

to Contract No. 6-1/41 of 27.09.2024 On the implementation of the project within the scope of the State Programme “Research and Sustainable Use of Local Resources for the Development of Latvia” 2023-2025”

### Form for the Final Scientific Report of the Project

Project title: **Research-based solutions for sustainable agri-food system addressed to the European Green Deal objectives (GreenAgroRes)**

#### Summary:

The overall objective of the project – to promote knowledge and develop scientifically grounded solutions for the sustainable and rational use of Latvia’s natural resources, thereby increasing their added value under changing socio-economic, environmental, and climatic conditions – has been achieved. This has contributed positively to the attainment of the European Green Deal (EGD) objectives. By bringing together researchers and students from four nationally recognized research institutions – the Latvia University of Life Sciences and Technologies (LBTU), the Institute of Horticulture (LatHort), the Institute of Agricultural Resources and Economics (AREI), and the Institute of Food Safety, Animal Health and Environment “BIOR” (BIOR) – interdisciplinary and internationally competitive research teams were established. In synergy, these teams carried out studies defined within the project’s work packages (WP) (see Results Table1).

**WP1:** (1) Technological elements were investigated, and scientifically substantiated knowledge was developed to reduce the use of synthetic plant protection products in cereals, fruits, berries, and vegetables; (2) New or previously insufficiently studied field and horticultural crop pathogens were examined in relation to climate change and cultivation technologies.

**WP2:** (1) New knowledge, approaches, and methods were developed to promote safe and high-quality food and feed chains; (2) Solutions were elaborated to improve animal health, welfare, and protection, and to mitigate public health and environmental risks in line with the “One Health” principle; (3) Technological solutions were created for the production of high-quality and competitive food products; (4) An integrated approach was developed and implemented to ensure the sustainable use of inland waters for enhancing fisheries productivity and high-quality ecosystem services.

**WP3:** (1) The competitiveness and performance of Latvian agriculture were evaluated with respect to achieving the EGD targets; (2) Possible scenarios for achieving these targets were developed; (3) The socio-economic and environmental impacts of the most promising agricultural practices on Latvian agriculture and rural environments were assessed; (4) New knowledge and solutions were generated for sustainable agriculture and rural development.

The knowledge produced and the documents developed are accessible to the relevant target groups, ensuring their wide dissemination. The research results have made it possible to identify and understand existing challenges; the insights gained and conclusions drawn have provided a basis for defining further tasks to strengthen national food, socio-economic, and environmental security, as well as resilience to climate change and external risk factors.

*(For abbreviations used in this document, see page 20.)*

Table 1. Results of the Project

Deliverables	Planned	Developed/ achieved	Partners involved	Stakeholders to whom the deliverable has been provided*
<b>WP1. Solutions for sustainable, qualitative and competitive food production in environmentally friendly agriculture</b>				
D.1.1. Scientific publications in peer-reviewed journals/conference proceedings.	2	2	AREI	Z
D.1.2. Recommendations for policy makers on winter wheat cultivation technologies.	1	1	AREI, LBTU	P
D1.3. Seminars for farmers on winter wheat cultivation technologies.	2	2	AREI	S, N
D1.4. Scientific publications in peer-reviewed journals.	2	2	LatHort	Z

D1.5. Recommendations for policymakers for the development of cultivation guidelines for apple, black currant and cabbage.	3	3	LatHort, LBTU	N, P
D1.6. Scientific conference abstracts.	3	3	LatHort, LBTU	Z
D1.7. Seminars for farmers on cultivation guidelines.	2	4	LatHort, LBTU	N, P
D1.8. Publications in professional journals.	3	3	LatHort, LBTU	N, S
D1.9. International research project application.	1	2	LatHort	Z, N
D1.10. Scientific publications in peer-reviewed journals (Q1-Q2).	2	2	Lathort	Z
D1.11. Review and alert list of legume and woody fruit crop diseases and pathogens.	1	1	LatHort, LBTU	P, Z
D1.12. Scientific conference abstracts (EFPP2025, BSPP2025).	3	6	LatHort, LBTU	Z
D1.13. Defended bachelor thesis on legume diseases.	1	1	LBTU	Z, N
<b>WP2. Novel knowledge and solutions for food and health</b>				
D2.1. Scientific publications in peer-reviewed journals (Q1-Q2).	2	2	LBTU	Z
D2.2. Scientific conferences abstract on consumption of antimicrobials and AMR associations.	2	2	LBTU	N
D2.3. Recommendations for policy makers, veterinarians, farmers, national controlling institutions on the prudent use of antimicrobials at cattle and pig farms.	1	1	LBTU	P, N, IP
D2.4. Recommendations for policy makers on reduction of the spread of AMR bacteria within the ‘from Farm to Fork’ approach.	1	1	LBTU	P, N, IP
D2.5. Recommendations for policy makers, FVS on introduction of granted special guarantees on <i>Salmonella spp.</i>	1	1	BIOR	P
D2.6 Scientific publication in peer-reviewed journal (Q1/Q2): profile of anthocyanins in Latvian blackcurrant genotypes.	1	2	LatHort, LBTU	Z, N
D2.7. Popular science article: Exploring the use of blackcurrant pomace in biodegradable dishes.	1	1	LatHort	S, IP, N
D2.8. Scientific conference abstract (Sustainable Horticulture, 2025): Berry pomace for the development of edible dishes.	1	1	LatHort	Z
D2.9. New product—prototype of edible dishes.	1	2	LatHort	N, S
D2.10. Innovative method: validated rapid RP-HPLC acetonitrile-free method.	1	1	LatHort	Z
D2.11. Recommendations for dairy processing companies for the transition from non-recyclable to environmentally friendly or/and recyclable packaging.	1	1	LBTU	P, N, IP
D2.12. Defended master theses optimisation of dairy products packaging.	1	1	LBTU	Z, N
D2.13. Scientific publications in peer-reviewed journals (Q1-Q2) (one accepted, one submitted).	2	2	LBTU	Z
D2.14. Scientific conferences abstracts (e.g., FoodBalt 2025; Nordic Dairy Congress 2025).	2	12	LatHort LBTU BIOR	Z
D2.15. Defended master theses on a) chemical composition and content of biologically active compounds of spent grains, considering several beer technologies and technological equipment impact; b) Latvian whey (permeate) as a substrate for mycoprotein production.	2	2	LBTU	Z, N, IP

D2.16. Project application.	1	2	LatHort	N
D.2.17. Scientific publications in peer-reviewed journals (Q1/Q2) on risk hazards associated with consumption data in Latvia and public health hazards associated with consumption of freshwater fish of Latvian origin.	2	2	BIOR	Z
D.2.18. Recommendations for policy makers on the safety of consumption of caught freshwater fish, smoked meat and fish of Latvian origin and managers of water-bodies for sustainable use of fish resources.	1	1	BIOR	P, IP, N, S
D.2.19. Scientific conference abstract on food consumption data analysis in Latvia.	1	1	BIOR	Z
<b>WP3. EGD pathways and socioeconomic implications</b>				
D3.1. Scientific publication on Latvia's agricultural competitive advantages within the EU.	1	1	LBTU	Z
D3.2. Report to policy makers on defined EGD scenarios.	1	1	LBTU	P, IP, N, Z, S
D3.3. Scientific publication on EGD agriculture-related objectives, ranking them by scope of ambition, and defining possible political scenarios.	1	2	LBTU	Z
D3.4. Scientific publication on mapping agricultural management practices and their impacts.	1	1	LBTU	Z
D3.5. Scientific publication on the impact of the EGD scenarios, Q1-Q2.	1	1	LBTU	Z
D3.6. Common research report for the Ministry of Agriculture (MoA): 1) on solutions for the development of a sustainable and viable agricultural sector 2) on assessment of Latvia's strengths and weaknesses compared to other EU Member States in achieving the EGD.	1	1	LBTU, AREI	P, IP, N, Z, S
D3.7. Project application for an international research project related to EGD objectives.	1	1	LBTU	Z

\*Abbreviations: P-policymakers, IP- stakeholders (NGOs, associations, etc.), N-industries, Z-scientists, S-society

## 1 Scientific excellence

The project's scientific excellence is grounded in an interdisciplinary approach that integrates agroecology, food science, microbiology, veterinary medicine, environmental science, and socioeconomics. This ensures the development of scientifically substantiated solutions for the advancement and functioning of a sustainable food system. For example: (1) Environmentally friendly crop cultivation technologies were developed to reduce the use of synthetic pesticides (D1.2); (2) Little-known pathogens and their genetic diversity were investigated, strengthening Latvia's response capacity to climate change-induced risks (D1.11); (3) High scientific and technological circular economy-adherent innovation was demonstrated in by studying the use of food by-products for obtaining high value-added raw materials, developing new food product prototypes, and creating biodegradable packaging material solutions (D2.11); (4) Based on the analysis of antimicrobial resistance and *Salmonella* prevalence, scientifically grounded recommendations were developed to ensure the safety of food of animal origin (D2.5); (5) An in-depth assessment of food consumption patterns provided evidence-based solutions for the production of safe and high-quality food (D2.18.1); (6) Three innovative methodologies were developed for assessing the implementation of the European Green Deal, including the creation of the Agricultural Green Competitiveness Index and the modelling of sustainable agricultural practice scenarios up to 2030 (D3.2 and D3.6). The results confirm the consortium's capacity to generate evidence-based, practically applicable solutions in the fields of agricultural development, food safety, climate adaptation, and sustainability.

## **WP1. Solutions for sustainable, qualitative and competitive food production in environmentally friendly agriculture (sub-programme Task 1.1.)**

Within the framework of the activities, practical and case-study-based crop production technologies were modelled, assessing optimal and efficient pesticide use and investigating alternative methods for plant protection against biotic and climate-change-related stresses in agroecosystems.

