

Pest control in the Baltic Sea Region via the PestSpace common data platform

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Abstract: The PestSpace system aims at the improvement of pest and disease control by identifying crop diseases and insect pests based on images sent via a mobile app. Pathogens and insects are identified using environmental DNA and machine learning, and the data is stored in a shared database on the PlutoF platform. The far goal of this system is to notify growers about pathogens and insect pests and provide guidance on crop protection. Currently, research is focused on the health of winter wheat and faba beans, but guidelines will ultimately be developed for further expansion of the system to include other crops. At present the PestSpace system is being developed in the Baltic Sea Region and covers Estonia, Finland, Latvia, Lithuania and Poland.

Key words: pests, diseases, integrated control, PlutoF, Baltic Sea Region

Introduction

As the climate changes, pests previously unable to survive in the Baltic Sea Region (BSR) will become viable and may survive and develop in new conditions. Therefore, it is necessary to collect and monitor data on the diversity of insect pests and plant diseases in common, shared data space, especially during the growing season of agricultural crops. Detailed data on the presence and the diversity of pests and pathogenic fungi is a crucial prerequisite to develop possible future scenarios of their spread. This data is also necessary to prepare the relevant recommendations for the farmers. At present such precise and digitally available monitoring schemes are not available in the BSR region. There is a challenge to collect a large amount of data, integrate it with the existing data and analyze it to find the patterns of pest occurrence and harmfulness. Moreover, the data should be easily obtained by farmers, advisers, officials, and researchers across countries to ensure that threats are identified and responded to as quickly and comprehensively as possible.

The new Interreg funded project PestSpace, started in March 2025. It uses existing technologies to create a system that identifies pests in the field using environmental DNA (eDNA) sequencing and photos uploaded via a mobile app. Machine-learning algorithms will be used to identify the pests and diseases (pathogenic fungi) based on photos, using a mobile app. The data is stored in a common data space on the PlutoF platform (<https://plutof.ut.ee/>). The system intends to quickly notify plant growers about the threats and provide guidance on how to respond to them. The plan is to develop guidance materials on the use of the system and engage all stakeholders along the value chain. We will validate the system using two important crops to the BSR (faba beans and winter wheat) and create guidelines on how the system could be further expanded to cover other crops in the other countries of BSR in the future. Link to project website: <https://interreg-baltic.eu/project/pestspace/>

Materials and methods

Project partnership

PestSpace unites researchers, officials, entrepreneurs, consultants, journalists, and farmers in five countries of the BSR – Estonia, Finland, Lithuania, Latvia and Poland. The project is led by the University of Tartu (UTARTU), one of Europe's leaders in developing digital tools for biodiversity research. UTARTU is responsible for the solution developed in WP1, piloted in WP2, and transferred in WP3. Researchers from all 5 countries contribute data and support dissemination. University of Warsaw (UW) contributes experience in taxonomy, systematics, and biodiversity research. It will share its knowledge in using DNA analysis in the field. Institute of Plant Genetics, Polish Academy of Sciences (IPG PAS)' Pathogen Genetics and Plant Resistance Team specializes in resistance assessment, early detection of pathogens, and operates the Polish System for Forecasting Disease Epidemics. Vytautas Magnus University (VMU) contributes plant protection specialists skilled in safeguarding crops and enhancing agricultural productivity. Latvia University of Life Sciences and Technologies (LBTU) performs R&D in agriculture together with industrial partners, including farmers and consultants. The Finnish Museum of Natural History at the University of Helsinki (UH) offers the country's largest infrastructure in biodiversity research with expertise in taxonomy and DNA-based species identification. The Centre of Estonian Rural Research and Knowledge (METK) and the Natural Resources Institute Finland (Luke) as well as LBTU in Latvia represent sectoral agencies researching, monitoring, and reporting plant diseases to their national governments. Together, they ensure that the solution is adopted by government agencies across the region. HR Smolice is a Polish seed and breeding company with its own glasshouses and molecular laboratory equipped for molecular studies. Beyond participating in development and piloting, they will make sure that the developed solution also fits the needs of large agribusinesses. The partnership is supported by a wide range of organizations representing key stakeholders of the project. LATRAPs is the largest farmers' cooperative in the Baltics with their own advisory department responsible for knowledge transfer and implementing new tools and technologies. APRA is Poland's leading publisher and printing house specialized in agriculture. The Kuyavian-Pomeranian Agricultural Advisory Center (KPODR) is the leading extension service for farmers in Central Poland with access to educational infrastructure and to the field. Innvigo, Väätsa Agro, and ProAgria represent small and medium-scale farmers and agribusinesses in Poland, Estonia, and Finland. The training will be provided to Poland's Main Inspectorate of Plant Health and Seed Inspection, which will then further disseminate the method and the results.

Data collection

The monitoring and collection of pests and diseases (fungal pathogens) is carried out for two years of faba bean cultivation (2025 and 2026) and two seasons of winter wheat cultivation (2025/2026 and 2026/2027) for 10 cultivars, two being chosen by each of the five participating countries (EE, FI, LT, LV and PL) (Figure 1). Field study is performed at 18 locations (Table 1). Each specimen and sample is assigned an individual QR code which is then matched to the results of visual and molecular identification. The data is stored at the data storage platform PlutoF.

