LAMMC

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

2022

ANNUAL REPORT

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

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DIRECTOR'S FOREWORD

The world started the year 2022 with a hope to emerge from two years of the COVID-19 pandemic and get back to normal, but Russia's invasion of Ukraine has posed new challenges for global food and energy security. Despite the growing geopolitical and economic uncertainty, the LAMMC community remained focused not only in supporting the Ukrainian resistance, but also in fulfilling its mission of creating and disseminating new knowledge in the fields of agro-, forest and food science.

For the third year now, we are strengthening the publication of scientific results in prestigious (Q1/Q2) scientific journals. In 2022, we published as many as 152 such publications (80% of all publications). Publishing in these types of journals increases the visibility of LAMMC and creates the preconditions for connecting to international scientific networks.

Last year, we also strengthened our efforts in international cooperation by participating in joint research projects. I am particularly pleased that we have successfully joined international groups of scientists and together we have applied for the Horizon Europe programme that has just started. In 2022, we and our partners have launched three projects under this programme: CHAMELEON, NUTRICHECK-NET and BELIS, the results of which will contribute to the achievement of the objectives of the EU Green Deal strategy by developing digital tools for forestry, improving plant fertilisation systems and developing methods of molecular selection of legumes. In 2022, the EJP SOIL programme is also in full swing with the launch of 6 new research projects on the sustainable use and conservation of soils.

In 2022, we celebrated the centenary of the establishment of the Dotnuva Plant Breeding Station. Throughout this period, plant breeding has remained one of the most important areas of scientific activity of LAMMC, so we rightly consider 1922 to the founding year of LAMMC. To mark this anniversary, on June 8–9 an international conference "Traditional and novel tasks for plant breeding" was held which was attended by guests from Lithuania, Latvia, Estonia, Sweden, and Norway, and during the conference esteemed breeders were honoured for their contributions. It is symbolic that in this anniversary year, long-time breeders are honoured with state awards. Academician Vytautas Ruzgas was awarded the Officer's Cross of the Order of the Lithuanian Grand Duke Gediminas, and Prof. Dr habil. Antanas Svirskis – the Knight's Cross of the Order of the Lithuanian Grand Duke Gediminas.

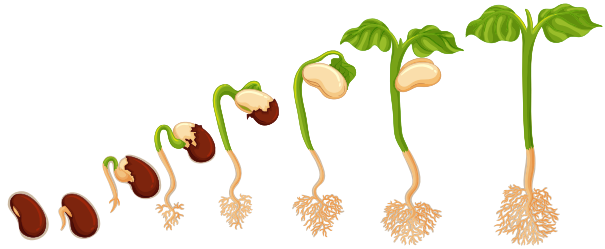
I would like to express my deepest congratulations to Dr Neringa Rasiukevičiūtė on becoming a member of the Young Academy of the Lithuanian Academy of Sciences. And congratulations to Dr Viktorija Vaštakaitė-Kairienė, Dr Karolina Barčauskaitė and Dr Monika Toleikienė for winning the scholarships from the World Federation of Scientists. I wish you heartfelt success in implementing your ambitious research ideas.

The year 2023 will be full of uncertainty and opportunities. Opportunities to change, find new solutions, and lay the foundation for a more sustainable world. I have full confidence in the LAMMC community's focused efforts to embrace bold ideas for the years to come.

Dr Gintaras Brazauskas
Director of the Lithuanian Research Centre for Agriculture and Forestry

SIGNIFICANT FACTS FOR 2022

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY
PLANT BREEDING 1922–2022



The **100th** anniversary of plant breeding in Lithuania was mentioned.

The Lithuanian Research Centre for Agriculture and Forestry (later referred to by its initials: LAMMC) had a total number of employees amounting to **476**, inclusive of **166** scientific researchers and **68** PhD students.

LAMMC conducted
51 international and
58 national research projects funded by the Research Council of Lithuania, Ministry of Agriculture of the Republic of Lithuania, and Ministry of Environment of the Republic of Lithuania; it fulfilled
75 contracts with Lithuanian and foreign business entities.

80 % of research papers were published in Q1/Q2 journals.

7 PhD students of the LAMMC received their PhD degree after defending their dissertation.

5 agricultural crop varieties were included in the Lithuanian National List of Plant Varieties and in the EU Common Catalogue of Varieties of Agricultural Plant and Vegetable Species.

6 long-term institutional research programmes were commenced.

Scientific researchers at LAMMC published **152** scientific articles in the journals indexed in the *Clarivate Analytics Web of Science* (hereinafter CA WoS) database.

4 international conferences, an international Forest Genetic Monitoring Training School, **3** international seminars, **4** national conferences, exhibition "Agrovizija", **3** national seminars, **2** public lectures and scientific afternoon discussions were organised.

1. VISION, MISSION, AND VALUES OF LAMMC

VISION

A leading state research institute in Lithuania and the North European region, whose activities are based on high-level basic research and applied research, acquisition of novel scientific knowledge, development of technologies and innovations, and their transfer and efficient experimental development. An advanced centre of excellence and expertise in agricultural, forestry, and food sciences.

MISSION

Generate, gather, and disseminate new scientific know-how geared to the awareness of sustainable land, forest, and environmental resources, their competitive development and use, elaboration of innovative technologies and products to meet the needs of the society.

VALUES

- The spirit of the scientific institution, long-standing traditions, and accountability to the society
- Competence, honesty, and transparency of educational activities
- Proactiveness, creativity, and continuous improvement
- Community-driven open-mindedness

2. STRATEGIC DIRECTION

Lithuanian Research Centre for Agriculture and Forestry's main priorities:

- **development of high-level research,**
- **enhancement of internationalisation,**
- **further development of doctoral studies,**
- **co-operation between science and business,**
- **community mobilisation,**
- **expansion of services to the public.**

3. IMPLEMENTATION OF LAMMC'S ACTIVITY GOALS

The goal of the Lithuanian Research Centre for Agriculture and Forestry (LAMMC), as defined in the Statutes of the LAMMC, is to serve the public interest by carrying out long-term scientific research and experimental development that are of interest to the state, society, international cooperation, and economic operators.

To achieve the operational goals in 2022, the following objectives were defined:

1) developing high-level scientific knowledge to address national and international economic, environmental, and social challenges;

2) increasing the availability of science-based innovations and solutions to domestic and foreign consumers and the general public;

3) raising the prestige of science and ensuring attractive working conditions in the country's regions.

One of the main objectives of the LAMMC is to generate high-level scientific knowledge to address national and international economic, environmental, and social challenges. In 2022, the scientists of the LAMMC published 152 scientific publications in journals referenced in the *Clarivate Analytics Web of Science* (CA WoS) database and with a citation index (IF), **80% of these publications appeared in high-level international publications (Q1 and Q2)**. The short-term goal is to achieve a minimum of one scientific publication per researcher and a gradual improvement in the quality of scientific publications.

The development of new, innovative, research-based products and technologies is an ongoing activity of the LAMMC. In 2022, plant breeding in Lithuania celebrated its centenary. In the course of hundred years, agricultural plant varieties have been developed that are both nationally and internationally competitive. During the reporting period, 11 plant varieties developed by the LAMMC underwent international expertise in specialised European centres, and 2 applications was filed with the European Patent Office.

Production of high-level scientific knowledge is directly linked to competitive funding and implementation of high-level national and international R&D and other projects. In 2022, LAMMC researchers submitted 88 R&D project proposals worth more than EUR 11.1 million. The project success rate is close to 25%. In our view, this is a good achievement, but in order to ensure the successful continuation of the activities of the LAMMC, preparation and submission of more applications to attract competitive funding will be encouraged.

The success of each department and institution is directly linked to attracting new enterprising researchers. Currently, there are 68 PhD students at the LAMMC, but this number is likely to increase as the opportunity to apply for the competitive PhD programme funded by the Research Council of Lithuania becomes available. Development of the internationalisation of doctoral studies is also foreseen. In 2022, 17 PhD students from foreign countries studied at the LAMMC, with an increasing number of both English-language and publication-based PhD dissertations. Not only does it facilitate joining international scientific networks, but also enhances the visibility of LAMMC scientists in the international arena.

Objective 1: Developing high-level scientific knowledge to address national and international economic, environmental, and social challenges.

Measures of the implementation of the operational plan	Criteria of the evaluation of the implementation of the operational plan	Indicators results of 2022
Conducting high-level fundamental and applied research	Scientific articles in peer-reviewed journals indexed in the CA WoS database and with an index of citation (IF), (number)	152
	Of which publications in Q1–Q2 journals, (number)	125
	Publications with participation of foreign institutions and/or businesses, (number)	57
	Research monograph (at least eight author's sheets) or part(s) of a research monograph (at least 8 author's sheets) published by an internationally recognised scientific publishing house, (number)	7
	Number of research traineeships	18

Development of new, innovative, research-based products and technologies	Number of plant varieties that underwent international examination in specialised European centres and/or the number of new species of organisms that underwent international examination	11
	Number of patent applications filed with the European Patent Office, the United States Patent and Trademark Office, or the Japan Patent Office (by registration certificate)	2
Implementation of high-level national and international R&D and other projects	Number of project applications	88
	Funding of project applications, million euros	11,1
	Funds generated by R&D projects, million euros	2,3
Conducting high-level international doctoral studies	Number of PhD students	68
	Number of doctoral theses defended	7
	Number of dissertations in English	5
	Number of publication-based dissertations	4
	Number of foreign PhD students	17

The key to a country's growth is science-based decision-making in the public and private sectors. In order to strengthen innovation at the national and international level, LAMMC focuses its activities not only on the implementation of scientific projects and innovation design, but also on their direct implementation and active dissemination of information. In 2022, researchers completed 75 orders from business enterprises worth EUR 2.6 million.

For many years, scientists of LAMMC have been actively participating in national working groups: they are members of expert groups for the evaluation of projects and national strategic documents, and in recent years their contribution to the activities of international working groups and expert groups submitting proposals to the European Commission has increased significantly. Researchers actively share their scientific knowledge at national and international conferences.

In 2022, the number of national events was slightly lower, but it is expected that in 2023 the number of national events will be bigger. The number of international events increased significantly due to a greater number of international projects organised.

To reinforce the credibility of scientists and the importance of research, there a strong emphasis is placed on the dissemination of information on social networks (*Facebook*, *LinkedIn*, and *Twitter*).

Objective 2: Increasing the availability of science-based innovations and solutions to domestic and foreign consumers and the general public		
Measures of the implementation of the operational plan	**Criteria of the evaluation of the implementation of the operational plan**	**Indicators**
		2022
Experimental development and innovation	Number of contracts with economic entities	75
	Sums of money received from contracts with economic entities, million euros	2,6
	Number of licensing agreements	26
	Total of monies received from licensing agreements, thousand euros	0,296

Developing and presenting science-based recommendations to decision-makers	Number of experts (in national and international groups)	75
Disseminating new scientific knowledge to the research community and target groups	Number of presentations at international conferences	170
	Number of public presentations (national seminars, field days, exhibitions)	50
	Number of national conferences organised	4
	Number of international events (conferences, exhibitions, international seminars, courses, briefings) organised	8
Dissemination of new scientific knowledge and innovation to the wider public	Number of website visitors	2436
	Number of visitors to the *LinkedIn* social network	760
	Number of visitors to the *Twitter* social network	80
	Number of visitors to the *Facebook* social network	2057

The LAMMC is increasingly contributing to the implementation of the EU Green Deal strategy of the European Commission and conducts its activities in a sustainable and resource-efficient manner. A strong emphasis is placed on ensuring Green Procurement, which aims at procuring goods, services, or activities with the lowest possible environmental impact at one, several or all stages of the life cycle of a good, service, or activity. In 2022, 53% of public procurement was recognised as green.

Objective 3: Raising the prestige of science and ensuring attractive working conditions in the country's regions		
Measures of the implementation of the operational plan	**Criteria of the evaluation of the implementation of the operational plan**	**Indicators**
		2022
Application of green technologies in the activities of LAMMC	Green procurement as a share of total procurement, %	53
	Proportion of electronic files prepared for archiving as a percentage of total files, %	50
Creating favourable working conditions at LAMMC	Increase in average salaries of researchers in per cent, no less than	22,6
	Percentage of staff participating in professional development activities per year, no less than	26

In addition, LAMMC also contributes to the implementation of the national regional policy, which has a differentiated impact on the socio-economic development of the regions, with the aim of reducing their socio-economic exclusion and inequalities of development within the regions themselves and promoting balanced and sustainable development throughout the territory of the whole country. The aim is to ensure salary progression and to raise the qualification of the faculty and staff by encouraging participation not only in scientific events, but also in generic skills and expertise development activities, and by establishing the preconditions for students to pursue their studies with flexible study and working hours.

In 2022, the performance of the LAMMC was good, but there is potential for improvement in 2023 and beyond. The main planned indicators are set out in the tables; targeted expenditure will be planned to achieve them. New research is planned, the internship fund will be continued, and the participation of researchers in scientific and expert activities, as well as in education and in raising public awareness will be encouraged.

4. HUMAN RESOURCES

4.1. THE RESEARCH BOARD

The Research Board is a collegial management body of LAMMC. The Board consists of 15 members with a term of service of five years (elected on 24 September 2020).

The Board sets key directions for the research activities and approves the educational activities plan of LAMMC, which is submitted by the Director, and annual reports. The Board sets forth qualification requirements for researchers and other employees and procedures for their performance assessment and employment, approves various documents related to research activities, and performs other activities laid out in the statute of LAMMC.

▲ LAMMC Research Board

Members of the Research Board

◀ **Prof. Dr habil. Zenonas Dabkevičius**
Adviser to the Director of the LAMMC, Chief Researcher, Chairman of the Research Board

Dr Giedrė Samuolienė
Head of the Laboratory of Plant Physiology, Chief Researcher, Institute of Horticulture, LAMMC, Deputy Chairperson of the Research Board

Dr Povilas Žemaitis
Senior Researcher, Department of Silviculture and Ecology, Institute of Forestry, LAMMC, Deputy Chairperson of the Research Board

Dr Audronė Mankevičienė
Chief Researcher, Department of Plant Pathology and Protection, Institute of Agriculture, LAMMC, Secretary of the Research Board

Dr Marius Aleinikovas
Deputy Director for Institute of Forestry Activities, Senior Researcher, Department of Forest Resources, Economics, and Policy, Institute of Forestry, LAMMC

Dr Vidmantas Bendokas
Deputy Director for Institute of Horticulture Activities, Senior Researcher, Department of Orchard Plant Genetics and Biotechnology, Institute of Horticulture, LAMMC

Dr Gintaras Brazauskas
Director, Lithuanian Research Centre for Agriculture and Forestry, Chief Researcher, Laboratory of Genetics and Physiology, Institute of Agriculture, LAMMC

Dr Zita Duchovskienė
Head of Technology and Innovation Division, Ministry of Education, Science and Sport of the Republic of Lithuania

Dr Saulius Jasius
Senior Advisor, Sustainable Agricultural Production Policy Group, Ministry of Agriculture of the Republic of Lithuania

Dr Žydrė Kadžiulienė

Chief Researcher, Department of Plant Nutrition and Agroecology, Institute of Agriculture, LAMMC

Dr Nerijus Kupstaitis
Head of the Forest Policy Group, Ministry of Environment of the Republic of Lithuania

Dr Virgilijus Baliuckas
Head of Department of Forest Genetics and Tree Breeding, Chief Researcher, Institute of Forestry, LAMMC

Rolandas Pridotkas
Director of LLC "Rūta"

Dr Alma Valiuškaitė
Head of the Laboratory of Plant Protection, Chief Researcher, Institute of Horticulture, LAMMC

Prof. Dr habil. Rimantas Velička
Professor, Institute of Agroecosystems and Soil Sciences, Agriculture Academy, Vytautas Magnus University

4.2. THE WORKS COUNCIL

The Works Council of LAMMC is a collegial representative body of employees that defends the professional, employment law, economic and social rights of employees of LAMMC and its branches and represents their interests.

