultural production ecosystem and undergoes various transformations before it can be taken up by plants. Soil microorganisms also play a crucial role in Nitrogen transformation and significantly affect their availability for plants. However, excessive application of N fertilizers beyond crops' requirement has resulted in a disturbance of the global Nitrogen cycle. This leads to significant N losses into the environment, through leaching of nitrogen into the groundwater (mostly as nitrate), and through emission of gases (mostly as nitrous oxide). Emitted nitrous oxide is a highly potent greenhouse gas and can cause global warming, while high N content in waters (as nitrate or ammonium) may deteriorate the water quality and pose a threat to human health. Hence, the major concern is to develop strategies to reduce soil residual Nitrogen and increase Nitrogen-use efficiency by crops, improve soil fertility and avoid loses of N into the environment.

In this research, we aim at tracking the nitrogen paths in agricultural environment studying various Nitrogen compounds in groundwater. Research studies have indicated nitrogen-stable isotopes as an ideal tool to identify different sources of nitrogen pollution. Isotopes are elements which contain same number of protons but a varied number of neutrons and are generally of two types, stable and non-stable isotopes. The principle of application of stable isotopes is based on the isotope signature of the compound, and the shift in the isotopic composition is studied which are due to transformation, pathways of production or consumption of the compound of interest. Our research plans to combine novel isotope studies and microbiological analyses to trace the sources and transformations of N compounds in groundwater (NO3 − , NO2 − , NH4 + , dissolved N2O). Structure of the microbial community along with identification of the microbial processes will be analyzed to better understand how various nitrogen compounds are produced, transformed or consumed. These results will be evaluated applying mathematical models, which is essential to identify the key factors driving complex N-cycling. This knowledge is important to be able to minimize negative effects associated with fertilizing.