1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title:The impact of subsoiling in strip tillage on the young glacial soils of Northern Poland

1.1. Project goals

- Determination of the impact of three different subsoiling methods on changes in soil water-air properties and the taxonomic biodiversity and metabolic activity of microorganisms.
- Assessment of the potential to increase organic carbon sequestration as a result of various subsoiling practices and correlation with microbial biodiversity.
- Estimation of the variability in the response of different soil types in glacial zone of North Poland to changes induced by various subsoiling methods.

1.2. Outline

Strip-till cultivation, by limiting the loosening of the topsoil, leads to the formation of a compacted layer at a depth of several tens of centimeters, commonly referred to as a "plow pan". This layer poses a significant physical and biological barrier, reducing both the functionality and productivity of the soil. One of the methods used to counteract the negative effects of this phenomenon is subsoiling—deep loosening or cutting of excessively compacted subsoil layers beyond the reach of conventional tillage tools. This treatment is especially important for medium to heavy soils, such as loamy soils. To date, no long-term comparative studies have been conducted in northern Poland on the impact of subsoiling on the properties and productivity of soils under long-term strip-till cultivation—particularly in the context of the spatial variability of moraine upland soils. The aim of this project is to determine the effects of various subsoiling methods on the properties of strip-tilled soils in the moraine upland areas of the young glacial zone. The study will include various types of soils commonly used in agriculture in post-glacial areas—from eroded soils (Regosols, eroded Luvisols), through Luvisols, to Chernozem-like soils. Over the course of three years, different management approaches will be compared: without subsoiling, with conventional subsoiling, subsoiling with humus enrichment of the subsoil, and subsoiling with humus-manure enrichment of the subsoil. The outcome of the study will be an evaluation of how these practices affect general properties, microbial diversity and activity, and the productivity of the investigated soils.

1.3. Work plan

October – December 2025

Selection study area. Preliminary field work – reconnaissance and sampling and measuring water-air field properties about 12-16 soil profiles: 3-4 types of soil x (reference, traditional subsoiling, subsoiling with humus enrichment, subsoiling with humus enrichment and fertilization)) in time “0”.

January – May 2026
Review of the literature on the subject under study. Laboratory works – e.g. texture, pH, organic carbon, nitrogen, microbiological diversity and activity. Preparation of review article.

June – September 2026
field work – sampling and measuring water-air field properties about 12-16 soil profiles: 3-4 types of soil x (reference, traditional subsoiling, subsoiling with humus enrichment, subsoiling with humus enrichment and fertilization) in time “+ 1 year”.

October 2026 – May 2027
Laboratory works – e.g. texture, pH, organic carbon, nitrogen, microbiological diversity and activity. Data processing, analysis, compilation. Preparation of article about variability of the studied soils – general properties.

June 2027 – September 2027
field work – sampling and measuring water-air field properties about 12-16 soil profiles: 3-4 types of soil x (reference, traditional subsoiling, subsoiling with humus enrichment, subsoiling with humus enrichment and fertilization) in time “+ 2 year”.

October 2027 – May 2028
Laboratory works – e.g. texture, pH, organic carbon, nitrogen, microbiological diversity and activity. Elaborating of data.

June – September 2028
field work – sampling and measuring water-air field properties about 12-16 soil profiles: 3-4 types of soil x (reference, traditional subsoiling, subsoiling with humus enrichment, subsoiling with humus enrichment and fertilization) in time “+ 3 year”.

October 2028 – February 2029
Final laboratory works – eg. Texture, pH, organic carbon, nitrogen, microbiological diversity and activity. Compilation of all obtained data and their preliminary processing.

March 2029 – **September 2029**
preparation of articles/manuscript based on the validation results

1.4. Literature *(max. 7 listed, as a suggestion for a PhD candidate preliminary study)*

- Rathinavel, S. 2020, Effects of Subsoiler on Farm Fields – A Review. International Journal of Current Microbiology and Applied Sciences, DOI: 10.20546/ijcmas.2020.910.066

- Cooper, P., Sanderman, J., van der Ploeg S. W. J. 2016. How does tillage intensity affect soil organic carbon? A systematic review. Environmental Evidence, DOI: 10.1186/s13750-017-0108-9

- Borrelli, P., Robinson, D. A., Fleischer, L. R., Lugato, E., Ballabio, C., et al. 2021. Soil erosion modelling: A global review and statistical analysis. Science of The Total Environment, DOI: 10.1016/j.scitotenv.2021.145331

- Świtoniak, M., 2014, Use of soil profile truncation to estimate influence of accelerated erosion on soil cover transformation in young morainic landscapes, North-Eastern Poland. Catena 116, 173–184.

1.5. Required initial knowledge and skills of the PhD candidate

- Completed degree in natural sciences;
- Completed basic course in soil science, soil geography and microbiology;
- Field and laboratory work skills.

1.6. Expected development of the PhD candidate's knowledge and skills

- Expanded competence in laboratory work;
- Proficiency in conducting soil microbiological analyses – microbiome analysis+;
- Enhanced knowledge of regenerative agriculture and simplified agrotechnical practices, particularly their effects on soil properties, carbon sequestration, and water-air conditions;
- Ability to write scientific articles and to prepare and present research findings.