[T1.1] Evaluation of technological modules for winter wheat production in field experiments indicates that replacing widely used synthetic pesticides with more environmentally friendly products, or eliminating them by applying forecasting systems adapted to Latvian conditions (e.g. veselsaug.lv) and biological preparations, can ensure crop productivity comparable to the standard technology without significantly increased implementation costs. When environmentally safer products were selected in high-input technological modules (N180), a reduction in total active substance use of 18–28% (in physical units) was observed, along with a 12–78% long-term environmental impact decrease. The greatest impact resulted from changes in fungicide and plant growth regulator application practices.

[T1.2] One-year trials demonstrated that mulching and the use of insect nets in cabbage cultivation can serve as alternative technological solutions, increasing yields by 20–26%, reducing herbicide use by 30% (limited to inter-rows between mulched beds), and eliminating insecticide use entirely (100%) in covered treatments. For effective control of plant pathogens in apple and blackcurrant production, selecting more resistant cultivars is recommended, while combining synthetic fungicides and inorganic compounds produces high-quality yields in integrated production systems and reduces environmental pressure. The use of multispectral cameras for assessing plant responses shows potential when adapted to specific tasks. Smart traps proved effective for targeted and efficient plant protection measures.

[T1.3] Underexplored pathogens have been identified in legumes or have been found on new host plants. Fungi of the *Didymellaceae* family and the *Alternaria/Stemphylium* genera are dominant. They have been isolated from peas *Pisum sativum*, beans *Vicia fabae*, white and red clover *Trifolium* spp., alfalfa *Medicago* spp., lupine *Lupinus* spp., fenugreek *Trigonella* sp., common sainfoin *Onobrychis* sp., galega *Galega orientalis*, and beans *Phaseolus* sp. This finding indicates that wild legume and nectar plants can be significant inoculum sources. Sequencing demonstrates the genetic diversity and wide occurrence of these potential pathogens on different host plants. A large diversity of pathogenic fungal species from more than 10 genera has been identified for sea buckthorn, blackcurrant, and other fruit trees (apple, pear, stone fruits), which include pathogens known for other woody plant species, including those in southern regions (e.g., *Eutypa*, *Diatrype* species). New pathogen species have been discovered or have been detected for the first time in Europe (*Pezizula* sp. on pears, *Ochropsora* rust on sea buckthorn). For a large number of identified potential pathogen species, their destructiveness to newly discovered host plants is unknown; therefore, further testing of their pathogenicity and aggressiveness is necessary. Research on these pathogens is essential to prevent their further spread and damage. The acquired knowledge, adaptation of research methods, and skills provide competence in situations when previously unknown or insufficiently studied plant diseases and pathogens occur in the region due to the growing technologies and climate changes.

## **WP2 New knowledge and solutions for food and health (Sub-programme 1.3.; Task 1.4.)**

Within the framework of the activity, solutions were created to reduce antimicrobial resistance in animals, technologies were developed for the production of competitive food products, knowledge was developed on by-product processing and packaging, food consumption characteristics, and sustainable use of inland waters.

[T2.1] Scientific excellence is based on an interdisciplinary approach, integrating scientific knowledge from the fields of veterinary medicine, microbiology, food science, and public health to address the challenges related to the European Green Deal and the Farm to Fork strategy. The work package generates **new knowledge on the prevalence of antimicrobial resistance (AMR)** and its relationship with antimicrobial use (AMU) in food-producing animal populations, especially in the dairy and pig farming, as well as develops scientifically based recommendations for promoting the production of safe, high-quality, and sustainable food raw materials. The development is based on modern laboratory methods, epidemiological data analysis, and evidence-based risk assessment. Scientific novelty is manifested in an in-depth analysis of the epidemiology of AMR and *Salmonella* spp., providing high added value to science, as well as in the development of practically applicable recommendations for the industry and policy-makers.

[T2.2] The project demonstrates high scientific excellence and international competitiveness, combining the development of innovative analytical methods with in-depth sustainability assessment in the food industry. One of the most important scientific achievements of the project is the development of a new, fast, and environmentally friendly RP-HPLC-DAD method for black currant anthocyanin analysis. The developed method ensures complete separation of anthocyanins within 11 minutes, using a mobile phase of 50% ethanol and HCl. This significantly reduces the

environmental burden and laboratory costs, while maintaining high analytical accuracy. The compatibility of the method with older generation HPLC systems (<15 MPa), which are still widely used in universities and research institutes, confirms its practical applicability and the ability of Latvian scientists to create globally significant innovations. Using this method, more than 100 Latvian black currant (*Ribes* spp.) genotypes were analysed, creating the most extensive regional anthocyanin composition dataset to date, which is publicly available (<https://doi.org/10.71782/DATA/27CTO7>). This dataset is an important resource for growers, breeders, and the food industry, facilitating knowledge-based decision-making. The methodology and results have been published in an open access Q2 scientific journal, ensuring knowledge transfer on a national and international scale.

In addition, the project stands out with a large-scale and methodologically sound sustainability assessment of **commercial dairy product packaging**. A unique, freely available dataset (<https://doi.org/10.71782/DATA/RZMAMX>) has been created of 600 dairy product packaging available in Latvian retail, which significantly contributes to data transparency and reproducibility. The impact of various environmentally friendly packaging materials on product quality during storage was analysed under experimentally controlled conditions using a wide range of physicochemical, structural-mechanical, microbiological, and sensory analyses, as well as scanning electron microscopy. A significant scientific novelty of the project is the quantitative demonstration of the problems of metallized polypropylene packaging and the evaluation of alternative solutions, ensuring recyclability and product quality during storage. The project results provide practical, evidence-based recommendations for manufacturers and policymakers, and demonstrate the ability to connect fundamental research and sustainable food system development.

[T2.3] The scientific excellence of the research is in the combination of fundamental research findings with innovative, sustainable solutions in the food industry to promote a circular economy. The comprehensive study of spent grain from Latvian breweries provides a unique insight into the impact of technological parameters on the nutritional value and bioactive substance profile of the by-product. The high protein content (17.8–30.8% dry matter), the presence of essential amino acids, and the diversity of the essential acid composition reveal the significant potential of brewery's spent grain in the development of functional food products and bioactive ingredients. The relationship between chemical composition of the brewery's spent grain, type of beer, scale of production and technological solutions, as well as polyphenol variations indicate a complex interaction between matrices and bioavailability.

The scientific novelty and interdisciplinary approach are complemented by the study on the development of **biodegradable food bowl prototypes from bran and the previously little-studied blackcurrant pomace**. The research demonstrates the ability to transform food by-products into high-added-value functional products whilst reducing plastic pollution and end-of-lifecycle problems, and potential for practical implementation on a national and international scale. In turn, the in-depth study of the yeasts *Kluyveromyces marxianus* MSCL 79 and *Cyberlindnera jadinii* MSCL 87 for mycoprotein production using cottage cheese whey is distinguished by high methodological accuracy. The interaction of the substrate preparation strategy with yeast metabolism has been demonstrated for the first time in a complex, statistically based analysis of technological factors, outlining the trade-off between biomass yield and product quality, thus creating a solid scientific basis for flexible, adapted technologies for sustainable mycoprotein production.

[T2.4] The complex methodological approach used in the study combined consumer habit dynamics with in-depth biochemical and toxicological characterization of region-specific food products for the first time in Latvian scientific practice. Using food frequency questionnaires and detailed consumer behaviour analysis, a robust data set was created, which serves as the basis for impact assessment and risk characterization in accordance with the "One Health" principles. The scientific expertise focused on evaluating the sustainability of the food system and the effectiveness of nutrition policy, comparing current data with indicators from 2014. Of particular value is the first complex freshwater ichthyological resource assessment carried out in Latvia, which performed not only the biological state and parasitofauna analysis for seven economically important fish species (zander, pike, tench, perch, roach and bream, carp), but also a determined detailed meat quality and pollution levels. The indicators used in the study (Fulton index and n-6/n-3 polyunsaturated fatty acid ratios) provide high-precision data on the nutritional value provided by local ecosystems. Phytochemical assessment of plant extracts expanded the understanding of dietary supplement safety by analysing the pharmacological and toxicological potential of bioactive compounds such as juglone, silymarin and curcumin, allowing to prioritize risk assessments in the future. The obtained nutritional data of freshwater fish will complement the food composition data set with previously missing information on the nutritional value of local products, facilitating future assessment of food and nutrient consumption, as well as production, and informing the public.

### **WP3 – EGD pathways and socioeconomic implications (Sub-programme 1.2. task)**

Within this activity, the social and economic impacts of the EGD on Latvian agriculture and rural areas were assessed, and new knowledge was generated to support the sustainable development of the agri-food sector and rural territories. The project delivered a comprehensive analysis and important contribution to national and EU-level discussions on the potential achievement of EGD targets by 2030.