Each member is elected for a three-year term of office. The Works Council consists of nine members (elected in 2020). In 2022, a new Chairman of the Council was appointed – Assoc. Prof. Dr Jonas Volungevičius.

Members of the Works Council

Assoc. Prof. Dr Jonas Volungevičius
Senior Researcher, Institute of Agriculture, Chairman of the Works Council

Dr Viktorija Gecaitė
Junior Researcher, Joniškėlis Experimental Station, Institute of Agriculture, Secretary of the Works Council

Dr Danguolė Juškevičienė
Senior researcher, Institute of Horticulture

Dr Gintarė Bajerkevičienė
Coordinator of Technology Transfer Projects, Department of Science and Innovations

Kęstutis Žemantauskas
Agricultural Advisor, Agrochemical Research Laboratory, Institute of Agriculture

Laura Ledeniova
Senior Personnel Specialist, Legal and Personnel Service

Dr Renaldas Žydelis
Senior Researcher, Institute of Agriculture

Ramunė Kvedarienė
Senior Economist, Financial Service

Dr Rita Asakavičiūtė
Senior Researcher, Vokė Branch, Institute of Agriculture

4.3. PERSONNEL

As of 1 December 2022, LAMMC employed a total of **476** persons, of which scientific researchers accounted for **35%**, specialists and other employees **38%**, laboratory assistants and technicians **25%**, and administration **2%**.

Among researchers, head researchers made up **20%**, senior researchers **34%**, researchers **24%**, and junior researchers **22%** (*Figure 1*).

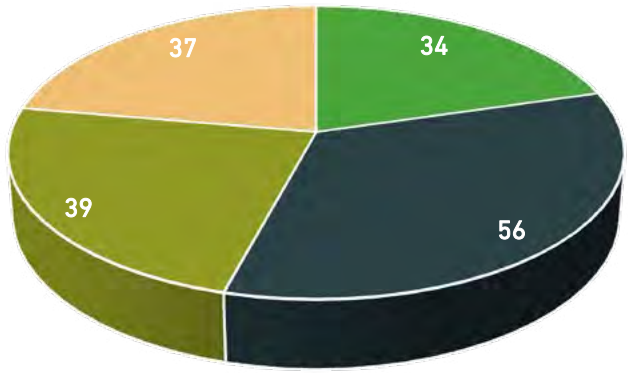


Figure 1. **Distribution of scientists by position, %**

In 2022, LAMMC had **68** PhD students in the fields of agronomy, forestry, ecology and environment, and biochemistry sciences (*Figure 2*).

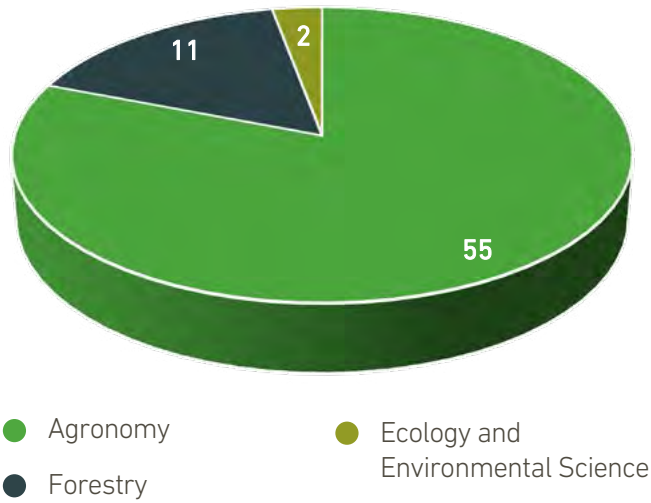


Figure 2. **Distribution of PhD students by field of study, %**

The majority of PhD students were studying in the field of agronomy and conducted their research at the Institute of Agriculture. In 2022, **17** foreign students were studying here, from a wide range of countries including Latvia, Ukraine, Belarus, Pakistan, Iran, Egypt, and Nigeria.

4.4. EQUAL OPPORTUNITIES AND GENDER EQUALITY PLAN REPORT

The LAMMC aims to ensure equal treatment of its faculty and staff, including those under consideration for employment, prior to and after the signing of an employment agreement, irrespective of gender, race, nationality, language, origin, social status, political beliefs or opinions, age, sexual orientation, physical disability, ethnicity, religion.

The LAMMC has zero tolerance for both direct and indirect forms of discrimination, including instructions to discriminate, sexual or other harassment, psychological violence or intimidation, bullying, or the use of position of authority, in any form that may occur.

In 2022, a description of the procedures for the implementation of the LAMMC policy on the prevention of violence and harassment of LAMMC's employees was prepared and approved, and a commission was established; an Equal Opportunities and Gender Equality Plan was also prepared, and a working group was established for its implementation with 8 members.

During 2022, no complaints or reports were received at LAMMC relating to gender equality issues. The work provided for in the plan achieved better visibility of female leaders in the public sphere. Indicators of gender balance in the organisation of events have improved. The LAMMC events are attended by women and men alike; for example, 60% of the participants at the scientific conference under review were women.

It is planned in 2023 to conduct further work provided for in the LAMMC Equal Opportunities and Gender Equality Plan.

5. DOCTORAL STUDIES

In 2019, based on the decree of the Minister of Education, Science and Sport of the Republic of Lithuania, LAMMC was granted the right for doctoral studies in four fields of science:

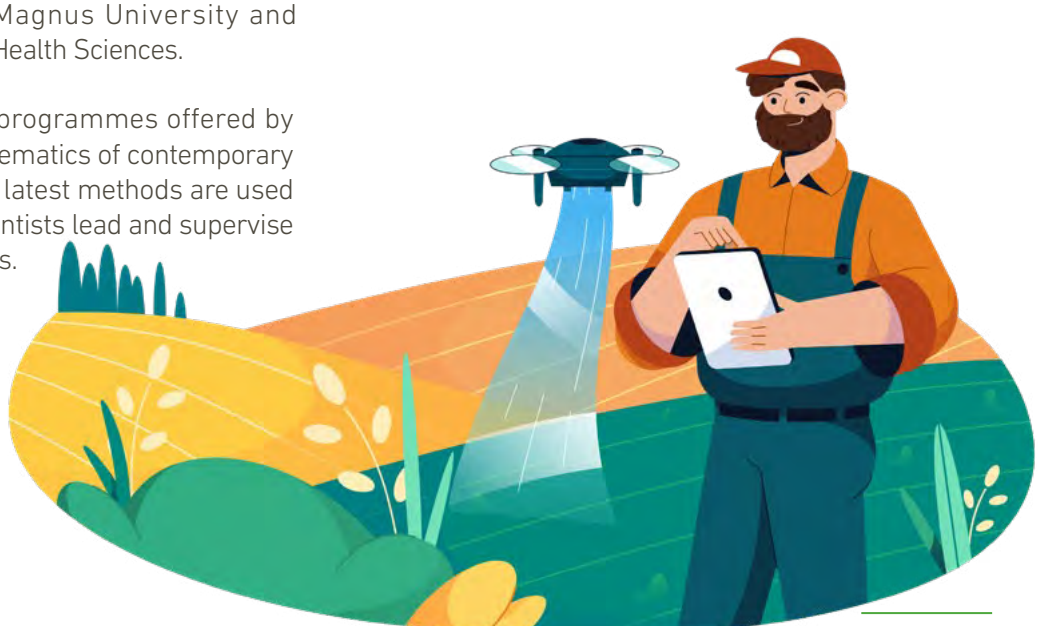
- **Agronomy**
  jointly with Vytautas Magnus University;
- **Forestry**
  jointly with Vytautas Magnus University;
- **Ecology and Environmental Science**
  jointly with Vytautas Magnus University;
- **Biochemistry**
  jointly with Vytautas Magnus University and Lithuanian University of Health Sciences.

The four-year doctoral programmes offered by LAMMC conform to the problematics of contemporary agriculture and forestry. The latest methods are used in research; experienced scientists lead and supervise research activities and studies.

LAMMC
LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

VYTAUTAS MAGNUS UNIVERSITY
MCMXXII

LITHUANIAN UNIVERSITY OF HEALTH SCIENCES



5.1. PHD STUDENTS ENROLLED IN 2022 AND THEIR RESEARCH TOPICS

Agricultural Sciences, Agronomy (A 001)

1. **Ardas Kavaliauskas.** Integrated Machine Learning and Unmanned aerial vehicle framework for plant stress prediction in agriculture. Supervisor Dr Renaldas Žydelis.

2. **Yasha Jamil.** Nitrogen fixation efficiency of symbiotic and associative bacteria in the changing climate conditions. Supervisor Dr Monika Toleikienė.

3. **Maksims Filipovičs.** Hyperspectral imaging for early detection of plant diseases. Supervisor Dr Jūratė Ramanauskienė.

4. **Mohsin Ali.** Evaluation of spring wheat adaptability to abiotic stress using sensor-based phenotyping tools. Supervisor Dr Rita Armonienė.

5. **Rokas Antanynas.** Management of agroecological niches by incorporating cover and catch crops. Supervisor Dr Lina Šarūnaitė.

6. **Rūta Maleckienė.** Evaluation of compost effectiveness on soil agrochemical properties using extraction fractionation. Supervisor Dr Romas Mažeika.

7. **Samanta Kaupaitė.** Physiological and technological aspects of improving the quality of greenhouse vegetable seedlings for high-quality crop production. Supervisor Dr Julė Jankauskienė.

8. **Simas Borkertas.** Effects of fruit and vegetable by-products substrates on the quality and biocemical composition of edible mushrooms. Supervisor Dr Dalia Urbonavičienė.

9. **Simonas Saikauskas.** The impact of winter and spring wheat cultivars mixtures on leaf spot diseases in different rotation sequences. Supervisor Dr Jūratė Ramanauskienė.

10. **Vaida Čepulienė.** Biodiversity and adaptability in perennial vegetable genus *Allium*. Supervisor Dr Rasa Karklelienė.

11. **Vaidė Sakalauskienė.** Use of fruit and vegetable processing by-products for the development of novel biopolymers. Supervisor Dr Jonas Viškelis.

Agricultural Sciences, Forestry (A 004)

1. **Emilis Armoška.** Influence of natural disturbances on tree species composition changes in coniferous stands. Supervisor Dr Povilas Žemaitis.

2. **Ilona Kavaliauskienė.** DNA marker based genetic structure and diversity of Norway spruce populations in Lithuania (*Picea abies* (L.) H. Karst.). Supervisor Dr Virgilijus Baliuckas.

3. **Raitis Rieksts-Riekstinš.** Tree breeding effect on growth and resistance of young Scots pine (*Pinus sylvestris* L.) stands. Supervisor Dr Virgilijus Baliuckas.

5.2. DOCTORAL DISSERTATIONS DEFENDED IN 2022

Agricultural Sciences, Agronomy (A 001)

1. **Ana Dovilė Juškytė.** Genetic control of resistance to blackcurrant reversion virus. Supervisor Prof. Dr habil. Vidmantas Stanys, scientific advisor Dr Ingrida Mažeikienė.

2. **Modupe Olufemi Doyeni.** The influence of digestate fertilization on the biomass productivity and quality of energy crops and on the composition of soil microorganizms. Supervisor Dr Vita Tilvikienė, scientific advisor Dr Skaidrė Supronienė.

3. **Paulina Martusevičė.** Enzymes-assistance extraction of buckwheat and oats grains for developing plant-based products and functionality. Supervisors: 2019–2022 Dr Jonas Viškelis, 2018–2019 Assoc. Prof. Dr Ramunė Bobinaitė.

4. **Rūta Sutulienė.** Environmentally induced oxidative stress in green pea and its management measures. Supervisor Dr Jurga Miliauskienė, scientific advisor Assoc. Prof. Dr Lina Ragelienė.

Agricultural Sciences, Forestry (A 004)

1. **Lina Beniušienė.** Influence of initial stand density and cuttings on conifers stand yield and stem quality. Supervisor Prof. Dr Edmundas Petrauskas (Vytautas Magnus University), scientific advisor Dr Marius Aleinikovas.

Natural Sciences, Ecology and Environmental Science (N 012)

1. **Gintarė Šidlauskaitė.** Legumes and grasses interspecies compatibility for perennial swards productivity and for sustainability of the agro-ecosystem functions. Supervisor Dr Žydrė Kadžiulienė.

Natural Sciences, Biochemistry

1. **Elena Andriūnaitė.** Application of endophytic bacteria to improve growth and adaptation of antibiotic-treated tobacco shoots *in vitro*. Supervisor Dr Danas Baniulis, scientific advisors: Prof. Dr habil. Vidmantas Stanys and Dr Inga Tamošiūnė.

©Ada Alejūnaitė

6. COLLABORATION

In carrying out research and experimental development (R&D) activities, the Lithuanian Research Centre for Agriculture and Forestry co-operates with national and foreign scientific institutions and business entities.

On 13 July, the Lithuanian Centre for Agricultural and Forestry Sciences, Vytautas Magnus University, VMU Agricultural Academy Training Farm, Lithuanian University of Health Sciences, LSMU Centre for Practical Training and Testing, Lithuanian Agricultural Advisory Service and the Lithuanian Agricultural Council signed an agreement on the establishment of the **Agricultural Knowledge and Innovation System cluster**, in order to implement the common agricultural policy of the European Union in the agricultural, food and forestry sector.

An example of successful cooperation is the project "Targeted implementation of integrated pest control in intensive farming conditions", which was implemented together with partners (leader Dr Antanas Ronis) was awarded the **1st prize in the "Cradle of Innovations" nomination (for promoting science and knowledge, creating and disseminating innovations in the fields of agriculture, forestry, and rural development)** of the Lithuanian Rural Network's Lithuanian Rural Development Programme 2014–2020 project competition "Future Rural Creators Awards".

