Soil salinity significantly reduces the productivity of arable soils due to **osmotic stress** (changes in environmental salinity causing an influx of water from/to organisms) and **ionic toxicity** (high content of salinity-related ions). This problem is steadily increasing mainly due to low rainfall, high evaporation, unsustainable agricultural practices and other industrial activities. Currently, soils with high salinity account for nearly 33% of the world's agricultural potential, and it is estimated that by 2050, 50% of arable land will be saline.

Supplementation of saline soil with bacteria (bioaugmentation) **tolerant to high concentrations of salts** (halotolerants) seems to be a promising method of mitigating osmotic stress and ionic toxicity because it works specifically and is considered a sustainable approach to soil regeneration. Most of the current research on the bioaugmentation of saline agricultural soils focuses on **mesophilic bacteria** (optimum temperature for their growth and development is between 30-40 °C), which, due to the relatively narrow preferred temperature range, may **show limited activity in colder periods of the year** (e.g., early spring and late autumn).

Psychrotolerant bacteria are characterized by highly efficient mechanisms of adaptation to cold stress and osmotic stress, whose genetic background is similar. One of the adaptation mechanisms of psychrotolerant bacteria is the production of **osmoprotectants** (molecules that help organisms survive osmotic stress), which can positively affect the **mitigation of osmotic stress and ionic toxicity** for soil microorganisms and plants. On the other hand, osmoprotectants can also **positively affect the physical and chemical properties of agricultural soils**, improving its physical structure and water retention, as well as reducing the mobility/bioavailability of salts.

Although the general potential of osmoprotectants produced by various mesophilic bacteria to improve soil quality and plant growth is generally known, the role of osmoprotectants produced by psychrotolerant bacteria is still not thoroughly explored. Furthermore, the knowledge about the links between the microbial, physical and chemical properties of agricultural soils under the influence of their supplementation with bacteria and osmoprotectants is completely undiscovered.

The main goal of the proposed project is therefore to explain and understand the **effect of supplementation of various agricultural soils with psychro- and halotolerant Antarctic bacteria**, optimized for the production of osmoprotectants**, on the physical, chemical and microbiological quality of soils** in the context of **improving the growth and development of crop plants**.

In order to achieve the main objective, the following specific objectives will be achieved:
1. revealing the links between the **optimization of osmoprotectant production** and **changes in the genome and physiological properties of bacteria**,
2. **determination of changes in physical** (water retention, shrinkage and structure) and **chemical properties** (e.g., electrolytic conductivity, pH, salt mobility) of agricultural soils supplemented with bacteria and osmoprotectants,
3. **study of the structure, activity and number of microorganisms in agricultural soils** enriched with bacteria and osmoprotectants,
4. **verification of the impact of physico-chemical and microbiological changes** in agricultural soils under the influence of their supplementation with bacteria and osmoprotectants **on the reaction of crop plants**.

The implementation of this project will fill an important gap in knowledge about the **complicated network of correlations** between the **physical, chemical and microbiological properties of saline soils** with agricultural potential and the **general condition of crop plants** under the influence of soil supplementation with psychro- and halotolerant bacteria and their osmoprotectants. Careful study of different **approaches based on changes in the bacterial genome and physiology** combined with **detailed (bio)chemical and physical analysis of soil and plants** will provide important insight into the mechanisms enabling microbial-mediated salt stress mitigation. In addition, the proposed project will, for the first time, apply the "**Adaptive Laboratory Evolution**" approach to increase the level of halotolerance of bacteria, in particular psychrotolerant bacteria. The implementation of the project will allow to propose a new microbiological strategy to combat the salt stress crisis in modern agriculture.