**[T3.1] Latvia's comparative advantages in the EU context were evaluated in relation to the EGD objectives,** resulting in the development of three scientifically innovative and methodologically robust approaches for assessing and achieving EGD targets. These approaches enabled the identification of Latvia's strengths relative to other EU Member States. The first methodology assessed actual Member State progress using the most recent statistical data across five EGD priority areas: reducing pesticide use and associated risks; reducing nutrient losses; decreasing antimicrobial sales; increasing organic farming areas; and enhancing landscape element diversity. The second methodology was based on the result indicators defined in the CAP Strategic Plans of EU Member States and enabled modelling of potential performance and required progress rates up to 2030 in the five priority areas. The third methodology involved the development of a unified composite indicator – the Green Competitiveness Index for Agriculture – integrating 15 individual indicators to provide a quantitative and comparable assessment of Member States' green competitiveness in terms of progress and target achievement. All methodologies have been scientifically validated and published in four Q1 scientific journal articles. **[T3.2] Existing and additional agricultural practices needed to address EGD challenges were assessed.** Agricultural practices were mapped comprehensively, and an economic, social, and EGD-target-related evaluation of the most promising practices under Latvian conditions was done, based on their potential to improve environmental and economic sustainability. **[T3.3] The impact of these practices on farm income, production, trade, competitiveness, employment, and rural areas was analysed.** The results provide a clear understanding of how the practices influence farm viability and regional development. The distribution of costs and investment burdens among farmers, consumers, and public resources was also assessed, highlighting the need for balanced support mechanisms to ensure a fair transition. **[T3.4] Solutions for ensuring a sustainable and viable agricultural sector under different EGD target achievement scenarios were developed.** Scenario modelling was carried out based on the evaluations in T3.1 and T3.3, resulting in three scenarios for improving agricultural performance in Latvia by 2030 in line with EGD objectives: (1) expansion of organic farming areas, (2) implementation of the most promising agricultural practice combinations, and (3) increasing the diversity of landscape elements. These scenarios provide a scientifically grounded basis for policy planning and for guiding sustainable agricultural development in Latvia.

## **2 Impact**

2.1 Impact of the project and its outcomes on the development of the relevant fields and the research community in Latvia and its international competitiveness

**Impact on Fields.** The research encompasses multiple scientific disciplines and a broad range of thematic areas: (1) **Agricultural, forestry, and veterinary sciences** – crop and horticultural production, focusing on controlling plant disease spread, integrated pest management, and soil health improvement solutions; (2) **Animal and dairy science and veterinary medicine** – exploration of the “One Health” concept and opportunities to reduce antimicrobial agents use; inland water fisheries development; (3) **Engineering and technology** – production of safe and high-quality food; promotion of environmentally sustainable food processing by-product utilization; (4) **Social sciences** – addressing agrarian and regional economics, and environmental governance, promotion of climate neutrality, socio-economic, and environmental assessments in agriculture-related sectors.

**Development of the Research Community in Latvia.** The project promoted cross-sectoral research and laid the foundation for long-term collaborative initiatives in the fields of bioeconomy and environmental sustainability, simultaneously strengthening the international influence and cooperation potential of Latvian scientific institutions. Collaboration was enhanced among consortium members and other scientific institutions, industry partners, governmental bodies, and non-governmental organizations, including Latvian State Forest Research Institute “Silava”, Rīga Stradiņš University, the Ministry of Agriculture, the business sector, professional associations, and civil society institutions.

**International Competitiveness.** As a result of project implementation, international cooperation and competitiveness of the participating research institutions within the European Research Area have significantly expanded and

strengthened. Key international partners include the University of Tartu (Estonia), the Norwegian University of Science and Technology, Wageningen University (the Netherlands), Lund University (Sweden), and the Inland Fisheries Institute (Poland). The Latvia University of Life Sciences and Technologies and the Institute of Horticulture, in collaboration with several leading European research centres, have participated in the preparation, submission, and implementation of international project proposals (Horizon Europe, LIFE, and SBEP) (see Table 2 for details). LBTU's participation in the approved Interreg Baltic Sea Region project *PestSpace* has substantially contributed to increasing the international visibility of Latvian scientific institutions and their integration into the European research community. Cooperation with Lund University (involving LatHort and LBTU Agrihort) was strengthened in the study of plant pathogens and pests. Drawing on the experience of Poland, an integrated fish stock assessment methodology was developed, providing practical contributions to the management of Latvia's inland water ecosystems.

The project results facilitate knowledge and technology transfer, promote interdisciplinary research, and create a foundation for long-term collaborative initiatives in bioeconomy and environmental sustainability, while reinforcing the international influence and cooperation potential of Latvia's scientific institutions.

Table 2. International Cooperation in the Project

No.	Cooperation institution / organisation, country	Type of cooperation	Outcome	Time period
1	Lead partner: <b>University of Tartu, Estonia</b>	Cooperation in the preparation of an international project application. The consortium: 13 partners from 5 countries, LV is represented by: LBTU	Submitted and approved project: Interreg Baltic Sea Region, "Improving resilience to the spread of plant diseases via regional Pest Common Data Space" (PestSpace), Nr.#C060. <a href="https://interreg-baltic.eu/project-posts/pestspace/%F0%9F%8E%AC-in-the-field-with-the-pestspace-team-how-we-document-crop-diseases/">https://interreg-baltic.eu/project-posts/pestspace/%F0%9F%8E%AC-in-the-field-with-the-pestspace-team-how-we-document-crop-diseases/</a>	2025-2028
2	Lead Partner: <b>Norwegian University of Science and Technology, Norway</b>	Cooperation in the preparation of an international project application. The consortium: 12 partners, LV is represented by: LatHort	Submitted: "Novel Opportunities for Valorisation of Aquatic and Seafood side streams by Technologically Efficient Solutions" (NO-VASTES), CALL ID: SBEP2024; Proposal ID: SBEP2024-966.	2024 - 2025
3	Lead Partner: <b>Norwegian University of Science and Technology, Norway</b>	Cooperation in the preparation of an international project application. The consortium: 16 partners, LV is represented by: LatHort, Ražošanas Tehnoloģijas Ltd	Re-submitted: "Full Resource Exploitation and Upcycling of Seafood Side streams" (FULL-REUSES), CALL ID: SBEP2025; Proposal ID: SBEP2025-959	2025
4	Lead Partner: Institute of Horticulture (LatHort)	Cooperation in the preparation of an international project application. The consortium: 11 partners, LV is represented by LBTU, LVMI "Silava", MoA, 2 entrepreneurs, and 2 associations (NGOs)	Submitted: "Revealing Climate Change Mitigation Potential in Fruit and Berry Orchards" (LIFE Orchard), Call LIFE-2025-SAP-CLIMA, Proposal ID 101294915.	2025
5	Lead partner: <b>Wageningen University, Netherlands</b>	Cooperation in the preparation of an international project application. The consortium: 11 partners, LV is represented by LBTU	Submitted: Health of Agricultural Land: Learning, Managing and Applying Regenerative Knowledge for Soil (HALLMARKS), no.101218871. Call: HORIZON-MISS-2024-SOIL-01.	2024 - 2025
6	Lead Partner: <b>Lund University, Sweden</b>	An international consortium (Norway, Sweden, Finland) is operating within the framework of	Coordinated information gathering on the problematic issues of pathogens and pests of blackcurrants and other Ribes g. plants	2024 - 2026

		the NKJ-funded project “Developing Integrated Pest Management in Nordic currant production”. Baltic States, as associated partners. LV is represented by: LatHort, LBTU Agrihorts	and preparation of a review article are underway. Further cooperation opportunities and funding for joint research are being sought.	
7	<b>Stanisław Sakowicz Institute of Inland Fisheries, Poland</b>	Exchange of knowledge and experience in fish resource assessment.	Methodology for assessing fish stocks developed	2025
8	<b>Estonian Rural Research and Knowledge Centre, Estonia</b>	Cooperation in the implementation of project tasks, preparation of the publication	Joint publication prepared and published: <a href="https://doi.org/10.3390/agriculture15151633">https://doi.org/10.3390/agriculture15151633</a>	2025

2.2 Impact of the project on students within the context of their study process, creating internship and employment opportunities, as well as platforms and the use of the scientific outcomes of the project in the process of attaining university degrees

A total of **124 researchers** of various academic levels (professors, associate professors, one tenure professor, lead researchers, research assistants, and laboratory technicians) and **22 students** participated in the project. Gender equality was ensured, with 89 women and 35 men involved. The total average **full-time equivalent (FTE)** of the participating researchers reached **25.94**, exceeding the planned 23.37, while the FTE of participating students was **6.17** (planned – 4.7). Under the supervision of experienced researchers, **six bachelor’s theses** and **three master’s theses** were successfully developed and defended (see Table 3). Research topics initiated within the project at LBTU are being continued in **three doctoral dissertations, one bachelor’s, and one master’s thesis**. Additionally, a **master’s student** from Rīga Stradiņš University’s inter-university study programme was involved, conducting a risk-benefit assessment of freshwater fish available in Latvia. The involvement of students from different study levels in the project has fostered the development of their **research skills and professional competencies**, creating preconditions for their future **scientific or industry careers**. Project partners **BIOR** and **LatHort** closely collaborate with **LBTU**, and thanks to their modern infrastructure, currently support the development of **three doctoral** and **one master’s thesis** within their institutions. All partner organizations are able to provide students with internship and employment opportunities.

Integration of Project Knowledge into Higher Education. The knowledge generated through the project has been integrated into **LBTU’s higher education programmes**. The project has had a **significant impact on the educational process**, ensuring that scientific results are effectively used in higher education, while simultaneously strengthening the capacity of both students and research teams. It was initially planned to integrate project outcomes into 15 LBTU study programmes in the fields of agriculture, veterinary medicine, food technology, economics, and environmental sciences. Following an evaluation of the programme content and the relevance of project-generated knowledge, by the end of the project, new knowledge was successfully integrated into **11 programmes** through **18 study courses: five bachelor’s, four master’s, and two doctoral programmes**. The remaining programme updates are scheduled for implementation after the project’s conclusion. Enhancements to higher education programmes included: a) modernization of lecture materials; b) inclusion of case studies based on project research; c) introduction of new tasks and exercises in practical classes; d) incorporation of newly produced scientific publications into independent study courses; and e) utilization of the **Dataverse.lv** data platform in research and scientific writing.