▲ Contract partners

Membership in international organisations is crucial to be active in international research. LAMMC is a member of the renowned international organisations:

- **European Plant Science Organization (EPSO)**
- **European Forest Institute (EFI)**
- **Global Research Alliance on Agricultural Greenhouse Gases**
- **European Vegetable Research Institutes Network (EUVRIN)**
- **International Society for Horticultural Science (ISHS)**
- **European Fruit Research Institutes Network (EUFRIN)**
- **International Union of Food, Science, and Technology (IUFoST)**
- **International Union of Forest Research Organizations (IUFRO)**
- **European Association for Research on Plant Breeding (EUCARPIA)**

7. INNOVATIONS

7.1. INNOVATIVE PRODUCTS

In 2022, science and business communication was intensively implemented at the Institute of Horticulture. Products were developed in cooperation between scientists from the Biochemistry and Technology Laboratory and LLC "Mėlynė" and LLC "Eno extractum": sea buckthorn oil, sea buckthorn and camelina oil, freeze-dried strawberry and lonicera delicacies, freeze-dried blueberry, and strawberry delicacies.

In addition, the Laboratory of Biochemistry and Technology, in cooperation with the MB "Limonadas Šimonadas", has contributed to the development of new fermented beverage technology and the assurance of their safety and quality indicators. The good lactic acid bacteria contained in the created drink "Shimonadas" (as well as *Lactococcus lactis*) have a beneficial effect on the human immune system, and fermented sea buckthorn leaves are characterised by increased antioxidant and prebiotic activity. Research and experimental development were conducted in accordance with the work plan "Promotion of the commercialisation and internationalisation of R&D results" measure (No. 01.2.2-MITA-K-702) of the project "Development of a prototype of fermented products of sea buckthorn leaves".

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7.2. PROJECTS OF MODERNISATION OF ACTIVITIES AND BUILDINGS

In 2022, LAMMC implemented the project **"Strengthening of the technology transfer and commercialisation of the knowledge created by Lithuanian research Centre for Agriculture and Forestry"**, funded by the European Structural and Investment Funds and supervised by Dr Vita Tilvikienė. In order to achieve a more active collaboration between science and business in developing innovative products of the agriculture, food and forestry sectors, LAMMC started applying entrepreneurial principles in commercialisation and technology transfer during the project implemented from 2021 to 2023.

Innovations have been introduced not only in commercialisation but also in modernisation of buildings. **The renovation of the scientific building (laboratory)** located at Sodų St. 5, Babtai, Kaunas district was completed in 2022. The project envisages reducing energy consumption by 146 MWh per year (representing 42–53% of the energy currently consumed) and greenhouse gas emissions to 11.35 t CO_2 eq.


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▲ Prototype of biological insecticide


©Vidmantas Bendokas

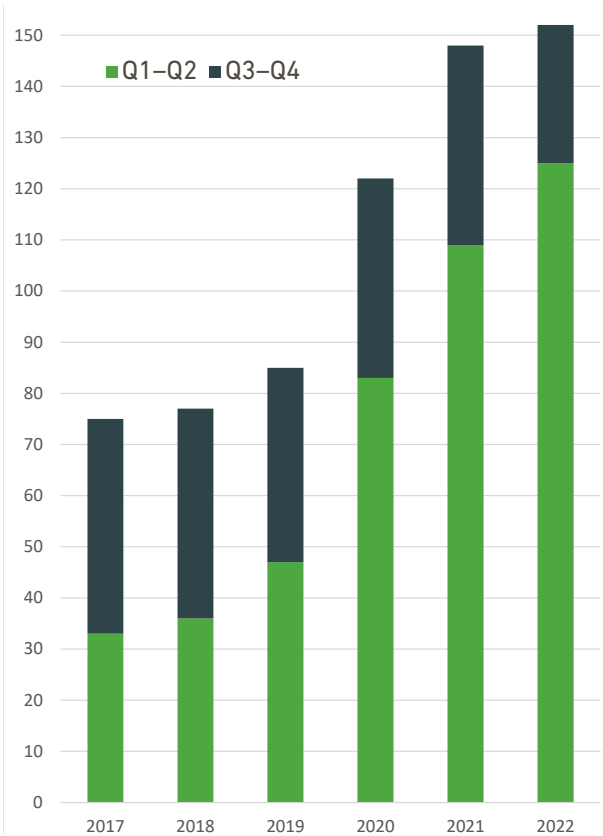
8. RESEARCH AND DEVELOPMENT

8.1. SCIENTIFIC PUBLICATIONS OF 2022

The year 2022 was the most productive in the entire history of LAMMC, with **152** scientific publications published in the journals with an impact factor (IF) indexed in the CA WoS database. The highest IF of the scientific journals, which published research data obtained by LAMMC researchers and colleagues from research and study institutions of other countries, was **13,211** (2021–2022).

In 2022, LAMMC researchers, in publishing their research results, paid considerable attention not only to the number of publications, but also to the quality of journals in which research was presented. **80% of publications appeared in Q1 and Q2 quartile journals**, reflecting both the activeness of the scientific researchers and the high level of research and the international recognition of their results (*Figure 3*).

In addition, in 2022, scientific researchers at LAMMC wrote and published **7** sections in monographs published by the internationally recognised publishers, also books, textbooks or their sections, and **17** articles in peer-reviewed periodicals.



▲ *Figure 3.* Number of publications in quartiles

8.2. LONG-TERM RESEARCH PROGRAMMES

LAMMC participated in **six long-term R&D programmes** (2022–2026). The results of the ongoing long-term research programmes for the year 2022 are presented below.

Biopotential of plants for multifunctional use and sustainability of agroecosystems.

Leader Dr Žydrė Kadžiulienė

This year we started a new stage (2022–2026) of the programme. The **aim of the programme** at this stage is to create and improve new scientific knowledge necessary for fulfilling the terms of sustainability of agroecosystems, for the more sustainable development of various farming systems in changing climate and market conditions, to create innovative measures of cultivation technologies that contribute to a healthier food system, a cleaner environment, and the development of a green economy.

From the previous stage of the programme, the strengthening of agro-ecosystems with binary crops, the efficiency of the legume-based fertilisation biomass for organic agro-system, the changes in the chemical composition and technological properties of winter wheat grains using organic liquid fertilisers, the improvement of the productivity and quality of fibrous hemp and other crops, and other relevant studies of plant cultivation and

▲ Experiment on the impact of agricultural plant diversity and agronomic practices on root biomass

utilisation were continued (17 scientific works). In 2022, several new studies have been initiated, which aim to determine the influence of the diversity of agricultural plants and agronomic practices on the biomass of roots, the regularities of their formation, and functions in different pedoclimatic conditions, pathways to better realise the potential of plant and ensure stability in systems of different intensity, how to make multi-species crop cultivation systems more efficient, how to use non-food plants and plant residues more appropriately.

Over the past year, more than 10 scientific articles have been published from the research of the long-term programme, the results have been presented at international and national conferences, and practical suggestions have been presented at seminars, field days and in science popular articles.

▲ Research results presented at the European Herbalism Conference EGF 2022

Sustainable forestry and global changes.

Leader Dr Marius Aleinikovas

In recent years, the country's forests and the forest sector have been significantly affected by global changes: climate change, increasing natural phenomena, changes in the condition of trees, loss of biodiversity, etc. Starting from 2022, the third five-year work cycle of the programme begins. The **aim of the programme** is to obtain and systematise new scientific knowledge necessary for sustainable forestry development in the context of global natural, economic, and social changes and to prepare recommendations for the application of this knowledge in practice.

The research on forest ecosystems and changes in their condition will include the determination of greenhouse gas emissions in forested peatland, both drained and un-drained, further research on the patterns of changes in metabolic processes in forest ecosystems in model ecosystems, and the analysis of the peculiarities of the formation of soil life cover and its significance for the formation of forest stands in the formation of forest carbon stocks in former plain logging sites.

The development of studies of a genetic nature provides for the development of a methodology and genetic monitoring by selecting the most valuable objects for the conservation of genetic resources and providing practical measures to increase genetic diversity.

In vitro and *ex vitro* studies of a biotechnological nature would aim to select selectively valuable planting material to meet the priorities of biodiversity conservation and organic forestry. It would also assess the impact of tree endophytes on enhancing plant adaptability.

As part of the research necessary for the development of forest protection methods, it is planned to carry out an assessment of the phytosanitary condition of Lithuanian spruce trees and the prevalence of harmful fungal diseases in pine plantations and the selection of protective measures, to study the influence of mass foci of pests gnawing needles on the functioning of the ecosystems of the common pine forest and the health of the soil in the context of changing climate. To identify the isolation of problem and endangered species of herbivores, develop guidelines for their management and recovery of endangered species, to continue studies on abundance and population change of wild boar in order to determine the possibility of further transmission and recurrence of African swine fever.

As part of the research on increasing forest productivity, i.e., the development of plantation forestry, there are plans to evaluate the possibilities and technologies of growing other types of trees (black alder, common spruce, etc.) in fast-circulation plantations; research into the spontaneous development of forests would continue to include soft-deciduous stands of other, hitherto little-studied high-yielding growing areas. In assessing the impact of economic and social changes on the development of forestry, it is planned to study the innovative potential of enterprises providing forestry services and to describe the possibilities of implementing the directions of the EU Green Deal strategy related to the country's forests.

▲ Genetic monitoring studies

Harmful organisms in agro- and forest ecosystems.

Leader Dr Roma Semaškienė

The **programme aims** to investigate the peculiarities of the behaviour of dominant and newly emerging pests in the agro-forest ecosystems and to develop a scientific basis for managing their destructive effects in a manner that maintains economic benefits without compromising environmental and human safety, biodiversity conservation.

In 2022, nine research works were continued, and three new ones commenced:

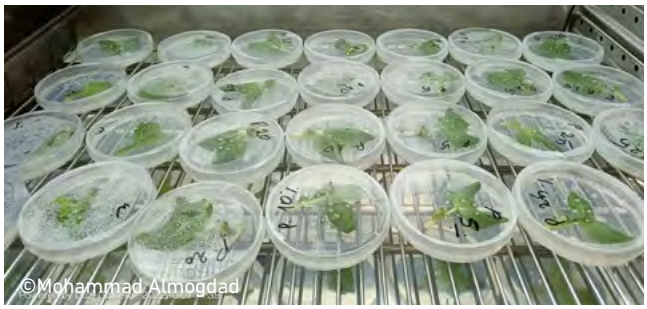
1. The mycorrhizal colonisation intensity on cereal-based cropping systems under different tillage practices and cover crop management. The aim of the research is to assess the effects of reduced soil tillage practices

and cover crops on the intensity of root colonisation of coexisting plants by arbuscular mycorrhizal fungi in a cereal-based cropping system.

2. Identification of *Pisum sativum* root-crow rot pathogens and antagonistic endophytes under organic farming conditions. The aim of the research is to isolate and identified of main pea root-crown rot fungal pathogens and antagonistic endophytes under organic farming conditions.

3. Potential use of hemp extracts to control black bean aphid (*Aphis fabae* S.). The aim of the research is to examine the defensive role of the extract from hemp (*Cannabis sativa* L.) plant against the black bean aphids (*Aphis fabae* S.) and to screen the insecticidal and repellent effect of the extract from *C. sativa* on *A. fabae*.

The results were presented in 15 scientific journals indexed in *CA WoS* database.



▲ Studies on the efficacy of hemp extract against *Aphis fabae* under controlled conditions

▲ Wheat harvesting

Horticulture: agrobiological foundations and technologies.

Leader Dr Giedrė Samuolienė

The **aim** is to create a scientific basis for agrobiological processes for horticultural plants seeking to increase the productivity potential and product quality by applying innovative, environmentally, and resource-friendly technologies.

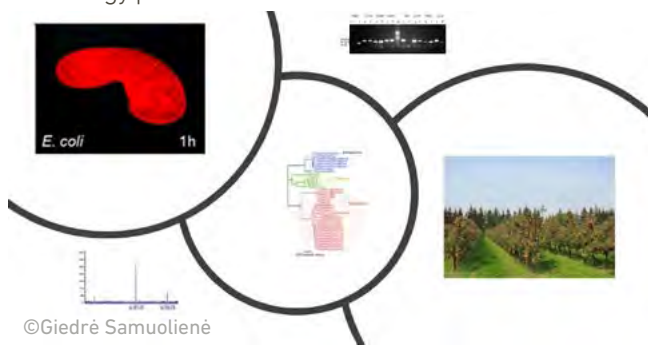
The main R&D directions are:

1. The targeted knowledge of plant physiology expansion and application of agrobiotechnological tools for the management of specific aspects of plant growth, development, photosynthesis and metabolism for higher quality, more valuable and sustainable plant production in the controlled environment horticulture.

2. R&D in modern horticulture by selecting rootstock-scion combinations and varieties of horticultural plants, emphasising the adaptability of rootstocks to agro-climatic conditions and tribal soil degradation. Influence of plant breeding, cultivation systems and technological tools on plant growth, productivity, yield stability and fruit quality.

3. Development of innovative growing technologies for greenhouse and outdoor garden plants. Adaptation of environmentally and pathogen-resistant varieties for a sustainable horticulture and supply of production for short food chains. Increasing and preservation of soil biopotential and protection of the environment by reducing environmental pollution using agro-biological and agro-ecological tools.

4. Analysis of chemical composition and technological properties of horticultural plants and created high-value products. Optimisation of horticultural products storage conditions, development, and optimisation of waste-free technology processes.



▲ *Figure 4.* Management of agrobiological processes in horticultural plants to increase productivity potential and production quality

Productivity and sustainability agrogenic and forest soils.

Leader Dr Virginijus Feiza

Soil resources are limited; therefore, the EU Green Deal strategy is directed towards sustainable soil management, within its ambition of having an environment free of harmful pollution by 2050. The **aim of the programme** is to investigate agriculture and forest soil resources due to identify degradation factors and to implement suitable means to maintain sustainability and productivity of mineral and organic soils, to optimise soil carbon cycle, reduce GHG emissions and crop nutrient losses in different pedoclimatic soil regions in Lithuania. Four research

directions are accompassed: 1) investigation of means for sustainability and productivity increase of agrogenic and forest soils of morainic and limnoglacial origin, soil degradation processes reduction; 2) changes in soil organic matter and different stability of carbon compounds and their relationship with other chemical elements in different soil types and textured soils; 3) soil functions and services improvement to reach an optimal plant nutrient cycling under climate changing conditions; and 4) evaluation the risks of soil pollution derived from by-products application containing a high amount of plant nutrients.

In 2022, the participants of the programme published 29 papers in journals having IF, published 25 abstracts in conferences, 14 papers in national popular press, participated in international and national scientific conferences with 19 oral and 9 poster presentations.

▲ Research on soil chemical properties – the basis for fertiliser savings

▲ Experiments on the application of specific agrotechnology in hilly terrain at the LAMMC

Genetics, biotechnology and breeding for plant biodiversity and innovative technologies.

Leaders Prof. Dr habil. Vidmantas Stanys and Assoc. Prof. Dr Vytautas Ruzgas

Aim: to ascertain biological markers for abiotic and biotic stress resistance, plant productivity and quality parameters; to create new multifunctional breeding material, plant genotypes and varieties for traditional and Green Deal strategy tasks, suitable for conventional and organic farming.

The main tasks of programme:

1. To investigate the base of genetic control of productivity, adaptability and usefulness of plant resources, methods of early diagnostics and improvement of plant adaptability.