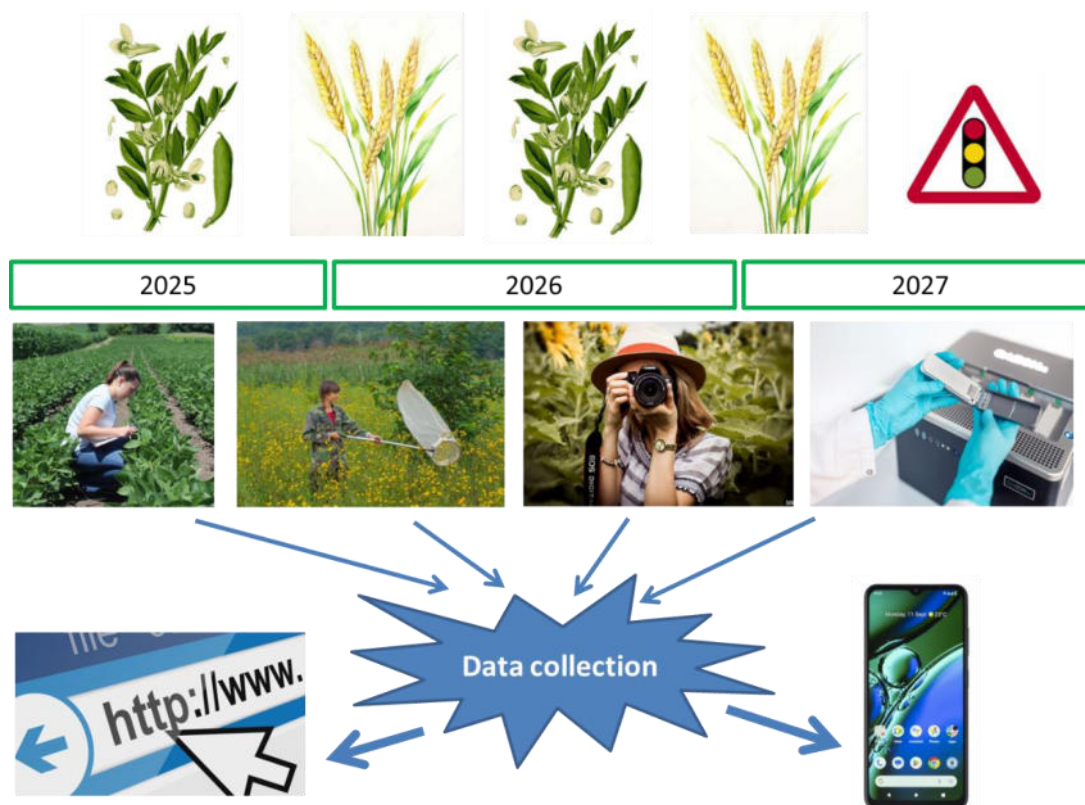


Figure 1. Scheme of the PestSpace project with two years of data collection from field experiments on faba beans and winter wheat, followed by DNA sequencing, bioinformatic analysis of the data and creation of the warning system for the farmers.

Table 1. Number and names of locations of the field experiments in the PestSpace project.

Country	No. of locations	Names of locations
Estonia	4	Jõgeva, Kuusiku, Viljandi, Võru
Finland	1 (+2)	Inkoo, (Jokioinen, Isokyrö - only Finnish cultivars)
Lithuania	3	Grinkiškis, Noreikiškės, Verėduva
Latvia	3	Kurzeme, Vidzeme, Zemgale
Poland	5	Chrzastowo, Radostowo, Rarwino, Smolice, Wrócikowo

Data storage platform PlutoF

PlutoF is an online data management platform and computing service provider for biology and related disciplines. Registered users can enter and manage a wide range of data, e. g., taxon occurrences, metabarcoding data, taxon classifications, traits, and lab data. It features an annotation module where third-party annotations (on material source, geolocation and habitat, taxonomic identifications, interacting taxa, etc.) can be added to any collection specimen, living culture or DNA sequence record. It also features an analysis module by providing digital services for molecular sequence identification and species discovery from eDNA samples (Abarenkov et al., 2010).

Results and discussion

Transnational value of the project

The PestSpace system will consist of a shared data space, a mobile app for disease and pest identification through image analysis, and an early warning system that will notify farmers and other interested end-users from various countries about the emergence of new threats to crop health in a given area. The spread of pests due to climate change is inherently international: pathogenic and parasitic species tend to shift northwards with rising temperatures. To simplify, the pests affecting Poland today could threaten Finland tomorrow. The policies and action of actors in one country can significantly affect others – allowing or hindering the spread of (invasive) pests. Thus, no single country can solve this problem alone. This is even more so for smaller countries such as the Baltic countries whose monitoring is geographically limited. For this reason, we involved partners from countries of different sizes along the North-South pathway: PL, LT, LV, EE, and FI. The PestSpace project brings together scientific organisations, farmers' cooperatives and businesses, public agencies, and other stakeholders in each country to map existing biodiversity data to determine how to integrate the PestSpace system into national monitoring systems as well as possible. A transnational approach is also needed to enable regular communication between farmers, public agencies, agricultural companies, and researchers across borders, so knowledge is spread, solutions are shared, and best practices introduced. Although natural ecosystems are similar among BSR countries, they are not identical. Involving actors from different countries will help account for this local variability. Beyond this, a joint effort will be more effective to gain the expertise in the domains covered by this project (biodiversity, AI, agriculture, public policy). We focus on a crop of high current importance to the BSR: wheat, of which over 5 million tons are produced each year in the BSR and is a major export crop. We also focus on a crop of future importance: faba beans, which can serve as climate-friendly alternative to importing soybeans. In the future, additional crop species and countries beyond the Baltic Sea region can be added to PestSpace, to further increase the impact and effectiveness of the system.

References

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