Study programmes in which the knowledge obtained through the project has been integrated (by activity):

**WP1 (3 study programs, 4 study courses):**

1. Bachelor's Study Programme "Agriculture", study course (LauZB003) Agricultural entomology and phytopathology;
2. Bachelor's Study Programme "Sustainable Agriculture", study course (LauZ3176) Plant pathology;
3. Master's Study Programme "Agriculture", study course (LauZM005) Integrated pest management;
4. Master's Study Programme "Agriculture", study course (LauZM006) Crop pests and pathogens.

**WP2 (4 study programs, 7 study courses):**

1. Doctoral Study Programme “Food science”, study course: (PārZD049) *Research Methodology in Food Science*;
2. Academic Master's Study Programme “Food science”, study course: (PārZM002) *Methodology of Research in Food Science*;
3. Academic Bachelor's Study Programme “Food quality and innovations”, study course: (PārZB002) *Beverage Production Technology*;
4. 2nd level professional study program “Veterinary medicine”, study courses: (VeteB050) *Pharmacology, Pharmacotherapy and Toxicology III*, (VeteB022) *Internal Medicine, Herd Health III*, (VeteB033) *Infectious Diseases II*, (Vete4107) *Infectious Diseases I*.

**WP3 (applicable to 4 study programmes – the Master’s programme Agriculture is also linked to WP1 and 7 study courses):**

1. Academic Master’s Study Programme “Economics”, study courses: (VadZ5081) *Eco-Entrepreneurship*, (VadZ6028) *Systems Analysis in Entrepreneurship*, (Ekon5157) *Knowledge-Intensive Bioeconomy*;
2. Master’s Study Programme “Agriculture”, study course: (Ekon5123) *Investments for Rural Development*;
3. Academic Master’s Study Programme “Sustainable Finance”, study course: (EkonM015) *Sustainable and Responsible Finance for Business*;
4. Academic Bachelor’s Study Programme “Economics”, study course: (Ekon3142) *Bioeconomy*;
5. Doctoral Study Programme “Agrarian and Regional Economics”, study course: (EkonD111) *Agrarian and Regional Economics*.

Table 3. Student Involvement in the Project

Doctoral, master’s, and bachelor’s theses supervised or advised by the project manager or principal investigators within the scope of this project (if defended, indicate this in the last section of the table, supplementing with the date and the relevant doctorate council)				
No.	Author	Title of the thesis, level of study, hyperlink to the doctoral / final theses database	Supervisor and consultant	Defence
1	Katrīna Apsīte	Pea diseases and their causal agents. Bachelor’s Thesis.	Prof., Dr.agr. Gunita Bimšteine, LBTU	02.06.2025
2	Renāte Ruska	Alternative solutions to metallized polypropylene packaging for cottage cheese dessert. Master's thesis.	Prof., Dr.sc.ing. Sandra Muižniece- Brasava, LBTU	06.06.2025
3	Inga Mažule	Barrier coatings as an alternative to replacing polymers in laminated packaging. Bachelor’s Thesis.	Prof., Dr.sc.ing. Sandra Muižniece- Brasava, LBTU	04.06.2025
4	Andrejs Bānis	Enzyme assisted the brewery's spent grain protein concentrate development. Master's thesis.	Prof., Dr.sc.ing. Tatjana Ķince (supervisor), Ph.D. Darius Sargautis, (consultant), LBTU	06.06.2025
5	Aļina Sivačova	Valorisation of acid whey for mycoprotein production. Master's thesis.	Prof., Dr.sc.ing. Inga Ciproviča, LBTU	06.06.2025
6	Sofija Moroza	Environmental Tax assessment for farmers in Latvia and the European Union. Bachelor’s Thesis.	Assist.prof., Ph.D., B. Mistre, LBTU	05.06.2025
7	Laura Dubkēviča	Evaluation of the socio-economic aspects of renewable energy in agriculture. Bachelor’s Thesis.	Dr.oec., prof., Aina Muška, LBTU	05.06.2025
8	Amanda Endija Vārna	Conceptualisation of competitiveness and approaches in the Latvian grain sector. Bachelor’s Thesis.	Ph.D., Assist.prof., Madara Dobeļe, LBTU	05.06.2025

9	Maija Runce	Assessment of agricultural green competitiveness in the context of the European Green Deal. Bachelor's Thesis.	Dr.oec., prof., Aina Muška, LBTU	05.06.2025
10	Marta Mazpreciniece	Fungi associated with legume seeds. Master's thesis.	Prof. Dr. biol. Biruta Bankina, LBTU	In progress
11	Asnāte Elizabete Universa	Investigation of the possibilities of brewery spent grains biorefining for the development of new value-added products. PhD Thesis.	TenurProf., Dr.sc.ing. Zanda Krūma, LBTU	Under development
12	Lana Janmere	Integrating consumer choices and policy design to enhance sustainability in food systems. PhD Thesis.	Prof., Dr.oec., Irina Pilvere, LBTU	Under development
13	Kristīne Drevinska	Characterisation of pathogenic fungi on sea buckthorn. Doctoral thesis.	PhD. Inga Moročko-Bičevska, LatHort; Prof. Dr. biol. Biruta Bankina, LBTU	In progress
14	Elizabete Mūrniece	Nutritional characteristics of freshwater fish and potential risk of chemical contamination. Master thesis.	PhD. chem. Jānis Ruško, BIOR	In progress
15	Madara Nikolajenko	The consumption of antibacterial drugs used in veterinary medicine in Latvia and its impact on the resistance of indicator microorganisms	Prof., Dr.med.vet. Kaspars Kovaļenko, Prof., Dr.med.vet. Līga Kovaļčuka, LBTU	In progress
16	Luīze Gidrevica	Identification of <i>Fusarium</i> fungi found on sea buckthorn ( <i>Hippophae rhamnoides</i> L.) in Latvia. *Students' scientific research work	K. Drevinska, M.agr., LatHort; G. Heistere, Dobeles State Gymnasium	Defended with distinction in 2025

\*The research results were used in the scientific and practical work of future students – pupils of Latvian secondary education institutions, thus encouraging the choice to study and pursue a career as a scientist.

### 2.3 Impact of the project and its outcomes on policy makers and policy implementers in the sector, providing recommendations for developing sector policy

Within the framework of the project, **12 scientifically based tools (guidelines, recommendations, reports, and policy briefs)** (see Table 4) have been developed. These are intended as tools for the needs of Latvia's agriculture and food processing policy-making (development of various policy and action documents and support instruments) and implementation institutions, mainly the Ministry of Agriculture, and other institutions involved in policy implementation, like the Food and Veterinary Service, the State Plant Protection Service, and the State Environmental Service.

Examples include tools designed for:

- (1) Promoting sustainable, environmentally friendly, and competitive practices within the agricultural sector;
- (2) Enhancing a safe and high-quality food and feed chain, improving animal health, welfare, and protection, and reducing public health and environmental risks in accordance with the “One Health” principle;
- (3) Implementing an integrated approach to ensure the sustainable use of inland waters for fisheries;
- (4) Developing solutions for the sustainable and resilient development of the agricultural sector under various scenarios for achieving the objectives of the European agricultural strategy.

The produced documents are also of significant relevance to sectoral organizations that prepare and implement projects and engage in interest representation, such as the Farmers' Parliament of Latvia, the Latvian Organic Farming Association, and others.

The informational materials and policy documents developed as a result of the project will be published on the websites of the participating institutions after coordination with the Ministry of Agriculture, no later than 1 April 2026.

**WP1** Four recommendations and policy-oriented guidance documents were prepared for policymakers to support the refinement of guidelines for environmentally friendly cropping systems, reducing the use of synthetic plant protection products. These recommendations will also be disseminated to non-governmental organizations representing growers

and producers. In addition, an early warning list of the most important diseases and pathogens affecting legumes and fruit crops (woody perennials) was developed.

**D1.2.** Recommendations were prepared on options to reduce Plant Protection Products (PPP) pressure or substitute synthetic products in **winter wheat** production technologies. The recommendations include preventive measures to limit the spread of weeds and disease agents in winter wheat crops, as well as technological solutions to reduce PPP inputs. In collaboration with sector experts, several technological modules were developed and tested in field experiments. The recommendations are based on the conducted field trial results, insights gathered during expert discussions and field day seminars, and a synthesis from publicly available results from previous studies conducted in the Baltic region.

**D1.5.** Recommendations and guidelines have been prepared for apple scab control in **apple trees**, based on: comprehensive information about challenges in its control, including non-organic substances; a summary of farm practices and the seasonal effectiveness of fungal infection control, linked to potentially influencing and comparable conditions; results from a trial comparing three fungicide application strategies and two orchard systems with different apple tree canopy types across apple cultivars. In addition, multispectral remote-sensing data on plant health indices was acquired at three different periods. The impact of orchard systems on production was evaluated over a two-year period.

**D1.5.** Recommendations and guidance for **blackcurrant** production were prepared based on results summarized in the report and an extensive literature review, compiling current practices and research in Latvia and internationally on the control of blackcurrant diseases and pests. The recommendations emphasize preventive methods and reduced use of synthetic PPPs. Additional focus is placed on frost protection, adequate water supply, sanitation measures at the end of the growing season, and the promotion of beneficial organisms within plantations. The recommendations are accompanied by a proposed seasonal plant protection plan.

**D1.5.** Recommendations and guidance for **cabbage** production were developed based on a review of scientific literature and the results of a one-year field experiment. The experimental results and methodological descriptions provide an overview of the implemented field trial and the monitored parameters. In 2025, a field experiment was conducted to evaluate weed and pest control methods in plantings of the cabbage hybrid ‘Jaguar’, using biodegradable plastic mulch and two types of insect nets. Through phenological observations, pest monitoring, and multispectral index measurements, the effects of protective covers on plant growth conditions, yield, and quality were assessed, along with the effectiveness of smart traps for pest management.