2. To develop the new plant genotypes and varieties of provided tasks to fulfil the requirements of competitive ability, organic farming, and EU Green Deal strategy.

The environment is in perpetual fluctuations due to of various influcluencing factors, such as climate change, hydrological regime, pests, and pathogen infestation. The quality parameters for the plant biomass are constantly changing in the processing industry too. The EU strategic plans will give greater emphasis to the path of the EU Green Deal strategy. Therefore, the genotypes and structure of plant population should be permanently in developing to correspond developing of bioeconomy.

Results: 446 new lines and populations of agricultural and horticultural plats have been developed in 2022. In the National and EU Catalogues were registered 8 new varieties, 10 new candidate varieties have been transmitted for the state registration testing.

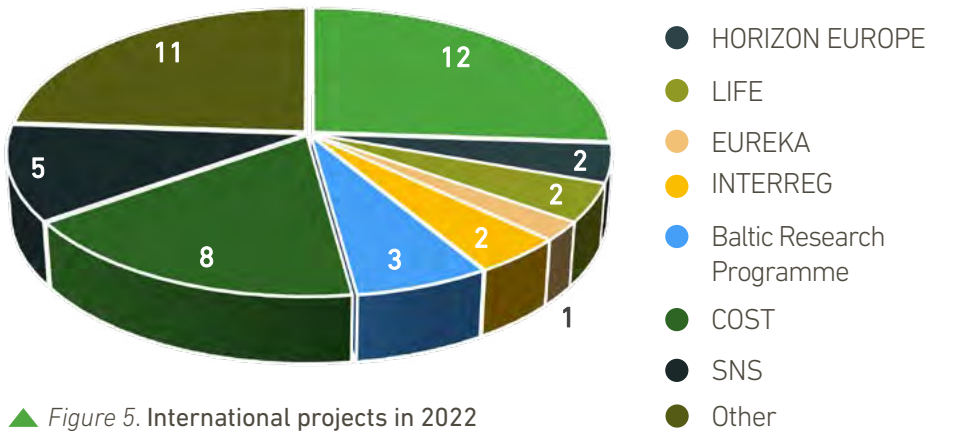
Long term activity of National plant breeding and genetics investigation were summarised in the monograph "Lithuanian Plant Breeding on Interface of Centuries" and the conference dedicated to the 100th anniversary of plant breeding in Lithuania have been arranged.

▲ Clover (*Trifolium rubens* L.) collection nursery

▲ Evaluation of winter wheat lines in a competition plot

8.3. PROJECTS

In 2022, **51** international (*Figure 5*) and **58** national projects were conducted at LAMMC. In total, over 200 research projects were conducted in 2022 under contracts with Lithuanian and foreign entities.



▲ *Figure 5.* International projects in 2022

17 of the international projects were funded by "Horizon 2020", 2 by "Horizon Europe", 2 by LIFE, 2 by INTERREG projects, 3 by Baltic Research Programme, 5 by Nordic Forest Research Committee (SNS), 1 by EUREKA, 8 by COST activities and other projects.

National R&D projects funded by the Research Council of Lithuanian, the Ministry of Agriculture and the Ministry of Environment were implemented.

A full list of international and national projects is provided in the appendices, below are descriptions of international projects launched and completed.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8.3.1. International projects launched in 2022

In 2022, LAMMC launched **14** international projects. The descriptions of all international projects launched are given below.

"Horizon Europe" projects

1. A holistic approach to sustainable, digital EU agriculture, forestry, livestock and rural development based on reconfigurable aerial enablers and edge artificial intelligence-on-demand systems (CHAMELEON).

Coordinator in the Institute of Forestry
Dr Vaida Sirgedaitė-Šėžienė. 2022–2025.

The **aim** is to optimise production and identify potential problems in agriculture, livestock, forestry, and rural areas using adaptive monitoring and artificial intelligence systems. The aim will be achieved using next-generation drones capable of resizing their configuration and performing functions on demand, while using artificial intelligence-based near-real-time decision-making packages that use information from different surveillance systems.

During the project, easily available custom packages (*App store*) will be created and optimised according to the information that the users want to receive and the possible steps for its implementation.

▲ Project participants

2. The NUTRI-CHECK NETwork to maximise site-specific precision in managing the nutrition of European arable crops (NUTRICHECK-NET).

Coordinator in the Institute of Agriculture
Dr Dalia Feizienė. 2022–2025.

The project **aims** to establish a thematic network which will foster innovation and exchange between research, industry, and the farming community to improve the precision

of crop nutrition across Europe through justified decision-making. Uncertainties about crop nutrition are common and large and their repercussions are substantial economically as well as environmentally. It will provide solutions for achieving balanced fertilisation and sustainable nutrient management, contributing to reducing nutrient losses. A bottom-up approach to defining end use needs, including summarising current practice, barriers for uptake and routes for success will be utilised. The project will create an inventory of crop nutrition decision marking solutions, drawing on research outputs, recommendation systems and commercial tools and products. Crop nutrition clubs will utilise co-creation methodologies to illustrate decision-making solutions. During the project, the thematic network will disseminate project outcomes widely, including through liaison with relevant thematic networks and EIP-AGRI (European Innovation Partnership for Agricultural Productivity and Sustainability).

▲ Countries carrying out the project

"Horizon 2020" projects

1. The development of methodological tool kits to evaluate selected genotypes of strawberry fruits in Lithuania (LTtraining).

Coordinator in the Institute of Horticulture
Dr Neringa Rasiukevičiūtė. 2022–2024.

▲ Improving the competence of qualitative and sensory analyses of berries during tasting

The **aim** is to gain knowledge and acquire new skills in berry quality analysis and sensory analysis. This project aims to evaluate at least eight genotypes with known sensory differences for the panel test. Besides, new skills and knowledge will serve us to develop new, modern strawberry cultivars that meet the current commercial and amateur cultivation needs. In addition, an assessment system based on methodological requirements will be introduced not only for professionals but also for the general public (consumers). Therefore, the new project opens new opportunities to increase strawberry production and quality.

EJP SOIL
MaxRoot-C

2. Optimizing roots for sustainable crop production in Europe – pure cultures and cover crops (MaxRoot-C).

Coordinator in the Institute of Agriculture
Dr Monika Toleikienė. 2022–2025.

The **aim** is to measure root carbon inputs to soil, including subsoil, to quantify the potential of maximised roots to enhance SOC stocks in the most ubiquitous cropping systems. The project will be conducted under a range of management practices in a standardised comparable manner (WP2) across a large climate gradient in Europe through the development of common protocols, to quantify the potential root-C inputs, from both main crops (WP3) and cover crops (WP4) which also include ecological service crops. The main aims are to investigate:

1) How did breeding affect root biomass and distribution during the last decades and what are the consequences of breeding-induced changes in root C inputs for SOC stocks in European agriculture?

2) To what extent can root C inputs in croplands be increased (e.g., by genotype selection or cover plant breeding) without compromising yield?

3) How does genotype and cover crop type affect C inputs to the soil (including subsoil) via carbon rhizodeposition?

4) Can genotype selection for beneficial root properties for climate change adaptation also contribute to increasing SOC stocks in arable farming?

▲ Expedition of German scientists at the LAMMC

EJP SOIL
EOM4SOIL

3. External organic matters for climate mitigation and soil health (EOM4SOIL).

Coordinator in the Institute of Agriculture
Dr Karolina Barčauskaitė. 2022–2024.

The project **aims** at proposing best management practices of external organic matter (EOM) pre-processing and application on soil to contribute to climate change mitigation and improve soil health. In Europe, representative farming systems (arable crops and vineyards) are selected taking into account the diversity of pedoclimatic conditions. The net budget of soil C storage and greenhouse gas emission including the pre-process step and field application, is assessed as well as the multiple effects of EOM application on soils including contaminants are quantified. To improve C budget and soil health, innovative pre-processing is recommended. The best management practices are defined from scenarios of use assessed with a multicriteria simulation tool, parameterized from long-term experiments.

▲ Results of the EOM4SOIL project were presented at the exhibition "Agrovizija"

EJP SOIL
MIXROOT-C

4. Are mixed species systems fostering belowground C inputs and C sequestration? (MIXROOT-C).

Coordinator in the Institute of Agriculture
Dr Monika Toleikienė. 2022–2025.

The **aim** is to gain a management-oriented understanding of the effect of mixed-species root systems on carbon flow and organic matter accumulation in European agricultural soils. The corresponding operational objective is to analyse root processes in mix-species systems and to quantify *in situ* root C production and to propose root traits related to soil organic C storage in topsoil and subsoil for most cropping system diversification in European agriculture. To address this objective, we will identify the main trade-offs between increasing plant diversity and root-derived C storage in soils by answering the following research questions:

1. Do diversified agroecosystems have specific trade-offs between root C inputs and yield?
2. Do diversified agroecosystems have a higher potential for soil C sequestration, what is the relative contribution of roots?
3. How do management practices (fertilisation, mowing, grazing) impact root C inputs and SOC?
4. What are the main root traits related to SOC? Are the predictors different in mixed versus single species agroecosystems?
5. What are the main benefits and limits of subsoil exploration by roots?

▲ Soil sampling from deeper layers

EJP SOIL
SERENA

5. Soil Ecosystem seRvices and soil threats modElling aNd mApping (SERENA).

Coordinator in the Institute of Agriculture
Dr Virginijus Feiza. 2022–2024.

The **aim** – to assess, analyse and map soil ecosystem services bundles across European agricultural landscapes, highlighting how soil chemical, physical and biological threats limit at a site-specific reference. The project intends to enhance soil policy effectiveness through the analysis of soil ecosystem services bundles across European agricultural landscapes, through adoption of a set of site-specific (i.e., for different pedo-climatic and agricultural systems) thresholds; to provide soil threats and soil-based ES evaluation at both the national and European scales, adopting a common methodology to share the indicators to be calculated and the way of evaluating bundles.

▲ Publicity of the project for farmers at the exhibition "Agrovizija"

EJP SOIL AGROECOseqC

6. AGROECOlogical strategies for an efficient functioning of plant–soil biota interactions to increase SOC sequestration (AGROECOseqC).

Coordinator in the Institute of Agriculture
Dr Skaidrė Supronienė. 2022–2024.

The **aim** is to study how agroecological intensification of cropping systems (e.g., introduction of plant services) can allow better regulation of degradation / resynthesis of soil organic matter and nutrient cycling by the plant-soil system. Advantages and disadvantages of such agroecological systems will be compared to less conservative ones for plant-soil fauna-microbial functional diversity, biomass production, N-leaching, soil C-stable pools, GHG emissions, and C sequestration.

▲ Assessment of the impact of intermediate crops on plant biomass

EJP SOIL SoilCompaC

7. Mapping and alleviating soil compaction in a climate change context (SoilCompaC).

Coordinator in the Institute of Agriculture
(Vėžaičiai Branch) Dr Danutė Karčauskienė. 2022–2024.

The **aim** of the project is mapping and alleviating soil compaction in a climate change context.

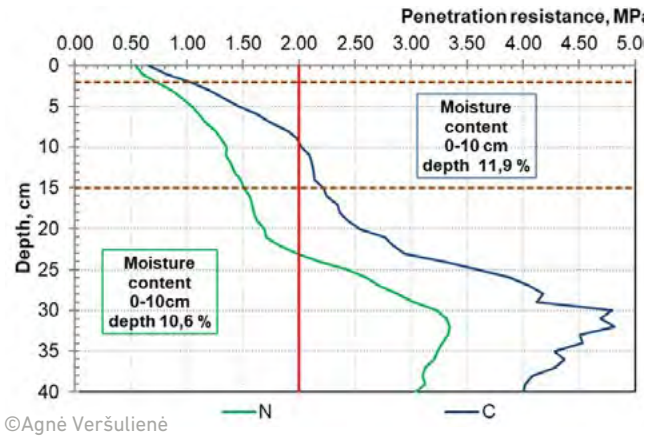
The objects are:

1) create a standard in terms of data availability and parameters needed for a country or a region mapping of soil compaction extent and severity;

2) evaluate how climate change affects the risk of soil compaction for a range of European pedo-climatic zones;

3) quantify impacts of soil compaction on soil carbon stocks in a climate change context and estimate impacts on greenhouse gas emission, crop growth and water balance, for a range of European pedo-climatic zones;

4) synthesize quantitative knowledge on mechanical, natural, and biological recovery of compacted soils across Europe.



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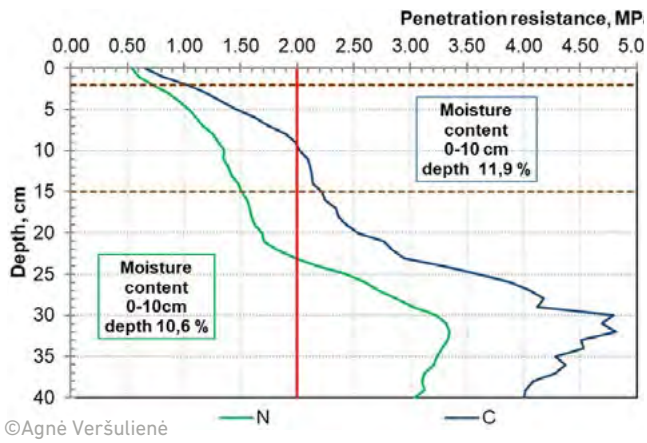
▲ *Figure 6*. Soil compaction and moisture content in *Endocalcari-Epihypogleyic Cambisol*. Akademija, Kėdainiai district



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▲ *Figure 7*. Soil compaction and moisture content in *Bathygleyic Dystric Glossic Retisol*. Vėžaičiai, Klaipėda district

Projects of other research supporting EU programmes

1. Swedish Institute (SI) project **Portfolio of technology transfer for acceleration and improvement of wheat breeding activities in Ukraine.**

Coordinator in the Institute of Agriculture Dr Rita Armonienė. 2022–2024.

The international capacity-building project "Portfolio of technology transfer for acceleration and improvement of wheat breeding activities in Ukraine" was granted by Swedish Institute (SI) to support the academic community of Ukraine. The **main aim** is to broaden the knowledge of Ukrainian scientists about the latest methodologies and technologies applied in wheat breeding, which can speed up the breeding of wheat cultivars. This will be very crucial for the Ukrainian economy at Post-War period. This project will also provide a basis for preparing research project applications to strengthen the wheat breeding programme in Ukraine. During the project, scientists and breeders from Ukraine will have the possibility to participate in training sessions in Sweden (SLU) and Lithuania (LAMMC), to participate in meetings, workshops, and conferences.

Project leader: Swedish University of Agricultural Sciences (SLU, Sweden); partners: Lithuania Research Centre for Agriculture and Forestry (LAMMC) (coordinator Dr Rita Armonienė), agricultural cooperative "Lantmännen" (Sweden) and Plant Breeding and Genetics Institute - National Center of Seed and Cultivar Investigation (PBGI-NCSCI, Ukraine).

