Abstract: Understanding how plants respond to micronutrient deficiency and which biogeochemical processes are induced at the root-soil interface, i.e. the rhizosphere, is crucial to improve crop yield and micronutrient grain content for high quality food and feed. Iron nutrition by grass species relies on the release and re-uptake of phytosiderophores, which are root exudates that form stable complexes with Fe but also other trace metals such as Zn and Cu. However, neither the importance of phytosiderophores under Zn and Cu deficient conditions nor the interplay of plant responses and rhizosphere processes are well understood as the majority of studies in the past was carried out under 'soil-free' hydroponic conditions. In this project, I aim to elucidate the mechanisms controlling phytosiderophore-mediated micronutrient acquisition of barley (Hordeum vulgare) under Zn, Cu, and as reference, Fe deficient conditions, with particular emphasis on soil environments. Barley is the fifth most produced crop worldwide and of great importance in regions that are characterized by harsh living conditions. In a holistic approach, my team and I will apply innovative soil-based and traditional hydroponic root exudation sampling approaches in combination with advanced plant molecular techniques to study the phytosiderophore release and uptake system under different experimental conditions. The chemical synthesis of otherwise commercially unavailable phytosiderophores in their natural and 13C-labelled form will allow us to trace their decomposition and metal solubilizing efficiency in the plant-microbe-soil system to uncover the interplay of plant genetic responses and rhizosphere processes affecting the time-window of PS-mediated MN acquisition. Moving beyond 'soil-free' experimental designs of the past, this project will generate key knowledge to improve selection of crops with highly efficient micronutrient acquisition traits to alleviate micronutrient malnutrition of people world-wide.