**D1.11.** A comprehensive scientific literature analysis was conducted on new and underexplored pathogens and diseases of legumes and woody fruit crops, focusing on pathogens whose significance is increasing or may increase due to climate change and changes in cultivation technologies (e.g., reduced use of PPPs or their unavailability, periods of drought and heat). The information was analysed in the context of the pathogens identified during the project. As a result, an **alert list of the most important diseases and pathogens** of legumes and woody fruit crops (cankers, diebacks, decline) was created, their potential impact was assessed, and recommendations for further research and actions were provided. The list is intended for internal use by the Ministry of Agriculture.

**WP2** Six documents have been prepared within the framework for policymakers to obtain and provide high-quality and safe raw materials for the development of environmentally friendly agriculture.

**D2.3.** Recommendations have been developed for policymakers on the integration of antimicrobial use-resistance (AMU-AMR) data, implementation of risk-based surveillance, adjustment of regulatory and market incentives, as well as prioritisation of prevention in agricultural policy. The document emphasizes the need for a unified, and mandatory accounting of antimicrobial use in food-producing animals, linking it to the results of national AMR surveillance, so that decisions are based on comparable risk indicators. The recommendations include the consistent integration of EMA antibiotic categories into national regulation, restrictions on the marketing of veterinary medicines, and the reorientation of incentives towards prevention. The recommendations are based on GreenAgroRes monitoring data in the dairy and pig sectors, a literature review, and the One Health approach, as well as insights from industry discussions, linking national goals with the EU Green Deal and the Farm to Fork strategy.

**D2.4.** Practical recommendations for veterinarians, farmers, and regulatory authorities on the prudent use of antimicrobials in cattle and pig herds were developed, based on AMR monitoring data obtained in Latvia and industry surveys. The document identifies the most significant resistance risks in the cattle and pig sectors and provides targeted recommendations for tracking antibiotic use, strengthening prevention, risk-based surveillance, and compliance with the EMA A–D antibiotic classification, ensuring a link between scientific data, EU “Farm to Fork” objectives, and practical implementation at the farm level.

**D2.5.** Recommendations have been prepared for obtaining special guarantees for *Salmonella* spp. in eggs and meat, based on EU regulatory framework and national surveillance practices. The document sets out proposals for improving salmonella monitoring, sampling, laboratory testing, and data interpretation to ensure compliance with special guarantee requirements and strengthen food safety. The recommendations focus on a risk-based approach, increasing the effectiveness of surveillance and cooperation between BIOR, the Food Veterinary Service, and industry participants, providing an implementable framework for maintaining and developing special guarantees in Latvia.

**D2.11.** Recommendations have been developed for dairy processing companies for the transition from non-recyclable to environmentally friendly and/or recyclable packaging. The development of recommendations is based on research results in cooperation with companies (LABIINK SIA, AS VG KVADRA PAK, AS Rīgas piena kombināts, AS Smiltēnes piens). An algorithm has been prepared detailed packaging audits, which is an essential tool for promoting sustainability and efficient use of resources. Its goal is to systematically evaluate primary, secondary, and tertiary packaging, analyzing recyclability, material structure, filling efficiency, use of double packaging, printing, and labelling. The audit is based on documentation and analysis of real packaging, in compliance with Latvian and European Union regulatory enactments, including Regulation (EU) 2025/40. Special attention is paid to multi-layer packaging, technological limitations, equipment flexibility, and production waste.

**D2.18.1.** A document for policymakers was prepared on the safety of caught freshwater fish, smoked meat, and botanical dietary supplement consumption. The summary provides main recommendations for policymakers, based on a study on the safety of smoked products, freshwater fish, and plant-based dietary supplements in Latvia. The need to improve data collection methods in national consumption studies is emphasized in order to effectively assess the long-term impact of these products. It is recommended to include local freshwater fish in national dietary guidelines as a healthy and sustainable choice. The need to strengthen risk communication on the safety of certain compounds, such as curcumin and piperine, is indicated. The document is intended for internal use by the Ministry of Agriculture.

**D2.18.2.** A document for freshwater reservoirs – lake managers: “Integrated analysis of fish stock assessment methods in Latvian lakes and perspectives of their application in the management of predatory fish populations”. A scientific literature review was conducted on the development of a methodology for assessing predatory fish resources. Documents developed in Latvia have been analysed, and two recommended methods for developing lake fishery exploitation regulations have been described and offered to lake managers. Several methods for assessing predatory fish resources are described, the practical testing of which is planned for the next season after the end of the project. The document will be used by lake managers: municipalities, lessees, and owners, to order an assessment of the state of fish resources, to companies that, in accordance with the procedures specified in the Fisheries Law of the Republic of Latvia, are entitled to carry out fishing for special purposes and to develop Fishery Exploitation Regulations.

**WP3**, through the preparation of two reports, a comprehensive analysis was carried out on the performance, challenges, and opportunities of EU Member States and Latvia in implementing the EGD objectives.

**(D3.2.)** The report “*European Green Deal Scenarios*” was prepared. Its seven chapters examine Latvia’s comparative advantages and green competitiveness in the context of EGD targets, as well as the key scenarios for potentially achieving the EGD indicators in Latvia. The Green Competitiveness Index for Agriculture (GCIA) for EU Member States for 2018–2022 (calculated using 15 indicators) shows an overall medium performance and significant untapped potential for achieving EGD targets, alongside moderate convergence between countries. The study identifies five critical areas with insufficient progress – organic farming, landscape elements, ammonia emission structure, and renewable energy production – which constrain improvements in green competitiveness across the EU. Latvia demonstrates moderately high green competitiveness due to strong environmental quality indicators, yet faces risks related to increasing pesticide hazard and low engagement in renewable energy production, highlighting the need for targeted policies and support to address structural weaknesses. Although substantial differences between Member States persist, moderate convergence is observed, driven mainly by average performance rather than rapid progress among leaders. Scenarios for achieving EGD targets by 2030 were developed, focusing on expanding organic farming, implementing the most promising agricultural practices, and increasing landscape elements. The results are summarised in the main conclusions and policy recommendations.

**(D3.6.)** The “*Final Report on European Green Deal Pathways and Socio-Economic Impacts*” has been prepared, providing a comprehensive assessment of the performance of EU Member States and Latvia, as well as the projected progress towards achieving EGD targets by 2030, particularly agricultural sustainability, effectiveness of management practices, and impact of policy instruments. Across ten chapters, the study offers an in-depth analysis of the five key EGD indicators, evaluates Latvia’s comparative advantages and green competitiveness in the EU context, and assesses

the environmental, productivity, and economic impacts of the most promising crop and livestock management practices. The report concludes with scenarios for achieving EGD targets in Latvia by 2030 and formulates key recommendations for policymakers at both the national and EU level.

Table 4. Cooperation within the Project and at the National Level and Outcomes of the Project

No.	In cooperation with	Type of cooperation	Outcome	Time period
1	AREI in collaboration with LBTU, including Agrihortos.	Joint field experiments, assessments of specific areas and their analysis, summarizing findings from previous research, participation in discussions between industry experts, field day seminars, and development of recommendations.	<b>D1.2.</b> Recommendations for reducing the load of synthetic PPP or replacing synthetic products in winter wheat growing technologies	2025
2.	LatHort in collaboration with LBTU, including Agrihortos.	Joint trials were carried out on apple trees to compare PPP application strategies; 10 farms were surveyed; one scientific and two popular-science publications were prepared jointly; and the data were presented at three conferences.	<b>D1.5.</b> Recommendations on guideline refinement for environmentally friendly cultivation systems, reduced use of synthetic plant protection products in apple orchards for policymakers, and economically viable solutions to reduce the use of synthetic plant protection products in high-density apple orchards for growers.	2024 - 2025
3	LatHort in collaboration with LBTU, including Agrihortos	A joint field experiment was implemented to evaluate the effectiveness of plant covers. A popular science publication, a presentation at a scientific conference, and a presentation at a Field Day event were jointly prepared.	<b>D1.5.</b> Recommendations for policymakers on guideline refinement for environmentally friendly cabbage production technologies, focusing on the use of different plant and soil covers to reduce the need for synthetic plant protection products.	2024 - 2025
4	LatHort in collaboration with LBTU, including Agrihortos	Joint farm surveys were conducted, including questionnaires and plantation assessments. A popular science publication and a conference presentation were jointly prepared	<b>D1.5.</b> Recommendations for policymakers on guideline refinement for environmentally friendly production systems with reduced use of synthetic plant protection products in blackcurrant plantations.	2024 - 2025
5	LatHort in collaboration with Institute of Soil and Plant Sciences, LBTU	Specific scientific competencies and technological capabilities (laboratories, equipment) were combined; theses for international conferences were jointly prepared. Development of a bachelor's thesis.	<b>D1.11.</b> Summary of information and an alert list of the most important diseases and pathogens of legumes and woody fruit crops.	2024 - 2025
6	LBTU Faculty of Veterinary Medicine in collaboration with 8 pig and 18 dairy cow farms	A survey of farms and a questionnaire survey of persons responsible for antibiotic use were conducted, animal and environmental samples were obtained for laboratory determination of AMR profiles, and AMR results were categorized according to EMA guidelines.	<b>D.2.3.</b> Recommendations for veterinarians, farmers, and state regulatory authorities on the prudent use of antimicrobials in ruminant and pig farms	2025