2. ERA-NET project **Connecting sustainable agroecosystems and farming with circular bioeconomy and new technologies (ConnectFarms).**

Leader in the Institute of Agriculture Dr Virmantas Povilaitis. 2022–2024. Support for international research and technology development projects funded by LR Ministry of Agriculture.

The project would allow for a sustainable increase in crop and livestock production, preserving soil quality and resistance to the negative factors of climate change, taking into account the climatic conditions of different European regions.

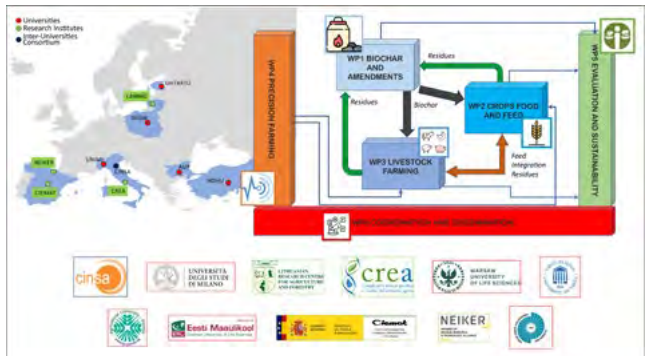
The project will solve the following tasks:

1) evaluation of quantitative and qualitative changes in soil properties and plant production after using alternative fertilisation products that are made from local renewable raw materials (plant residues, biochar, etc.);

2) evaluation of the productivity of the used crop rotations after supplementing the fertilisation technologies with alternative fertilisation products;

3) evaluating the possibilities of using remote technologies for monitoring changes occurring in the soil-plant system and applying their results in modelling and forecasting processes;

4) assessing the sustainability, stability of productivity and the ability to adapt to climate change processes affected by changing environmental conditions.



▲ Project promoters

3. Nordic Forest Research Co-operation Committee (SNS) project **PROTECT: Effects of defence priming on Norway spruce needle microbiome and pest resistance.**

Head of LAMMC part in the Institute of Forestry Dr Vaida Sirgedaitė-Šėžienė. 2022–2024.

The **aims** are determine: 1) how defence priming affects the ability of spruce plants to form mutualistic relationships with microbiota and the composition of these microbial communities; 2) how defence priming and microbiota composition affect photosynthetic ability and photosynthetic metabolites; 3) how defence priming and microbiota composition affect spruce production of defensive metabolites; 4) how defence priming and microbiota composition affect spruce plants resistance to pest and pathogens.

The tasks are: 1) to perform chemicals tested with methyl jasmonate, pipecolic acid, β-aminobutyric acid (BABA), gibberellic acid, and hexanoic acid *in vitro*

▲ Chemical stressors affect the seedlings of common spruce planted on different types of soils (sterile, inoculated and forest soil)

culture and perform seedling resistance screening: we will assess roots for damping-off symptoms and select that kind of preparation, which will have the least damping-off symptoms; 2) to perform soil inoculation: after seed treatment and germination in a Petri dish, spruce seedlings will be planted in microcosms with three types of soil: (i) sterile, (ii) mycorrhiza inoculated, and (iii) forest soil. Inoculation will be performed with fungi of *Amphinema* (inoculations will be performed once every other week for 8 weeks); 4) to assess the needle microbial community, metabolite analysis and gene expression analysis: needle samples will be taken from the 2-year-old spruce trees.

▲ Saplings of common spruce grown *in vitro* culture

ILCA
Innovation Laboratories for Climate Actions

4. European Institute of Innovation and Technology (EIT) project **Innovation Laboratories for Climate Actions (ILCA).**

Coordinator in the Institute of Forestry
Dr Diana Lukminė. 2022–2023.

The project **aims** to strengthen human capital in climate innovation and entrepreneurship for systemic problem-solving. It advances multidisciplinary climate and social innovation capacity by establishing Climate Innovation Laboratories and involves ecosystem actors in the design of Climate Innovation. The preparedness and competitiveness of small- and medium-sized (start-ups, scale-ups) enterprises in climate transition and digitalisation are supported.

▲ Countries implementing the project

5. Nordic Forest Research Co-operation Committee (SNS) project **Development of ash reproductive material for forestry and nature conservation.**

Coordinator in the Institute of Forestry Dr Diana Marčiulynienė. 2022–2024.

The **aim** is to continue the efforts started in partnering Nordic and Baltic countries leading to restoration of ash trees in the region. The objective is to start monitoring and conduct the development of 2nd generation genetic test trials that can be crucial for ash conservation established under the SNS-126 project "Conservation of resistant ash (*Fraxinus excelsior*) genotypes in Nordic and Baltic regions to maintain the full range of ecosystem-services provided by this keystone species".

▲ Visit to the ash gene bank in Phoenix Park

8.3.2. International projects completed in 2022

This section presents descriptions of **8** international projects implemented in 2022.

"Horizon 2020" projects

FAIRshare
DIGITAL TOOLS FOR FARM ADVISORS

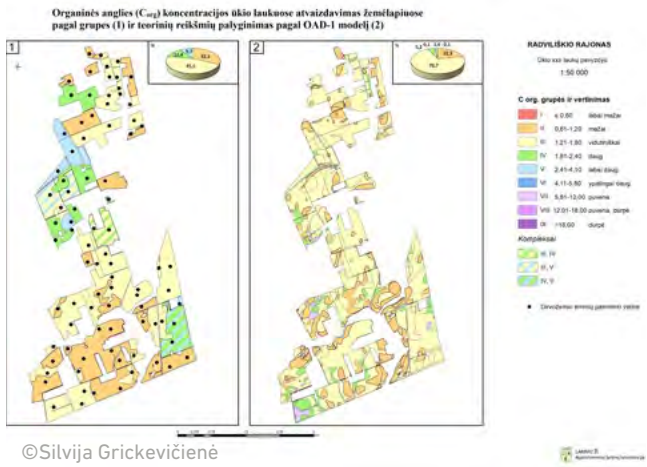
1. Promotion of sustainable and innovative farming based on soil organic carbon knowledges (FairShare).

Coordinator in the Institute of Agriculture (Agrochemical Research Laboratory) Dr Aistė Masevičienė. 2022.

Intensification and unsustainable agricultural activities, where more attention is paid to food production from a quantitative point of view, have a negative impact on the sustainability of the soil itself and cause changes in the organic carbon (Corg) imbalance. Therefore, recently, both agricultural consultants and farmers are faced with the challenge of the direction of farming: whether in their fields Corg is it accumulating, decreasing, or staying the same? The objective of this measure is to implement the latest materials more rapidly for soil agrochemical testing and land evaluation, providing farmers with special knowledge about the use of individual soils in order to grow the most abundant and high-quality crop production, reducing the risk of pollution of the natural environment and increasing Corg accumulation in the soil.

The **aim** was to create and present more informative digital maps based on available information. The activities include: 1) preparation and refinement of research methodology, analysis, and selection of research objects; 2) processing of Corg research data and analysis, summarisation, modelling, and digital mapping of results. During the project, the data were summarised and the broader information composition Corg the maps are prepared considering the country's zones (West, Central and East), former Corg amount, type of soil and granulometric composition, as well as according to the latest research data, entered into a digital computer database, in certain selected farms in districts located in different zones (Western Lithuania – Skuodas, Mažeikiai and Akmenė districts, Central – Radviliškis and Panevėžys districts, Eastern – Vilnius, Anykščiai, Molėtai, Širvintos, Švenčioniai, Trakai and Ukmergė districts).

Practical significance. This digital instrument (tool) will be useful for most agricultural sectors related to both intensive and organic farming. A specific tool will be able to be adapted at the country level, but for this it is necessary to have accumulated 10–20 years of Corg database of soil research as well as classification of soils by soil types and granulometric composition. The improved tool will allow agricultural producers to familiarise themselves with soil Corg change in your zone or district, to assess the measures applied on the farm Corg for soil conservation, choose and apply measures for more sustainable farming, contribute to environmental protection requirements and their implementation.



▲ *Figure 8*. Representation of organic carbon concentration in farm fields on maps by groups and comparison of theoretical values according to the OAD-1 model

2. Innovative soil management practices across Europe (i-SoMPE).

Coordinator in the Institute of Agriculture
Dr Lina Šarūnaitė. 2021–2022.

Project had two **main aims**:

1. Identify and document SMPs across Europe. In a broad way and with a focus on innovative farming systems and related innovative SMPs.

This first objective, more descriptive, is subdivided in three sub-ones:

1.1. Technical description of each innovative SMP and its variants;

1.2. Actual application of each practice in Europe (mapping);

1.3. Potential effects on the five **aims of the EJP SOIL project**: 1) soil and climate mitigation – soil carbon sequestration, 2) soil and climate change adaption, 3) sustainable agricultural production, 4) environment and ecosystem services, 5) land soil restoration – soil fertility and soil erosion prevention) and on other goals (pest and disease control).

2. Assessing the potential application of each innovative SMP in Europe, consider as well as technical and environmental constraints as well as socio-economic and cultural barriers. The proposal is built around one main stocktaking activity and is based on a surveying approach for identifying, documenting and analysing SMPs in each Member State.

3. Stocktaking for agricultural soil quality and Ecosystem Services Indicators and their Reference values (SIREN).

Coordinator in the Institute of Agriculture
Dr Dalia Feizienė. 2021–2022.

▲ Visual assessment of soil quality indicators to determine the functionality of ecosystems

The **aim** was to make an inventory of indicator systems for assessing soil quality and ecosystem services, as currently used by Member States associated in the EJP SOIL and beyond. During the project, it has identified and reviewed the national frameworks and logic chains from soil properties via soil functions to soil ecosystem services and the indicators of soil quality state and functions plus their reference values. Has been identified whether these have been implemented into policy, and what immediate cross-cutting challenges remain.

INTERREG Programme projects

1. Nutrients cycling for sustainability (NUTCY).

Coordinator in the Institute of Agriculture
(Vėžaičiai Branch) Dr Danutė Karčauskienė. 2022.

One of the **aims** was with the circular economy is the use of marine biomass resources as both a fertiliser and an adsorbent for nutrient recovery. These solutions will prevent fertilising nutrients from being dissipated in the environment and becoming pollutants.

This project involves a novel technological approach from which the entire region can benefit. Through the innovative potential for the use of nutrients from marine resources by closing cycles, on the other hand there is a very rapidly growing market for mineral fertilisers that can be replaced with our developed technology. The project will provide the technical guidance needed to formulate and standardise competitive innovative products, which will then have regional distribution and transcendence beyond the South Baltic region.

▲ Project workshop at Klaipėda University

Other projects of EU programmes supporting research

1. SNS (Nordic Forest Research Co-operation Committee) project **Biochar in forestry.**

Coordinator in the Institute of Forestry
Dr Iveta Varnagirytė-Kabašinskienė. 2022.

The **aim** was to organise a workshop on biochar use potential in forests in the Nordic-Baltic countries. The workshop was organised in Oslo, Norway, on June 15–16, 2022. The project workshop was attended by scientists, practitioners, and biochar producers from seven countries (Norway, Sweden, Finland, Denmark, Estonia, Latvia, and Lithuania), who discussed, exchanged knowledge, and experience in this relatively new and rapidly developing field; the current updates on the research and development in this field in the Nordic-Baltic countries were discussed. During the meeting, biochar production methods and facilities, possible feedstocks for biochar production, effects on forest and seedling growth, soil carbon stores, soil respiration, nutrient cycling and leaching, biodiversity, and climate change mitigation potential were presented and discussed. A report on the status of biochar in boreal forestry and a database of biochar experiments were established, and the first draft of a research application was discussed.

The project's activities were beneficial for the Nordic-Baltic region as the use of biochar in forests may have a large potential for climate change mitigation and a positive effect on forest growth and nutrient leaching. Establishing this network was crucial to the development of this new research field, and strengthened cooperation between practitioners, researchers, and PhD students from different countries.

▲ Seminar participants from Scandinavia and the Baltic States: scientists, practitioners, and biochar producers

2. European Food Safety Authority (EFSA) project **Wildlife: collecting and sharing data on wildlife populations, transmitting animal disease agents (EOW).**

Coordinator in the Institute of Forestry Dr Olgirda Belova. 2022.

The project **aimed** to develop and complement the European capacities for monitoring wildlife populations. The collection of comparable population data at the European level is essential to conserve wildlife and manage wildlife-related conflicts, but the same data are also needed to analyse the risks of the spread of diseases. In this project, the new methodology was tested and implemented on the ground of metadata from multiple camera traps and using the innovative program AGOUTI.

▲ Video footage obtained by high-definition CCTV cameras is being prepared for processing by the innovative AQOUTI mobile app for mobile devices applied for the first time in the country

3. Lithuanian–French Programme "Gilibert" for Bilateral Cooperation **Impact of urban trees on air pollution and human health.**

Coordinator in the Institute of Forestry
Dr Valda Araminienė. 2021–2022.

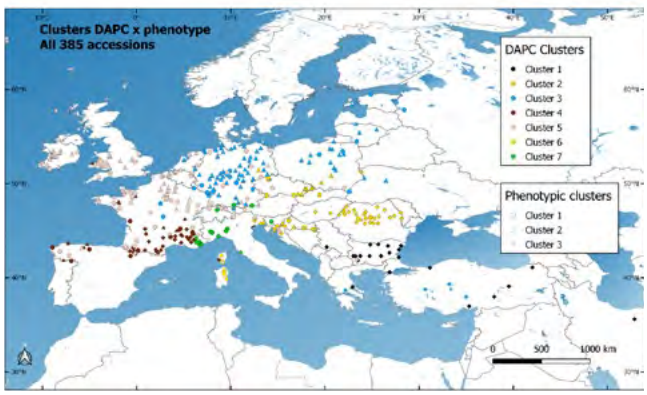
Using the Urban FORest Effects (UFORE) model and GIS capabilities, the project **aimed** to quantify the role of current forest cover in cities (absorbing air pollutants and carbon) and to assess the impact of forests on air quality. In addition, this project modells situations to eliminate / reduce air pollution in urban areas with collaborative efforts.

▲ A flagship park established in Aix-en-Provence was visited during a trip to the ARGANS research company

4. European Cooperative Programme for Plant Genetic Resources (ECPGR) project **Facilitating use on the European perennial ryegrass collection: improving access to genetic resources and C&E data.**

Coordinators in the Institute of Agriculture:
Dr Eglė Norkevičienė (2018), Dr Vilma Kemešytė (2018–2022) and Dr Gražina Statkevičiūtė (2019–2022).

