

Project title: Development and evaluation of organic heterogeneous material and variety mixtures in spring grain peas with special consideration of foot and root diseases, processing quality characteristics and their suitability for intercropping cultivation (LegumeMIX)

Project partners:

- Andrea Gallehr, Dr. Carl Vollenweider – Forschung & Züchtung Dottenfelderhof in der Landbauschule Dottenfelderhof e.V. (FZD)
- Dr. Moritz Reckling – Leibniz-Zentrum für AgrarlandschaftsBayerische Landesanstalt für Landwirtschaft (LfL) forschung e.V. (ZALF)
- Andrea Winterling – Bayerische Landesanstalt für Landwirtschaft (LfL)
- Dr. Adnan Šišić – FB11, FÖP, UNIKASSEL

Period: 01.01.2025 – 31.12.2027

Overall Ambition:

The objective of the project is to establish a basis for the development of spring pea cultivars suitable for organic agriculture, taking into consideration the recently extended legal possibilities to use genetic diversity within the framework of the new European regulation on organic farming (2018/848/EU). The aim is to increase the buffer capacity (resilience) to biotic and abiotic stresses through increased genetic diversity via the development of organic heterogeneous material (OHM) as defined in the new EU Organic Regulation as well as variety mixtures. Studies prove the positive yield effects of increased diversity: In grain peas, significantly higher positive yield effects could be realized through increased morphological

diversity in mixtures of genotypes with different leaf morphology than are known, for example, for cereal variety mixtures. However, there are still considerable gaps in our knowledge of the development of complex variety mixtures or of OHM in grain pea, which will be closed in the present project. In the first two work packages, fundamental questions on breeding methodology and selection criteria for the development of OHM and variety mixtures will be investigated. In further work packages, resistance and tolerance properties of different pea genotypes to root diseases will be studied as well as quality and processing characteristics, the latter especially in the area of use for human consumption. In order to identify genotypes (including OHM and mixtures) with suitability for this cropping system, all trials will be set up in a mixture with cereals, and in some cases also in pure stand for comparison. The strategies of increasing resilience through intra- and interspecific diversity are thus combined in this project.

The project is divided into the following work packages (WP):

(WP1) In WP1 breeding methods and selection criteria for organic heterogeneous material (OHM) of spring pea will be developed and tested. Concepts to bring a high pheno- and genotypic heterogeneity with the required homogeneity in agronomic and quality traits into an optimum are investigated experimentally. The selection criteria take agronomic traits as well as processing qualities into account.

(WP2) Procedures and criteria to develop variety mixtures in spring pea are systematically investigated in multi-location field trials. The trials will include selected combinations of two-way-mixtures together with all components. From the third year of the project onwards, the best variety mixtures, the OHM developed in WP1 as well as new elite varieties and some of the components will be comparatively tested with respect to their agronomic performance. In addition to the field trials, quality tests will be carried out.

(WP3) In this WP on phytopathology, resistance and tolerance properties of cultivars and OHM against foot and root diseases, which occur more frequently in complex, organic crop rotations with a high proportion of legumes, will be investigated. For this purpose, in the tests of AP2, the composition of the pathogen populations will be characterized by molecular methods and the content of arbuscular mycorrhizal fungi (AMF) in the roots will be determined. Based on the collected data, insights relevant for breeding will be derived on genotype-environment interactions as well as the territorial effectiveness of resistances.

(WP4) In this WP, processing and baking trials with grain pea flours will be conducted. In addition, the knowledge transfer of the new results on OHM and variety mixtures will be organized in close collaboration with the legume network (LeguNet) and farmers.

Our role:

The University of Kassel, Section of Ecological Plant Protection (FÖP), is involved in the coordination, data collection and data analysis of WP3 (phytopathology). The main objective of AP3 is the visual assessment of foot and root rot severity in the field grown plants (3 locations in Germany: FZD, LfL, ZALF), along with the identification and quantification of the associated fungal pathogens and the content of arbuscular mycorrhizal fungi (AMF) in the roots of representative pea genotypes. Additionally, the project aims to assess seed health and identify relevant seed-borne pathogens.

In the first year of the project, the University of Kassel will organize a workshop at one of the trial sites to support the project partners in visually assessing the severity of foot and root rot and in collecting relevant data. Based on variations in root health status, root samples and seeds from up to 5 genotypes per site and year will be collected for further analysis. Species-specific quantitative Real-Time PCR (qPCR) assays will be used to determine the main pathogens causing foot and root rot and to measure AMF content in the roots. In addition, culture-based methods will be used to identify seed-borne pathogens, with the identity of representative isolates confirmed by Sanger sequencing.

Expected outcomes:

The project focuses on developing and evaluating breeding methods and selection criteria for Organic Heterogeneous Material (ÖHM) in line with the new EU organic farming regulations, as well as for variety mixtures in field peas. This will help create improved field pea genotypes and lay the foundation for developing and managing ÖHM. A workshop in the third project year will explore methods for designing and selecting ÖHM, along with statistical models for creating variety mixtures. The collaboration between breeding initiatives will optimize resource use, with plans for long-term cooperation in legume breeding.

The information gained on resistance to foot and root diseases can be used to directly integrate resistant material into breeding programs. The insights into genotype-environment interactions and the site- or region-specific effectiveness of these resistances are of fundamental importance for pea breeding. Characterization of quality traits will be used to adjust selection criteria in breeding. The project results are highly relevant for legal offices, seed recognition authorities and political decision-makers, as they rely on sound data to assess the legal handling of novel ÖHM. Project results will be continuously shared through the involved breeding and agricultural research institutions and knowledge and practice transfer networks, particularly via LeguNet.

See also sister project: **FABARobust**.