7	Clinical Institute of the Faculty of Veterinary Medicine of LBTU in cooperation with the Institute of Food and Environmental Hygiene	The combined scientific expertise of both institutes (medical treatment, epidemiology, infectious diseases, food safety, One Health) was used, existing regulations, monitoring system, support mechanisms were evaluated; work on developing recommendations was carried out.	<b>D.2.4.</b> Recommendations for policymakers on reducing antimicrobial resistance in a “farm to fork” concept.	2025
8	LBTU Faculty of Veterinary Medicine in collaboration with BIOR	Pooled specific scientific competencies and technological capabilities (laboratories, equipment); mutual exchange of information	<b>D.2.5.</b> Recommendations for policymakers to obtain national special guarantees for Salmonella spp. in eggs and meat.	2024 - 2025
9	LBTU Food Institute in collaboration with three industry companies, retail stores	Mutual exchange of information, data and knowledge; research on the packaging of dairy products in retail chains; packaging materials and their coatings provided; offer of existing dairy products for research.	<b>D.2.1.</b> Recommendations for dairy processing companies to transition from non-recyclable to environmentally friendly and/or recyclable packaging.	2024 - 2025
10	BIOR in collaboration with LBTU	Shared competences and technological capabilities (laboratories, equipment) of scientists from different fields; exchange of data and knowledge.	<b>D2.18.1.</b> Recommendations for policymakers on the safety of consumption of caught freshwater fish and smoked meats, botanical dietary supplements	2025
11	BIOR laboratories and the Fish Resource Research Department	Mutual exchange of information in sample collection, analysis, data compilation; preparation of method	<b>D.2.18.2.</b> Integrated analysis of fish stock assessment methods in Latvian lakes and prospects for application in predatory fish population management	2024 - 2025
12	Collaboration within WP3 with WP1, WP2, the MoA, and stakeholders	Joint exchange of information, research results, data, and knowledge with researchers from LBTU, AREI, LatHort, BIOR, and policymakers	<b>D3.2.</b> The report “ <i>European Green Deal Scenarios</i> ”.	2024 - 2025
13	Collaboration within WP3 with WP1, WP2, the MoA, and stakeholders	Joint exchange of information, research results, data, and knowledge with researchers from LBTU, AREI, LatHort, BIOR, and policymakers	<b>D3.6.</b> The “ <i>Final Report on European Green Deal Pathways and Socio-Economic Impacts</i> ”.	2024 - 2025

#### 2.4 Impact of the project and its outcomes on society as a whole, through knowledge transfer and awareness raising of the role of research and contribution thereof to society

The GreenAgroRes project has significantly contributed to knowledge transfer and the enhancement of public awareness regarding the role of research in the development of a sustainable economy and society. The main external target groups included the MoA and its subordinate institutions, farmers, food processing companies, industry associations, and civil society organizations addressing socio-economic development, climate, and environmental issues. Overall, the project’s results and scientific insights were widely disseminated through **the websites of partner institutions** (*over 150,000 views in total*), **social media platforms** (*over 45,100 views*), and **sectoral events**, ensuring broad accessibility of knowledge across diverse audiences. All consortium partners maintain close cooperation with policymakers and implementing authorities in Latvia. During the project, six events (seminars and discussions) were organized with representatives from the public sector, enterprises, and associations, resulting in the preparation of recommendations, policy guidelines, and proposals aimed at improving sustainable agriculture and food policy in alignment with the EGD objectives. Practical knowledge for sector specialists and stakeholders was promoted during four **Field and Garden Days**, where environmentally friendly cultivation solutions for wheat, apples, black currants, and cabbage were demonstrated, attracting more than 270 participants in total. Knowledge transfer was further supported through four popular science

articles published in the journal *Profesionālā Dārzkopība* (“Professional Horticulture”). Science communication activities also targeted the general public, using five television programs, social media, and the Ministry of Education and Science platform **ResearchLatvia** (<https://www.viegliparzinatni.lv/tava-zeme/tava-zeme-1/>) (>54000 views). Particular emphasis was placed on youth engagement in TV features, contributing to the education and awareness of the younger generation about the importance of science. Research findings on freshwater fish resources were presented in the TV program *Copes garša* (“The Taste of Fishing”) ([link](#)), one of the most-watched shows among anglers, fishers, and sector specialists (6700 views), thereby increasing public interest in the role of science in natural resource management. At the **international food exhibition Riga Food 2025**, five presentations showcased circular economy solutions for developing high value-added products. At the project’s conclusion, a **final conference** was organized jointly with the VPP project Forest4LV, bringing together 130 participants – researchers, students, policymakers, implementers, and industry representatives – to foster discussions on the contribution of research to the economy and society. The project’s outcomes – technologies, products, and recommendations – provide direct support to the MoA in advancing sustainable and competitive agricultural development. They assist farmers in adopting and improving technologies, and processors in introducing innovative products, reducing by-products, and adopting recyclable packaging solutions. In this way, the project strengthens the innovation capacity of the food sector, enhances environmental awareness, and promotes the sustainable development of society as a whole.

Table 5 summarizes the main communication channels and publicity activities used for knowledge transfer.

Table 5. Overview of Communication and Publicity Activities

No.	Communication channel (e.g., radio, TV, social networks, etc.)	Activity (interview, popular science article, seminar, etc.)	Target audience planned / reached (describe the target audience and the size of the audience reached)	Available (hyperlink)	Date of publication / event
1	LBTU website <a href="https://www.lbtu.lv/">https://www.lbtu.lv/</a>	Information about project activities (seminars, interim press releases, etc.)	Scientists, industry representatives, policymakers, society	<a href="https://www.lbtu.lv/lv/projekti/astiprinatie-projekti/2024/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai">https://www.lbtu.lv/lv/projekti/astiprinatie-projekti/2024/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai</a>	Information publication period: 17.10.2024. - 01.2026
2	LatHort website <a href="https://www.darzkopibasinstituts.lv/">https://www.darzkopibasinstituts.lv/</a>	Information about project activities (seminars, interim press releases, etc.)	Scientists, industry representatives, policymakers, society	<a href="https://www.darzkopibasinstituts.lv/lv/projekti/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai-eiropas-zala-kursa-merku">https://www.darzkopibasinstituts.lv/lv/projekti/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai-eiropas-zala-kursa-merku</a>	Information publication period: 10.10.2024. - 01.2026
3	AREI website <a href="https://www.arei.lv/">https://www.arei.lv/</a>	Information about project activities (seminars, interim press releases, etc.)	Scientists, industry representatives, policymakers, society	<a href="https://www.arei.lv/lv/projekti/2024/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai-eiropas-zala-kursa">https://www.arei.lv/lv/projekti/2024/zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistemai-eiropas-zala-kursa</a>	Information publication period: 11.10.2024. - 01.2026
4	BIOR website <a href="https://bior.lv/lv/">https://bior.lv/lv/</a>	Information about project activities (seminars, interim press releases, etc.)	Scientists, industry representatives, policymakers, society	<a href="https://bior.lv/lv/projekts/uzsakta-valsts-petijumu-programmas-vietejo-resursu-izpete-un-ilgtspejiga-izmantosana-latvijas-attistibai-projekta-zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistem/">https://bior.lv/lv/projekts/uzsakta-valsts-petijumu-programmas-vietejo-resursu-izpete-un-ilgtspejiga-izmantosana-latvijas-attistibai-projekta-zinatniski-pamatoti-risinajumi-ilgtspejigai-partikas-sistem/</a>	Information publication period: 08.10.2024. - 01.2026
5	Communication events for scientists and industry representatives	Informative seminars at the Ministry of Agriculture	Policymakers, industry and LZP representatives (total 203 participants), seminar 16.06.: > 14.1k views	Six in-person seminars/discussions <a href="#">Turpinās zinātniskie pētījumi lauksaimniecības un pārtikas ražošanas attīstībai - LV portāls</a>	20.12.2024. 27.03.2025. 30.04.2025. 16.06.2025. 12.11.2025. 13.11.2025.

6	Electronic magazine "Professional GARDENING"	Popular science articles (four)	Representatives of industry, public and state institutions, gardeners (150 readers)	<a href="https://fruittechcentre.eu/sites/default/files/izdevumi/pdf/Profesionala_DARZKOPIBA_Nr23.pdf">https://fruittechcentre.eu/sites/default/files/izdevumi/pdf/Profesionala_DARZKOPIBA_Nr23.pdf</a> ; <a href="https://fruittechcentre.eu/sites/default/files/izdevumi/pdf/Profesionala_DARZKOPIBA_Nr22.pdf">Nr22.pdf</a>	28.11.2025 01.06.2025
7	Information in national media, TV story	Interviews in all partner institutions	Society, interested parties	<a href="https://replay.lsm.lv/lv/skaties/ieraksts/lv/364096/abelu-dzivzogi-un-droni-jaunas-metodes-auglkopiba">https://replay.lsm.lv/lv/skaties/ieraksts/lv/364096/abelu-dzivzogi-un-droni-jaunas-metodes-auglkopiba</a>	07.10.2025.
8	International food exhibition RIGA FOOD 2025	Seminar "High added value and sustainable circular solutions for the food processing industry"	Exhibition visitors (average ~200 people)	<a href="https://www.lbtu.lv/lv/raksts/2025-09-04/satiec-lbtu-parstavjus-partikas-izstade-riga-food">https://www.lbtu.lv/lv/raksts/2025-09-04/satiec-lbtu-parstavjus-partikas-izstade-riga-food</a>	06.09.2025
9	Joint event of two VPP scientific projects GreenAgroRes and Forest4LV, Latvia, Jelgava	Final scientific and practical conference of the projects. GreenAgroRes - 10 presentations, 16 poster presentations	Scientists, students, representatives of industry, public and state institutions (130 participants)	<a href="https://www.lbtu.lv/lv/raksts/2025-12-11/piecejams-tiesraides-ieraksts-aizvadita-valsts-petijumu-programmas-divu-zinatisko">https://www.lbtu.lv/lv/raksts/2025-12-11/piecejams-tiesraides-ieraksts-aizvadita-valsts-petijumu-programmas-divu-zinatisko</a>	10.12.2025.