To further the achievement of the ECPGR Objectives 1 and 2 of phase IX for perennial ryegrass by taking advantage of data and results of the FACCE-JPI ERA-NET + project GrassLandscape. Out of the 438 accessions used in the GrassLandscape project, 301 were registered in EURISCO and 171 accessions were flagged in AEGIS at the start of the Activity. At the end of the Activity, 433 accessions are now registered in EURISCO and 231 are flagged in AEGIS. The values of the 27 bioclimatic variables at the collection sites of 418 natural populations registered in EURISCO (including the 385 populations with C&E data) were uploaded to the EURISCO perennial ryegrass portal. The clustering of the whole set of 427 perennial ryegrass natural populations based on allele frequencies at 507 583 SNP loci resulted in a partition to seven genetic clusters. This partition revealed an essentially neutral structure mainly shaped by the history of Pleistocene expansion of perennial ryegrass across Europe and by demographic factors like isolation by distance. The differentiation between the three phenotypic clusters was consistent with adaptation to different climatic conditions. Populations from cluster 1 originated from areas with combined mild winter and cool summer seasons. These populations had early heading and high speed of spring growth. Populations from cluster 2 had late start of spring growth and late heading but strong growth in cold spring conditions. Populations from cluster 3 had a high investment in seed production and very small canopy growth potential in summer, in accordance with adaptation to hot and dry summer seasons.



▲ Distribution of perennial ryegrass genetic resources into genetic and phenotypic clusters based on 385 genotypic studies and bioclimatic data from collection sites

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8.3.3. National projects completed in 2022

In 2022, **31** national projects were implemented:

- **17** projects of the Research Council of Lithuania,
- **7** projects of the Ministry of Agriculture,
- **7** pprojects of the Ministry of Environment and its subordinate state institutions.

Descriptions of all national projects implemented in 2022 are presented below.

Research funded by the Research Council of Lithuania

Project of researchers' teams

1. Light as a tool of biofortification: photophysiological aspects of essential trace elements management in leafy vegetables.

Project leader Dr Aušra Brazaitytė. 2019–2022.

The project **aimed** to evaluate the biofortification of leafy vegetables with Fe, Zn, Se by manipulating the light spectrum and photosynthetic photon flux density, and to analyse their interaction with other minerals and phytochemicals through photophysiological aspects. It was determined that a higher percentage of blue light positively affected the accumulation of mineral nutrients in mustard and kale microgreens but decreased the growth parameters. This shows that technological and nutritional quality are not always compatible. When investigating the effect of various Fe, Zn and Se doses in the nutrient solution, it was found that a higher percentage of B light enhanced the accumulation of these nutrients, except for Se, which accumulated more with the dominance of R light in the lighting. However, with increasing concentrations of these elements in solution, the efficiency of their uptake in plants decreased, as shown by the lower bioconcentration factor. Increasing translocation factors in Brassica seedlings with increasing Fe, Zn, and Se doses indicate that younger plants absorbed these nutrients better. Adding green to blue and red-light spectra (BRG) was beneficial for the accumulation of Fe, Zn, and Se in

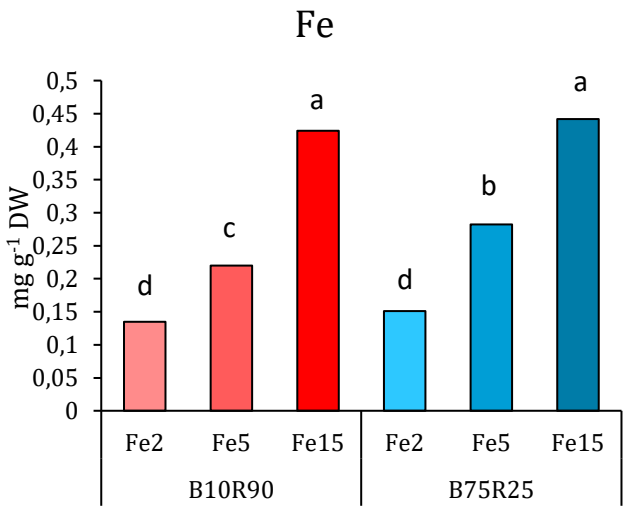

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Figure 9. Influence of different blue and red light ratios under LED illumination and iron doses on Fe content in kale seedlings

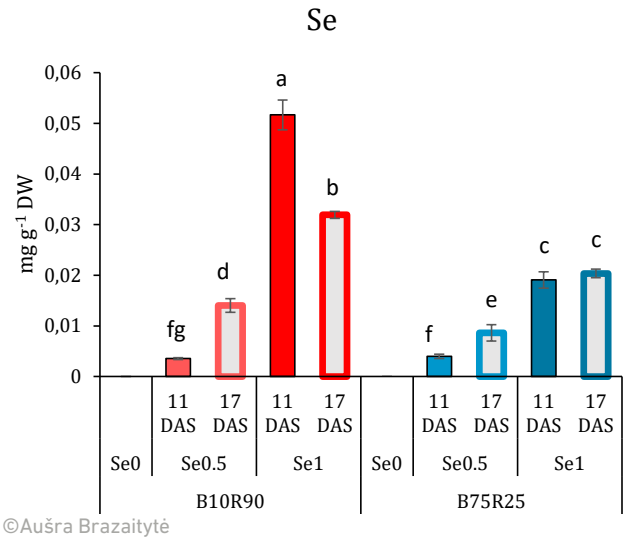

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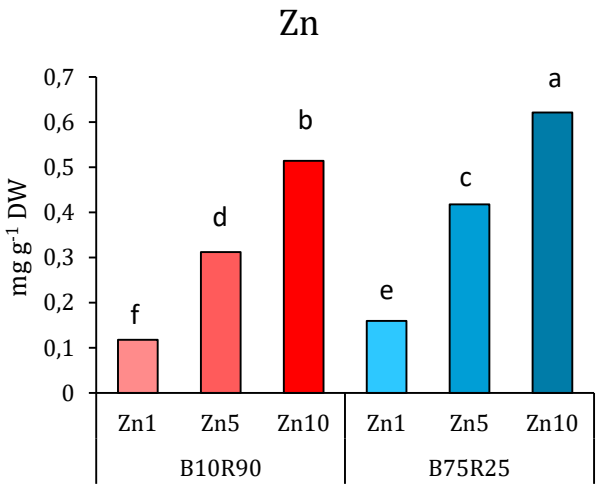
Figure 10. Effect of different blue to red LED light ratios, selenium doses, and duration of application on Se content in lettuce sprouts

mustard seedlings and lettuce. Under white (W) LED lighting conditions, the use of Fe, Zn, and Se in nutrient solutions significantly increased their content in plants, especially mustard seedlings, but did not significantly affect growth indices and did not reduce the contents of phytochemicals which are beneficial to human health. 3500K and 4000K B LED treatments were found to be more suitable for enhancing the amount of these compounds, so they can be recommended as a light source for biofortification.



▲ *Figure 11*. Effect of varying blue to red LED light ratio and zinc doses on Zn content of mustard sprouts

EU-funded projects implemented by world-class researcher groups and aimed at developing results in line with R&D topics relevant to the economic sectors, which could then be commercialised

1. Development of wood modifying eco-friendly technology for higher value products.

Project leader Dr Marius Aleinikovas. 2017–2022.

The **aim** was to develop environmentally friendly wood modification technology based on the reaction of bioactive compounds with modification reagent, ensuring rational use of lignocellulosic raw material and providing higher added value to the products. The project aims to develop and test bioactive compounds for wood modification and technological parameters of the modification process for selected tree species, improving the basic properties of natural wood and adapting the modification technology for commercialisation. Unique and environmentally friendly technologies will improve the properties of wood, thus expanding the potential of wood use in Lithuanian and international markets. The results have been patented in the Republic of Lithuania and European (EPO) patent offices. An environmentally friendly wood modification technology was developed. Wood modified in this way is characterised by hydrophobicity and improved properties of wood durability and resistance to wood-destroying fungi.

▲ Wood longevity experiment

2. Closed plant cultivation system for production of raw materials for peptide nanoengineering applications.

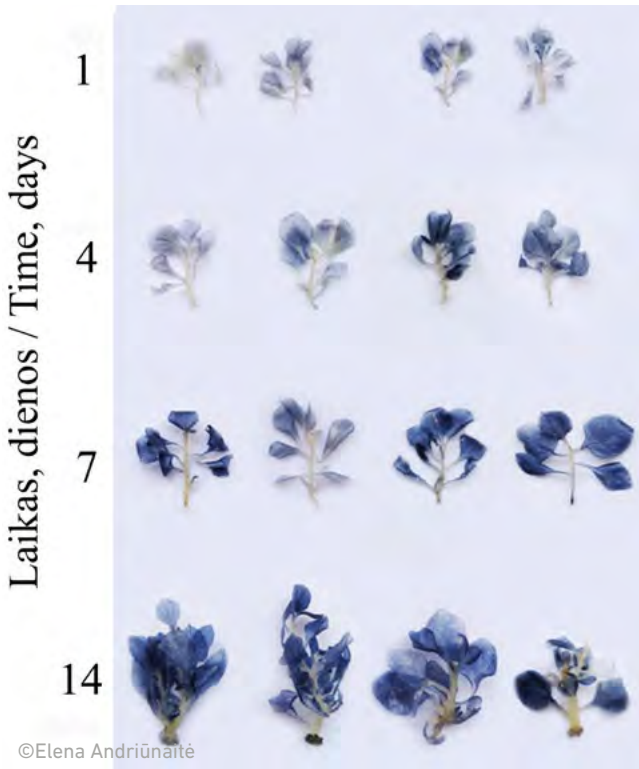
Project leader Dr Danas Baniulis. 2017–2022.

The project **aimed** at development of *in vitro* plant tissue cultivation techniques for production of biomaterials and search for effective solutions for extracellular matrix mimicking protein (PMEM) production was carried out. During project implementation, five distinct structure

▲ Inoculation of tobacco shoots with endophytic bacteria

PMEM constructs including peptides mimicking separate or combined functional regions of fibronectin, elastin, laminin, or collagen were developed. The selected PMEM constructs were prepared and tested in *E. coli* bacterial expression system and were used for plant transformation. Recombinant PMEM purification experiments using the plant material were carried out, and structural integrity, modifications, and purity of the PMEM was assessed.

Cultivation of plant tissue biomass is an important stage of molecular farming process; therefore, the project research was focused on the improvement of recombinant protein production methods using *in vitro* tissue culture. Tobacco *in vitro* shoots co-cultivation with endophytic bacteria experiments revealed that strains of *Bacillus cereus* group species *B. toyonensis, B. wiedmannii*, and *B. mycoides* stimulated shoot growth from 11% to 30%, reduced symptoms of oxidative stress and had no negative impact on the expression of recombinant protein.



▲ Visualisation of the accumulation of active oxygen compounds in tobacco shoots by tissue staining with nitro blue tetrazolium

3. UV-A lighting strategies for controlled environment horticulture: upgrade to sustainable, high-value production.

Project leader Dr Akvilė Viršilė. 2017–2022.

The **aim** was to expand the potential of artificial lighting for controlled environment horticulture, supplementing the traditional visible light with UV-A (~315–400 nm) irradiation. The hypothesis was explored, that UV-A evokes the reaction of the antioxidant protective system in plants and enhances the accumulation of phytochemical compounds, which are important for human nutrition or pharmacy. In this way, high-value plant production is obtained with the high nutritional value indices, organoleptic properties, which could not be achieved by illuminating plants solely with the visible spectrum (400–700 nm) light. The results show that the effects of UV-A light parameters (wavelength, intensity, duration) are specific for plant species, growth stage, and other environmental factors, therefore, the lighting strategies should be developed specifically for plant and agronomic objectives. Targeted selected UV-A light parameters (in the combination with certain parameters of basal lighting), enable to tailor the internal and external quality of green vegetables, herbs and/or medicinal plants. Plant material was enriched with phytochemical compounds and had positive or no impact on plant photosynthetic functioning. As a result of the project, the resource of SR&ED for LED lighting parameter recipes for controlled environment agriculture were created.

▲ Basil grown under LED illumination supplemented with UV-A wavelengths

4. Quality diagnostics of biogas production by-product (digestate) for innovative use as a biofertiliser.

Project leader Dr Alvyra Šlepetienė. 2017–2022.

The **aim** was to substantiate, assess and compare the quality of various agricultural raw materials received in the country with scientific knowledge; to reveal their potential for use, taking into account their suitability for industrial processing into biogas; to promote the use

▲ Assessment of the biomass content and chemical composition of differently fertilised plants

of biomass from biogas production as a biotechnology in agriculture and to improve its quality diagnostics by developing an innovative and accurate near-infrared spectrometry method. The high levels of organic carbon detected in the dry digestate demonstrate the ability of this biofertiliser to replenish soil organic carbon. This result is particularly important because more than one-third of the country's soils are deficient in organic carbon and organic matter. Fertilisation with digestate increases the yield of grassy biomass up to three times compared to unfertilised, and this grass biomass can be used as a raw material for biogas production.

The project was completed in 2022, and the results led to a patent application being submitted.

5. Development of winter wheat varieties for amylose-free starch and vital gluten processing.

Project leader Dr Gintaras Brazauskas. 2017–2022.

The **aim** was to develop new varieties of winter wheat with a specific composition of starch and protein adapted to Northern European climatic conditions by employing innovative and traditional breeding methods. PCR marker method was developed for the quick and robust identification of glutenins. The markers for Glu-A1 and Glu-D1 loci are applicable for the marker assisted selection in wheat with good correlation with SDS-PAGE. An automated system of leaf growth tracking was developed to precisely monitor leaf elongation during plant hardening stage. Simultaneously ivestigated genotypes were evaluated for freezing tolearance under artificial freezing conditions (LT50 value). A negative correlation ($r = -0.641$, $p < 0.05$) was observed between these two physiological parameters, which indicates a tendency that genotypes with limited growth during hardening are more frost tolerant and could be used to select genotypes with better overwintering potential. Ten amylopectinous (waxy) genotypes were developed by applying innovative genomic and phenomic methods. The genotypes developed were transferred to further breeding cycles for stability improvement and evaluation for agronomic traits. Genotypes with waxy starch and high gluten content were selected for further development of varieties. Three winter wheat breeding lines (DS 6460-1, DS 6460-3, and DS 7183-1) were evaluated at official plant variety testing centres in Lithuania and Poland. Positive testing results were obtained which led to the registration of three winter wheat varieties. Varieties 'Eldija' (DS 6460-1) and 'Sarta' (DS 6460-3) produce waxy (amylose-free) starch, while variety 'Vaiva' (DS 7183-1) is characterised by enhanced protein qualities. All three varieties were tested in production farms and initial seed multiplication was performed for the submission to the market.

▲ Fields of plant breeding at the Institute of Agriculture, LAMMC

6. Enhancement of the multifunctional properties of legumes in feed and food value chains (SmartLegume).

Project leader Dr Žydrė Kadžiulienė. 2017–2022.

In the context of climate change and the environment, the contribution of legume crops to sustainable agriculture is increasingly important. The **aim** was to develop innovative legume-growing systems based on their multifunctional value and to enhance their use as more environmentally friendly plant-derived raw materials in feed and food chains.

The scientific studies envisaged in the project have been conducted, and the planned implementation indicators have been achieved: two new pea varieties have been developed, and 4 technologies for the cultivation of peas, lentils and chickpeas have been developed. During the research, it was found that the new pea varieties 'Egle DS' and 'Lina DS' are more productive and have accumulated more crude protein than previously developed ones. Although both varieties are suitable for growing in various crop production systems, considering the early signs of the varieties, it is recommended to grow the variety 'Egle DS' under the conditions of conventional farming, and the variety 'Lina DS' – under the ecological farming system.

During the implementation of the project, chickpea and lentil cultivation technologies were studied using traditional and organic farming systems. The results of the study show that lentils and chickpeas have the potential to grow in the climatic conditions of our country, the initial technologies / recommendations for their cultivation have been prepared, but the research with these uncultivated beans needs to be continued and expanded.

▲ Lentil cultivation technology experiment

In the project plan it was expected to prepare 5 scientific articles, during the implementation of the project 6 articles were prepared. As foreseen in the project application, the results of the project were publicised at international scientific conferences. In total, 6 oral and 6 poster presentations were presented at 5 international conferences.

▲ The project is focused on pea productivity and quality research

Grant for high-level researchers group project, financed by the European Union funds

Insights into future forests: challenges of climate change and diseases, and possible measures for saving biodiversity and ecosystem functioning.

Project leader Dr Audrius Menkis. 2017–2022.

The **overall aim** was by using a holistic approach to collect high-quality empirical data and based on that to model how different scenarios of climate change and tree diseases can affect the distribution and health of forest trees and associated biodiversity in Lithuania, and to evaluate possible practical measures in order to retain biodiversity and sustainable functioning of forest ecosystems.

The health status of evaluated trees was found to be deteriorated in most of the plots due to the increased defoliation, dechromation and die-off of the branches. It was found that different samples were associated with relatively high richness of fungal species, but the relative abundance of these fungi varied considerably among the sample plots, thereby demonstrating the complexity of interactions among the host trees, fungi, and local environmental conditions. Along the north-south transect from Finland to Slovakia the health status of pine and spruce trees in assessed study plots were in many cases deteriorated. The most damaged stands, especially spruce stands, were in the northern part of the range, which has shown that they are most susceptible to changing environmental conditions or diseases. Modelling has shown that during this century there can be expected significant changes in the composition of fungal communities, and these changes will be primarily driven by mean annual temperature, precipitation seasonality, and precipitation in the warmest and coldest quarter of each year. Results also revealed that lichen communities in spruce and larch stands were very similar. The results suggest that the partial replacement of spruce stands by larch stands should not have a greater impact on lichens. A greater number of pest insects were found on spruce stems than on larch stems. Importantly, the spruce bark beetle has not been detected on larch as it is responsible for the massive dieback of spruce trees in Europe. Thus, larch compared to spruce is potentially more resistant to attacks by pest-insects. During the activity, a new insect species for Lithuania was detected.

▲ Specimens of needles to be collected

Postdoctoral internships in Lithuania, financed by the European Union funds

1. Toxigenicity of *Fusarium graminearum* residing in alternative host-plants to wheat as influenced by the environmental conditions.

Supervisor Dr Skaidrė Supronienė,
post-doc Dr Sigita Janavičienė. 2020–2022.

The project **aimed** to evaluate the potential of different trichothecene genotypes of *F. graminearum* isolated from an alternative host plant to produce B type trichothecenes under different spring wheat grain incubation conditions.

The potential of *F. graminearum* to produce the mycotoxins deoxynivalenol (DON), 15-acetyl-deoxynivalenol (15-ADON), 3-acetyl-deoxynivalenol (3-ADON), nivalenol (NIV), deoxynivalenol-3-glucoside

(D3G), fusarenone-X (FUS-X), and zearalenone (ZEA) in spring wheat grain was indetified. The strains of 3-ADON genotype consistently produced higher concentrations of 3-ADON, and the strain of 15-ADON genotype produced more 15-ADON in spring wheat grains after 5 weeks of incubation. The production of DON, ZEA, NIV, 15-ADON, and 3-ADON in spring wheat grains was more often dependent on the strain of *F. graminearum* and the environmental conditions than the trichothecene genotype. The results point to the potential role of weeds and dicotyledonous plants as a reservoir of inoculum sources of *F. graminearum*-induced Fusarium head blight and the risk of mycotoxin contamination in spring wheat grain. To our knowledge, this is the first report on mycotoxin production in spring wheat grain inoculated with *F. graminearum* strains isolated from alternative host plants in Europe.

▲ Grains infected by *Fusarium graminearum*

2. Epigenetic and genetic variation of trees, ecogenetic plasticity and adaptation possibilities in climate change.

Supervisor Dr Alfas Pliūra, post-doc Dr Valda Gudynaitė-Franckevičienė. 2020–2022.

The **aim** was to gain new scientific knowledge on epigenetic and genetic variation of trees, interactions between genotype and environment, ecogenetic plasticity and their role in short- and long-term adaptation to the effects of climate change and related stress factors.

The study shows that certain environmental conditions during reproduction not only have a short-term effect on the tree's viability or growth but can also help the tree adapt to climate change conditions and grow successfully in the long term. Different conditions during vegetative reproduction lead to changes in genetic variation after outplanting to the field, long-term changes in the proportions of genetic variation in various traits. Stressful conditions during propagation strongly imbalanced the heritability of important dendrometric, phenological traits, as well as heritability of a strongly genetically controlled trait – the amount of phenolic compounds in leaves. The environmental conditions during vegetative propagation not only determine the further growth of the tree and biochemical processes but can influence the genetic gain of traits and further selection. The obtained results are important in order to understand epigenetic phenomena in trees, because research with perennial plants is still lacking not only in Lithuania, but also in the world.

▲ Rooting of hybrid poplars in the phytotron of the Institute of Forestry, LAMMC

3. Adaptation potential of *Alnus glutinosa* in future forests under climate change: genetic monitoring in natural distribution extremes (ALNUSGENMON).

Supervisor Prof. Dr Filippos A. Aravanopoulos, post-doc Dr Rita Verbylaitė. 2020–2022.

The **aim** was to create a genetic monitoring system for *Alnus glutinosa* in Lithuania and to prepare a conservation plan for this species. During the project, genetic diversity of Lithuanian and Greek black alder populations was studied, the initial criteria of genetic diversity of the populations were determined, the parameters of the new generation of genetic diversity of the studied populations were evaluated, which are currently high, and the state of natural black alder populations does not raise concerns about the survival of black alder populations. It was established that the populations of Lithuanian black alder are characterised by high heterozygosity and high allelic diversity. Differences among black alder populations are low,

but statistically significant, which indicates possible adaptation of populations to local environmental conditions. Also, during the project, the genetic diversity of black alder progeny trial was investigated, and it was determined that this trial can serve as an *ex-situ* object of black alder, where the genetic material of Lithuanian black alder populations is conserved. During the project, a plan for the conservation of black alder in Lithuania was prepared, and a methodology for genetic monitoring of black alder was developed.

PhD student Valentinas Černiauskas measures leaf area index above the rain collectors in the forest monitoring area of level II

4. Evaluation of phytocomponents on the functional and physical properties of silicone caoutchouc composite.

Supervisor Prof. Dr Pranas Viškelis,
post-doc Dr Aistė Balčiūnaitienė. 2020–2022.

The **aim** was to develop multifunctional plant-derived fillers capable of imparting antifungal / antimicrobial properties to biocompatible silicone rubber and to investigate the structure and properties of the resulting polymeric biocomposite.

During the project, a consistent research plan was drawn up, which included the selection of medicinal plants, taking into account the desired properties of the final biopolymeric matrix. The aim of the work was the evaluation of the antioxidant activity of silver nanoparticles obtained by the green synthesis method of metal particles. For this, three medicinal plants: *Calendula officinalis*, *Thymus vulgaris*, and *Hyssopus officinalis* were selected and the methodology for synthesis was drawn up. The antioxidant activity of plant extracts and plant extracts with silver nanoparticles was evaluated using several different methods, the phytochemical composition was analysed, and the amounts of phenols and tannins were determined.

During the implementation of the project, two articles were published (DOI: 10.3390/pr9081304 and DOI: 10.3390/plants11081085), a patent application was submitted (granted No. 2021 010), title "Broad antimicrobial spectrum latex composite". Authors: Aistė Balčiūnaitienė, Pranas Viškelis and Jonas Viškelis.

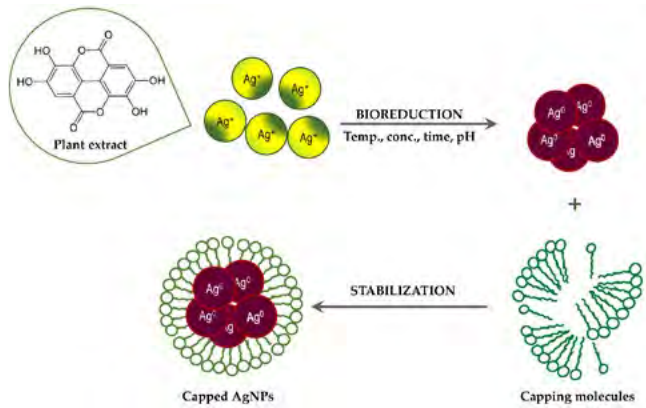


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Figure 12. Green nanoparticle biosynthesis using plant extracts

5. The influence of agrotechnological measures on fibre hemp (*Cannabis sativa* L.) morphological parts phytochemical composition.

Supervisor Dr Vita Tilvikienė,
post-doc Dr Karolina Barčauskaitė. 2020–2022.

The **aim** was to investigate the changes in the phytochemical composition of fibre hemp (*Cannabis sativa* L.) by applying different agrotechnological measures. After the implementation of the project, it was established that the cultivation of fibre hemp as a multifunctional plant including the extraction of biologically active substances and biomass in the North-Baltic climate can be considered depending on the applied agrotechnological measures (fertilisation and sowing density). By applying appropriate

Participants of the European Society of Phytochemical Society of Young Scientists' Congress

argotechnological measures, it would be possible to obtain the best composition of the final product, which depends on the further use of fibre hemp biomass.

The obtained data showed significant differences between the applied agrotechnological measures and the quantitative changes in the composition of fatty acids methyl esters and the content of essential oil in the inflorescences. Regarding the quantitative analysis of primary, fibrous hemp secondary metabolites – cannabinoids, it was observed that fertilisation had a greater influence on the decrease of cannabinoid content than sowing density, but the changes were not statistically significant. Furthermore, (E)-β-caryophyllene was the predominant compound in the essential oil composition, regardless of the applied agrotechnological measures.

Project of the national research programme "Sustainability of agro-, forest and water ecosystems"

1. Dynamic changes and restoration of soil properties, fungal and insect communities following clearcutting and biomass utilization in pine ecosystems.

Project leader Assoc. Prof. Dr Artūras Gedminas. 2020–2022.

The **aim** was to conduct multidisciplinary research obtaining fundamental and applied knowledge on soil properties, fungal and insect communities' restoration in pine ecosystems disturbed by forest clearcuttings and intensive biomass utilisation. Results showed that compared to the mature forest, lower concentrations of org. C and total N, P, K, Ca, and Mg were found in the forest floor in the 1–2 years old plantations. Seven insect species among two insect orders of Coleoptera and Hymenoptera were identified during the examination of xylophagous exit holes on pine stumps. Comparing pine forest, clear-cut sites and 1–4-years old pine plantations, the composition of the litter arthropods by order was very similar: the Coleoptera order dominated, composing between 64–73% of the total trapped arthropods. It was found that the total diversity of fungal species in the 4-years old plantation was up to 1.5 times higher than in the mature forest. This may have been due to a new vegetation cover formation and the changes in the habitat, while the pine-related fungal communities were almost reaching the pre-felling structure 4 years after the clear cutting.

▲ Exit flight holes of longhorn beetles (Cerambycidae)

Development of scientific competence of scientists, other researchers, and students through practical scientific activities funded by the European Union funds

Sub-activity "Development of students' abilities in scientific (art) research during semesters"

1. Assessment of the biopolymer chitosan impact on the Scots pine (*Pinus sylvestris*) early development and formation of antipathogenic resistance.

Supervisor Dr Vaida Sirgedaitė-Šėžienė, student Milana Augustauskaitė. 1 September 2021 – 31 March 2022.

Studies conducted with selected concentrations of chitosan solutions *ex vitro* showed that chitosan perfectly neutralised the negative effects of the used acidic solvent and plant growth indicators not only did not decrease, but also had a slight but positive effect. However, the lower concentration of 2 g L^{-1} chitosan solution was more favourable for plant growth, both using insect and commercial chitosan. Depending on the genetic background of the plant, chitosan solutions had a strong positive effect on plant-synthesised secondary metabolites, which form plant defence mechanisms and increase plant resistance to biotic and abiotic stress. In some cases, the concentration of secondary metabolites increased by about 30% compared to the common control variant. A slightly different situation was found in studies of interactions between chitosan solutions and tree phytopathogens. It was found that the spread of the pathogen Lophodermium seditiosum (Ls) was negatively affected by a lower concentration of 2 g L^{-1} chitosan solutions. Meanwhile, the spread of *Heterobasidion annosum* into plant tissues was often inhibited by a higher concentration of 10 g L^{-1} chitosan

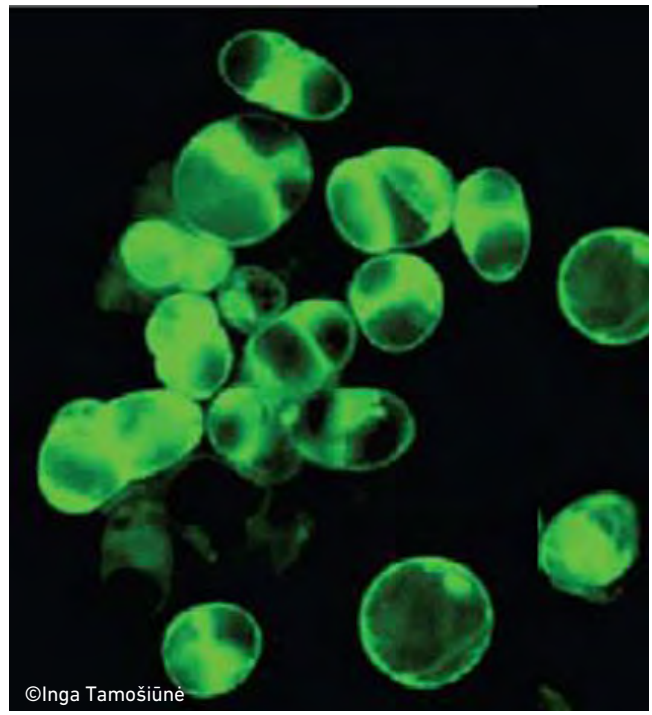
solutions. However, in many cases, the use of chitosan solutions had a significant effect on the spread of pathogens.