## 2.5 Scientific results of the project and ensuring access thereto

The main scientific outputs of the project – **scientific publications, conference abstracts, and data sets** –are made **openly accessible** at both national and international levels:

(1) Nine scientific articles were published in internationally recognized journals indexed in the Web of Science and Scopus databases. Of these, six articles were published in Q1 and Q2 journals. Manuscripts for an additional ten articles have been submitted to topic-relevant journals, choosing Q1/Q2 issues;

(2) Research results have been disseminated in the form of posters and oral presentations at 18 international conferences held in the Netherlands, the United Kingdom, Greece, Hungary, Turkey, Poland, Sweden, Slovakia, France, Croatia, Serbia, and the Baltic States (Latvia, Lithuania, Estonia). In total, 30 conference abstracts are publicly available on the respective conference websites;

(3) At the start of the project, a Data Management Plan (DMP) was prepared and implemented, maintained on the ARGOS platform (<https://devel.opendmp.eu/>) using a template developed by Latvian Council of Science. The DMP was published on ZENODO on 10 December 2024 and is available at: <https://doi.org/10.5281/zenodo.14364971>.

Within WP1–WP3, seven scientific data sets have been created. These are stored and made accessible to interested parties through the Dataverse.lv data repository:

1. <https://doi.org/10.71782/DATA/ONYMFM>
2. <https://doi.org/10.71782/DATA/XDLJDQ>
3. <https://doi.org/10.71782/DATA/8WC92K>
4. <https://doi.org/10.71782/DATA/GHMSF7>
5. <https://doi.org/10.71782/DATA/27CTO7>
6. <https://doi.org/10.71782/DATA/RZMAMX>
7. <https://doi.org/10.71782/DATA/CXYC4R>

More information about the results of each WP is provided in Chapter 3.

## 3 Implementation

The project was implemented in accordance with the plan and timeline developed in the application.

**WP1** research activities were implemented through collaboration, integrating the scientific expertise and technological capacity of LatHort, AREI, and LBTU. The processing potential of black currant berries was investigated in cooperation with WP2 and WP3. **[T.1.1]** For winter wheat, five crop production technology modules with reduced use of synthetic PPPs were developed for high- and medium-input systems. These modules were tested in field experiments and compared with a widely applied standard technology under practical farming conditions in two agroecologically distinct regions of

Latvia – Kurzeme and Latgale. The effects of the developed modules on winter wheat yield, grain quality, production costs, and the long-term environmental burden of applied PPPs were assessed. Based on results from previous studies conducted in Latvia and findings from this project, recommendations were developed on options for reducing synthetic PPP use in winter wheat production. These recommendations highlight the benefits and risks of implementing specific measures and identify research areas where additional data are needed. Two discussion workshops were organized with crop production sector experts to address farm-level practices and the practical applicability of the proposed recommendations. Target group – farmer – perspectives were assessed through two regional seminars (field days).

[T.1.2] For apple trees, the combination of synthetic plant protection products and inorganic substances was studied in an integrated approach together with canopy management solutions. For black currants, the impact of a complex of plant protection measures on yield was evaluated in five farms, and cultivar resistance was assessed. For cabbages, the combination of biodegradable mulch with insect nets was evaluated to reduce the impact of harmful organisms on yield. Relevant literature was reviewed, and existing experience with plant protection systems for the horticultural crops included in the study was compiled. In the trials, the effectiveness of smart and automated solutions and the potential of multispectral cameras for assessing plant responses were evaluated. A citizen science approach was implemented by surveying 13 commercial farms to determine the effects of various technological solution combinations on apple and black currant yield and quality, together with the use and reduction of synthetic fungicides. [T1.3] Underexplored legume and woody fruit crop pathogens were researched in relation to climate change and cultivation technologies. A comprehensive scientific literature analysis was conducted, focusing on pathogen species found in Latvia, identifying knowledge gaps, evaluating potential future impacts, and providing an alert list of pathogens and suggestions for further studies and actions. Farms with the most extended history of legume production and trial plots (peas, lupin, soy, faba beans, etc.) were surveyed. As a result, a collection of potential pathogens was established (520 strains), and was preserved, sequenced, and identified at the species or genus level (200 strains). An assessment of woody fruit crop canker- and dieback-inducing pathogens was performed, focusing on blackcurrants, sea buckthorn, and apple. Data (*Neofabraea* on *Malus* and *Pyrus*: species, virulence, genotype resistance) were revised and summarised. Pathogen collections were revised at LatHort (2680 strains from sea buckthorn, blackcurrants, pome fruits, stone fruits, other rosaceous, including wild and ornamental), and identification was complemented by sequencing (990 strains, mainly for strains from blackcurrants, sea buckthorn, and apple). Results were summarised and presented in eight presentations in six scientific conferences, eight conference abstracts, and two submitted publications in peer-reviewed journals (Q1 level).

**WP2** the research was carried out in collaboration, combining the scientific competences and technological capacity of LBTU, LatHort and BIOR. In cooperation with WP3, valorisation of food production by-products was carried out in the implementation of the goals of the European Green Deal. [T2.1] The implementation of the research is based on close cooperation between research partners, veterinarians, farms, and supervisory authorities. The work package included targeted sampling in the dairy and pig sectors, for the detection of indicator microorganisms (*Escherichia coli* and *Enterococcus* spp.), laboratory examinations and analysis of epidemiological data, ensuring comparability of results and scientific reliability. Antimicrobial resistance studies integrated AMU data with microbiological results using evidence-based risk assessment. During the project, 26 farm veterinarians and 26 farm managers/supervisors were surveyed, and a total of 900 rectal, milk, and environmental samples were obtained and examined on farms. The AMR profiles of the obtained isolates were analyzed according to the EMA classification. The results of WP2 have been summarized in scientific publications, recommendations for the industry and policymakers, as well as integrated into educational and professional development activities, promoting their practical implementation and long-term impact. [T2.2] To accomplish the task, a rapid (11 min) RP-HPLC-DAD method for determining the anthocyanin profile blackcurrant interspecific crosses and genotypes was optimized during the project, testing columns, gradients and mobile phases for complete separation of compounds at pressures <15 MPa (for older HPLC systems). A sustainable sample preparation protocol using 50% ethanol/HCl (single extraction, cryogenic grinding for increased anthocyanin recovery) was developed, replacing methanol and acetonitrile. The study found significant genotype differences, higher anthocyanin content in small berries due to the higher peel proportion, and identified little-studied black currant anthocyanins—peonidin, petunidin, and pelargonidin 3-O-rutinosides and glycosides. The lack of healthy black currant products on the market inspired the development of a new value-added product that combines the nutritional trends of modern consumers to include plant proteins in their daily meals. Based on the evaluation of black currant genotypes, a prototype of a new product (black currant-pea pastilles) was developed. Raw materials selected for the development of the recipe: three black currant berry samples were tested to ensure the anthocyanin content, sweet cherry juice, and apple puree to ensure taste and consistency; gluten-free pea flour as a protein source. The product prototype (TRL6) had nutritional and health

claims: high in fiber, a source of protein, and no added sugar (contains natural sugar). The results of the analysis indicate that using blackcurrant genotypes with a high total anthocyanin content allows to maintain the content of active substances in the product at an average of 60% of the original value. Work on refining the product production technology, implementing it in industrial production, and conducting market research at the Institute of Horticulture is expected to begin within one year of project completion. As part of the practical implementation of the project, a **detailed analysis of dairy product packaging in Latvian retail companies was carried out**, covering more than 600 different packages. The created dataset (<https://doi.org/10.71782/DATA/RZMAMX>) includes information on packaging materials, shapes, labels, and closure parameters, providing evidence-based information for evaluating product quality and sustainable packaging. These data served as the basis for further research, especially the study of alternatives to metallized polypropylene packaging in the packaging of cottage cheese desserts. The experimental part was carried out under controlled conditions, packaging cottage cheese in ten different packaging types, including the original metallized polypropylene packaging (control sample). Storage was carried out at a temperature of  $4\pm 2$  °C for 30 days, regularly assessing the pH, moisture content, water activity, peroxide value, and stickiness of the mass. In parallel, the structural strength and recyclability of the packaging material were analyzed using ash content analysis and SEM microscopy. The results confirmed that biaxially oriented polypropylene packaging with a pearl coating provides an optimal solution between product quality preservation and material recyclability. In addition, barrier coatings were investigated as an alternative to replacing polymers in laminated packaging. The suitability of cardboard types and water-based barrier varnish for sour cream packaging was evaluated, analysing the water and fat absorption capacity of the material and the structural changes of the barrier varnish during storage (proven by SEM microscopy). The best tested combination was Aegle Pro cardboard with a barrier varnish coating, ensuring minimal absorption, stable structure and preservation of product quality during 28 days of storage. Based on the obtained results, recommendations were developed for dairy processing companies and targeted policy interventions on the choice of packaging materials, recyclability, and the transition to more environmentally friendly alternatives. [T2.3] Project implementation was based on a full-cycle, methodologically structured approach to the valorisation of food by-products, purposefully directing scientific results towards practical application in the food industry to promote a circular economy. The brewer's spent grain valorisation study was implemented as a multi-stage process, starting with the establishment of cooperation with 11 Latvian breweries of various sizes. A detailed survey of entrepreneurs made it possible to link beer production parameters with the properties of the obtained spent grain. The samples were standardized and analysed: nutritional value, amino acid profile, polyphenol content and antioxidant activity, while statistical data processing ensured the reliability and comparability of the results. The results of the study are summarised in a high-impact scientific publication (<https://doi.org/10.3390/foods14234052>) and a publicly available dataset (<https://doi.org/10.71782/DATA/CXYC4R>). In the experimental stage, enzymatic processing methods using commercial enzymes or microorganisms were developed and optimized for the production of protein concentrates, and phenolic compound extraction studies were conducted. This approach created a reproducible and practically applicable knowledge base for further development and implementation of the technologies. A targeted set of studies was also implemented within the project to develop biodegradable edible containers from wheat bran and blackcurrant pomace. By testing more than 30 recipes and analysing the 11 most promising ones in depth, the pressing parameters were optimized and three solutions for functional bowls types were obtained. Comprehensive physicochemical, structural-mechanical, sensory and microbiological analyses confirmed the safety and suitability of the bowls for food use. The achieved TRL 4–5 level and the developed production protocol provide a clear basis for the industrialization of the technology. In turn, the study on the use of a dairy processing by-product—cottage cheese whey—as a substrate for fermentation was implemented as a sequential fermentation technology development process for the production of single-cell protein (mycoprotein). The substrate preparation and fermentation strategies tested under controlled conditions, combined with statistical data analysis, allowed the formulation of a flexible technological approach, adaptable to the studied *Kluyveromyces marxianus* and *Cyberlindnera jadinii* yeasts, which is oriented towards practical implementation in sustainable production. [T2.4] The practical implementation of the project ensured the fulfilment of all the set tasks, reaching a sample of at least 300 participants in different demographic groups. When evaluating consumer trends in the period from 2015 to 2025, a significant decrease in the intensity of smoked product use was found: for men from 35 g per day to 10.38 g, and for women from 13 g to 8.41 g per day. These changes directly affect the population's exposure to the risk of polycyclic aromatic hydrocarbons (PAHs), while indicating the need to improve consumers' ability to identify traditionally smoked products on the market. Data analysis found that the use of the consumption frequency method to assess specific food products may yield lower consumption than in data obtained from food diaries with a coverage of at least three days, which was not planned within the framework of this study, considering the time and resource capacity, but should be considered in future studies. The

risk analysis of dietary supplements carried out during the implementation identified specific substances and combinations that require increased monitoring. It was concluded that the presence of juglone in black walnut extract may cause a concentration- and time-dependent decrease in cell viability. Risks associated with the use of turmeric supplements have also been identified, where highly bioavailable forms and piperine supplements may be associated with cases of acute hepatitis. Analysis of algae-based products, such as spirulina, indicates the need to control the presence of heavy metals (aluminum, vanadium) and pharmaceutical residues. These results serve as a scientifically sound basis for targeted policy interventions and public health measures. Monitoring of fish resource quality demonstrated that the health status of fish in Latvian lakes is optimal, with lower total lipid content in predatory fish species, but significantly higher concentrations of n-3 polyunsaturated fatty acids, confirming their high nutritional value. During the implementation of the project, methods for developing fishery exploitation regulations have been theoretically described and offered to lake managers; however, the one-year research cycle was a limiting factor for the full approbation of these methods in practice, as objective practical studies require data from several meteorologically different seasons.

**WP3**, in collaboration with WP1 and WP2, a comprehensive analysis was carried out using appropriate research methods to assess the performance, challenges, and opportunities of EU Member States and Latvia in implementing the EGD objectives. The work covered the following key dimensions: progress across EU Member States, Latvia's comparative advantages and green competitiveness, as well as the impact of agricultural management practices and future scenarios. A thorough assessment was conducted of Member State performance dynamics in five EGD target areas: pesticide risks and their reduction, nutrient loss reduction, decreased use of antimicrobials, expansion of organic farming, and the increase of diverse landscape elements. The evaluation was based on standardised indicators, synthetic indices, and convergence analysis, identifying significant differences between Member States and structural weaknesses hindering overall progress. Latvia's advantages were analysed in the European context, particularly in environmental quality indicators (low pesticide and antimicrobial use, good water quality, low emissions), while risks were identified in the increasing hazard of pesticides and insufficient engagement in renewable energy production.

A detailed mapping of agricultural management practices was carried out, assessing their impact on various EGD indicators across both crop and livestock sectors. Practices analysed included diversified crop rotation, reduced tillage, precision farming, cover crops, biochar use, liming, improved animal feeding, breeding, and others. A portfolio of the most promising practices was developed, identifying those with the highest potential to support EGD target achievement. A financial assessment of these promising practices was conducted at both farm and national levels, and potential scenarios were developed for implementing EGD targets in Latvia, including expansion of organic farming, adoption of promising crop management practices, and increasing landscape elements. The scenarios were based on productivity, costs, revenues, labour, and other factors, as well as EGD indicators such as emissions and biodiversity. The evaluation results are summarised in the main conclusions on EU Member State progress, Latvia's competitiveness advantages, the effectiveness of agricultural management practices, and the feasibility of achieving EGD targets. Key recommendations for policymakers were developed. The implementation of WP3 delivered high-quality scientific results, and the achieved publication output significantly exceeded the initially planned targets.

#### **WP4. Communication and Knowledge Dissemination**

Project implementation progress and results were actively communicated to the public, sector stakeholders, policymakers, researchers, and students through the public channels of partner institutions: LBTU, BIOR, AREI, LatHort, and the Latvian Council of Science, providing information on project objectives, funding, partners, and its relevance for the sustainable development of Latvian agriculture. Project publicity included announcements about its launch, highlighting its contribution to developing scientifically grounded solutions for food system transformation and emphasising cooperation among research institutions. Throughout the project, information on achievements in each implementation phase was made publicly available. A key component of communication was the organisation of seminars with policymakers and stakeholders interested in the project's results. A final project conference was held at LBTU, bringing together policymakers, researchers, and sector organisations and ensuring direct dialogue between science and policy on the project outcomes. During the project, researchers participated in seminars, exhibitions, discussions, and international scientific conferences with presentations. "Field days" and demonstrations were organised to provide direct, hands-on information to sector entrepreneurs and their organisations. The project results were disseminated through conference proceedings, scientific publications, sectoral professional outlets, the project's Data Management Plan, and publicly accessible datasets. The National Stakeholders' Advisory Board, composed of

representatives delegated by national stakeholder organisations, was actively involved throughout the project. Draft scientific publications and research progress were discussed with high-level experts in the relevant fields within the Scientific Excellence Advisory Board established by the project. The project was implemented with a high level of transparency and targeted communication, strengthening public understanding and support for the development of a sustainable food system by effectively using and disseminating project results.

**WP5. Management and Coordination**

Project management and coordination were ensured by LBTU in cooperation with LatHort, AREI and BIOR. Scientific leadership was provided by LatHort Lead Researcher Dr.sc.ing. D. Segliņa, while administrative management was carried out by LBTU Professor Dr.oec. I. Pilvere. Both management lines, working closely with the WP leaders, ensured the strategic direction, quality, coordination, and oversight of the project.

The project management structure was based on regular communication and a systematic cycle of meetings in which tasks, deadlines, and responsibilities were defined. A kick-off meeting was held at the start of the project, while day-to-day management was maintained through continuous communication among partners via phone, email, and online meetings. The Steering Committee, as the highest management level, assessed scientific progress, analysed interim results, and agreed on the work plan for the next period. Decisions and responsibilities were recorded during each meeting and reviewed at the following session. WP leaders regularly organised operational meetings with task implementers to assess progress, identify challenges, and provide necessary support. The administrative manager maintained communication with the Ministry of Agriculture, the Latvian Council of Science (LZP), and the National Stakeholders’ Advisory Board, while the scientific manager coordinated research activities and prepared scientific reports. Progress and financial reports were submitted to LZP every four months. Throughout the project, six seminars and a final conference were organised for policymakers and stakeholders, ensuring high scientific and administrative quality. At the beginning of the project, each WP identified potential risks, developed mitigation measures, and updated the Risk Management Plan. Quality assessment was carried out every four months, analysing information provided by partners and preparing consolidated reports for LZP. Four interim reports were prepared, three of which have already been approved. In the final phase, an evaluation of result quality, stakeholder satisfaction, and the sustainability of developed solutions is being conducted.

A Research Data Management Plan was developed, defining data origin, structure, security, and ethical considerations. All partners adhered to intellectual property management rules and the principles of Responsible Research and Innovation, promoting open science, public engagement, and gender equality. Financial management was implemented transparently, in accordance with regulatory requirements and the project agreement. LBTU ensured centralised financial oversight, while partners carried out internal expenditure checks prior to submission, thus implementing a two-level financial control system and ensuring efficient use of resources.

Table 6. Abbreviations Used in the Report

<b>AMR</b>	Antimicrobial resistance	<b>LBTU</b>	Latvia University of Life Sciences and Technologies
<b>AMU</b>	Antimicrobial use	<b>LVMI</b>	Latvian State Forest Research Institute
<b>AREI</b>	Institute of Agricultural Resources and Economics	<b>LZP</b>	Latvian Council of Science
<b>BIOR</b>	Institute of Food Safety, Animal Health and Environment “BIOR”	<b>MoA</b>	Ministry of Agriculture
<b>DMP</b>	Data Management Plan	<b>NVO</b>	Non-governmental organizations
<b>EGD</b>	European Green Deal	<b>PPP</b>	Plant protection products
<b>EMA</b>	European Medicines Agency	<b>SEM</b>	Scanning electron microscope
<b>EU</b>	European Union	<b>VMF</b>	Faculty of Veterinary Medicine
<b>LatHort</b>	Institute of Horticulture		