▲ Sapling of common pine

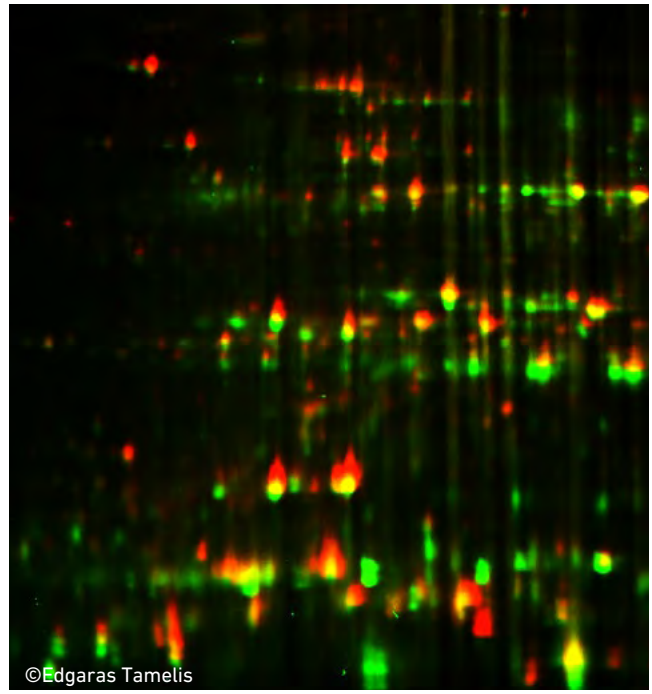
2. Plant and endophytic bacteria interaction analysis using *in vitro* model system.

Supervisor Dr Danas Baniulis, student Edgaras Tamelis. 1 September 2021 – 31 March 2022.

Endophytic microorganisms colonise a variety of plant tissues and they are found in every plant. Despite an abundance of information about endophytic microorganisms, mechanisms of plant-endophyte molecular interaction and in particular processes that occur at the early phase of tissue colonisation remain ambiguous. Therefore, the **aim** was to employ a model tobacco (*Nicotiana tabacum* L.) cell suspension system to assess changes in plant cell redox balance and protein carbonylation at the early phase of the plant and endophytic bacteria interaction. Six strains of endophytic bacteria isolated from tobacco tissues were used for the analysis of endophytic bacteria effect on plant cell redox balance. The study revealed that accumulation of reactive oxygen species in tobacco cells was stimulated by *Bacillus simplex* strain Nt 21 and it was reduced by *Pseudomonas koreensis* Nt 32 as compared to the control. Application of two-dimensional electrophoresis revealed that protein expression pattern was not affected by incubation with *B. simplex* Nt 21 but it induced changes in protein carbonylation of 19 proteins. The changes involved proteins related to cell response to oxidative stress and metabolic processes such as the synthesis of isoprene and phenazines.



▲ Microscopic visualisation of the accumulation of active oxygen compounds in tobacco cells



▲ Results of the analysis of protein carbonylation by bidirectional electrophoresis (samples of control and bacteria-incubated tobacco cells are shown in red and green)

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Sub-activity "Development of students' abilities through participation in scientific (art research) summer internships"

1. The optimisation of *Pinus sylvestris* L. growth and induced systemic resistance using jasmonic acid *ex vitro*.

Supervisor Dr Vaida Sirgedaitė-Šėžienė, student Emilija Beniušytė. 1 July – 31 August 2022.

The **aim** was to evaluate the influence of jasminic acid on the development of plants of different genetic families of *Pinus sylvestris* and to optimise the influence of this chemical signal on the formation of plant systemic resistance *ex vitro*.

During the study, it was found that jasminic acid had an impact on changes of secondary metabolites in different genetic families of Scots pine, but no positive effect on morphometric plant growth parameters was found. This is likely due to a long-term compensatory mechanism. The use of jasminic acid can be one of the effective ways to increase the resistance of Scots pine seedlings to adverse environmental factors by creating inducible systemic resistance. However, as can be seen from the results of the study, it is important to determine the optimal concentration of jasminic acid.

Based on the obtained results, it is recommended to use jasminic acid at a concentration of 0.75mM to induce the systemic resistance of *Pinus sylvestris*. Genetic selection is also an important factor in this type of research. However, this depends both on the genetic differences of *Pinus sylvestris* and on the chosen concentration of jasminic acid.

▲ *Pinus sylvestris* seedlings treated with jasmonic acid

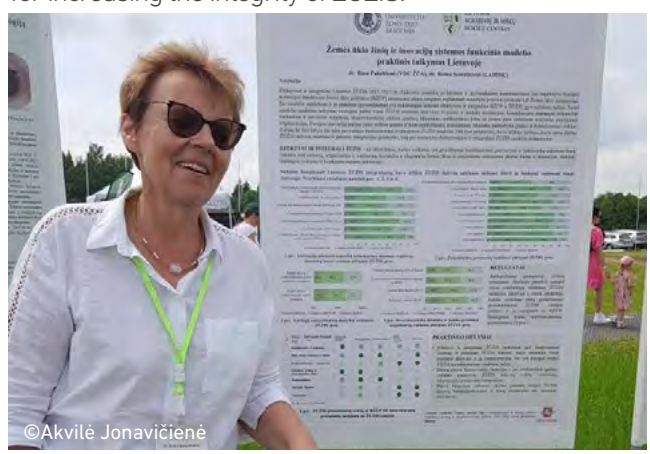
Applied research funded by the Ministry of Agriculture of the Republic of Lithuania

Agricultural, food, and fisheries research and development projects

1. Research on the development of a functional model of the agricultural knowledge and innovation system in Lithuania.

Leader Dr Rasa Pakeltienė (VMU), coordinator Dr Roma Semaškienė (LAMMC). 2021–2022.

The **aim** was to arrange a functional model of an efficient and integrated Lithuanian agricultural knowledge and innovation system (ŽŪŽIS) for 2023–2027. A survey of ŽŪŽIS participants regarding the conceptual effective and integrated functional model of ŽŪŽIS in 2023–2027 revealed that ŽŪŽIS participants have different understandings of ŽŪŽIS; therefore, it is necessary to increase understanding about this system, its principles, and goals. Respondents expressed a consensus that the ŽŪŽIS is fragmented and activities should be taken to reduce it, as well as to promote the cooperation of ŽŪŽIS participants. Fragmentation is observed not only in the system but also in the flow of knowledge. Information on agricultural knowledge and innovation is scattered, and difficult to find, which creates the need for the creation of a unified or centralised digital system. In the new Common Agricultural Policy (CAP) period, special attention remains on the training of advisers and farmers, raising skills and knowledge by updating the accreditation system of advisers or applying good practices of foreign countries, such as CECRA. Higher funding of the ŽŪŽIS system, investment in digital platforms that already comply with ŽŪŽIS principles, for example ensuring the development and improvement of TITRIS, LKT platforms, and strengthening EIP partnerships are an important basis for increasing the integrity of ŽŪŽIS.



▲ Presentation of the project at the exhibition "Agrovizija"

2. Evaluation and preparation of fibre hemp products as organic carbon accumulators in long-term products and soil for their application according to IPCC methodology in GHG inventory.

Leaders Dr Egidijus Zvicevičius (VMU) and Dr Vita Tilvikienė (LAMMC). 2020–2022.

Lithuania's obligations in trying to control climate change and other global challenges increase. Effective measures are necessary not only to reduce greenhouse gas (GHG) emissions, but also capable of "binding" CO_2 gas improving soil quality and contributing to the development of the bioeconomy. The **aim** was to evaluate the possibility of including the amounts of organic carbon stored in the long-term products of hemp (including biochar) and soil in accordance with the 2006. Accounting for GHG emissions and absorption carried out according to the guidelines of the IPCC.

Hemp is one of the most promising plants. They are used in the production of furniture, bioplastics, textiles, and other products, as well as organic carbon (biocarbon). Biochar is a product of controlled combustion that can be used for long-term carbon sequestration, soil fertilisation and soil recovery / improvement, as well as in other areas of the bioeconomy. Research has shown that hemp is a suitable raw material for the production of biochar, and the use of biochar in agriculture improves the sorption properties of the soil and has a positive effect on plants. In order to include biochar as a means of reducing GHG emissions in the national GHG emissions report, it is necessary to assess the long-term impact of these products on both the soil and the environment.

▲ Impact of various fertilisers on the growth of hemp cultivated for fibre

3. Evaluation of factors limiting the yield of beans and peas and their management with IPM tools.

Leader Dr Roma Semaškienė. 2020–2022.

The **aim** was to evaluate assess the importance of factors limiting the grain yield of beans and peas and to prepare recommendations to reduce the influence of these factors. The data of the study suggest that the grain yield losses of different cultivars of peas due to the spread of weeds in the crop ranged from 0.27 to 0.51 t ha^{-1} in the research year. Without applying any control, the weeds reduced up to 0.91 t ha^{-1} of grain yield of beans. In years favourable for the spread of diseases, due to diseases in peas, the grain yield decreased from 0.34 to 1.24 t ha^{-1} of grain yield, or from 105 to 385 EUR depending on the cultivar. According to the conducted study, it is suitable to name *Ascochyta* as the main factor limiting the productivity of peas. The resistance of different pea cultivars to this disease could be an important control tool. Bean grain yield data correlates directly with disease control data. To produce a competitive bean crop, disease (especially chocolate spot) control in beans is mandatory. When occurrence of diseases was severe, the 1.2 t ha^{-1} of bean grain yield was saved after using a fungicide (in terms of benefit, this would correspond to 384 EUR).

▲ Bean leaves damaged by diseases

4. The state of agricultural crop stands and yield forecast in Lithuania.

Project leader Dr Virginijus Feiza. 2020–2022.

The **aim** was to carry out the analysis of agricultural crops growing conditions and make a prognosis of their yielding of different agro climatic zones (West, Central and East) of Lithuania four times per growing season.

Conclusions of 2022. Crop fertilisation this spring was less intensive due to mineral fertilisers shortage in the market and price increase. Some farmers were not able to follow up the recommendations for suitable fertilisation. These farms may expect 8–20% lower crop yielding than usual. Crop lodging before harvesting was different: from 5–20% (in the Western part) till 30–40% (in the Central part) or even more in the Northern part of Lithuania. This year, the harvesting date was later

than expected; meanwhile winter cereals and winter oil-seed rape have been successfully harvested at the second half of August. Conditions for sowing the winter cereals for the harvesting year of 2023 were favourable this autumn.

▲ Only healthy plants guarantee a good harvest

▲ Diseased plants reduce yields by 30% or more during the experiment

5. Demonstrating the potential for climate change mitigation in nutrient-rich organic soils through research-based national values for greenhouse gas (GHG) emissions from lowland peatlands.

Project leader Dr Kęstutis Armolaitis. 2020–2022.

The **aim** was to base on measurements of the annual emission factors of greenhouse gases (GHG) CO_2-C, CH_4 and N_2O-N emissions from Lithuanian undrained and drained low moor soils (*Terric Histosols*) in different land uses: perennial grasslands, cultivated productive land and forest land.

The Intergovernmental Panel on Climate Change (IPCC) only assesses GHG emissions from drained peatlands. The measurements carried out in 2021–2022 revealed what, currently applied (IPCC 2006) or significantly increased new (IPCC 2013; 2014), annual emission factors of drained peatlands should be applied when preparing Lithuanian GHG reports.

For drained peatlands, annual emission factor 5.0 t CO_2-C ha^{-1} yr^{-1} (IPCC 2006) is suggested for cultivated productive land, while 2.6 and 6.1 t CO_2-C ha^{-1} yr^{-1} – for forest land and perennial grassland, respectively (IPCC 2014, 2013). Meanwhile, an annual emission factor of 8.0 kg N_2O-N ha^{-1} yr^{-1} (IPCC 2006) for cultivated productive land and perennial grasslands and 2.8 kg N_2O-N ha^{-1} yr^{-1} for forest land (IPCC 2014, 2013) can be applied for N_2O emission accounting. In drained peatlands, annual emissions of CH_4 were negligible or not detected and, therefore, may be underestimated in GHG accounting (IPCC 2016).

In order to reduce GHG, especially CO_2, emissions, it is recommended to afforest drained arable peatlands with forests, as the increase in stand growth after peatland drainage (additional C accumulation in wood) can compensate for CO_2 emissions.

▲ Greenhouse gas (GHG) experiment

6. Development of cultivation technologies for quinoa (*Chenopodium quinoa*), chickpea (*Cicer arietinum*) and amaranth (*Amaranthus*).

Project leader Dr Lina Šarūnaitė. 2020–2022.

In order to expand the biological diversity of plants in agriculture and ensure specific nutritional needs (diabetes, allergies), it is important to study the main technological parameters of the cultivation of new, promising plants, such as Bolivian quinoa, chickpea and amaranth – the regularities of growth, development and yield formation under Lithuanian conditions of intensive and ecological farming. After scientifically proving the

optimal sowing time and seed rate of Bolivian quinoa, chickpeas and amaranth, evaluating the patterns of formation of the biopotential of these non-traditional plant varieties, yield and their optimal harvesting time, evaluating the need for plant protection measures in Lithuanian climatic conditions, recommendations have been prepared for the participants of the food chain, which will allow agriculture entities to improve production processes and increase production productivity, will ensure a stable supply of raw materials for the food industry and the stability and vitality of agro-ecosystems and preserve a clean environment.

During the project implementation, the dissemination was conducted with 3 organised seminars and 3 published articles in the popular press. A study of the possibilities of growth and the technologies of Bolivian quinoa, chickpeas and amaranth in Lithuanian climate conditions has been prepared.

▲ Amaranth

▲ Quinoa

7. Evaluation of effectiveness and perspectiveness of different agricultural practices from economic, energy-efficient and environmental viewpoints.

Project leader Dr Dalia Feizienė. 2020–2022.

The **aim** was to evaluate technologies of different crop management systems according to their economic, agroenvironmantal and energetic value in contrasting soils under changing climate conditions as well as to ensure GHG emission reduction.

Economic evaluation. The highest costs on different textured soils exhibited plough tillage soil technology. The highest crop yielding was also under plough tillage application, while ploughless tilage technology produced the lowest crop yields. The digestate produced from pigs and hens' manure was the same effective as N mineral fertilisers application.

Energetic evaluation. The least fuel consumption for one ton grain production was under plouhless sustainable tillage application, while the highest-under intensive plough tillage application. Sustainable plough tillage and sustainable ploughless tillage technologies ensured a reduction of mineral fertilisers application on loamy soil on average by 49%, on sandy loam soil by 44% compared with intensive crop management.

Environmental evaluation. The highest GHG emission (CO_2 eq.) was from soil of intensive plough tillage technology, while the least – under sustainable plough tillage system. Both mineral and organic fertilisers increased emission by 2.40–2.46 times compared with the soil of unfertilised cereals.

▲ No-plough technology is the most energy and economically viable for winter oilseed rape

Applied research projects funded by the Ministry of Environment of the Republic of Lithuania and its subordinate state institutions

1. Determination of the influence of growth of young pine and spruce stands at different densities on the productivity and sustainability of stands.

Project leader Dr Benas Šilinskas. 2021–2022.

The **aim** was to investigate the influence of early thinning of pine and spruce stands on their productivity and sustainability in high productivity growing area, and to evaluate the impact of thinning in 2015 on the condition of these stands. The average tree diameter, as well as the ratio of their diameter to height, together with the sustainability of the stands, increases as the stand density decreases. Pine trees grown at the lowest density have reached 1.5 times the average diameter and growth in diameter compared to the densest variant. Between the sparsest and most densely growing spruces, the difference in average diameters reaches two times, the ratio of diameter increments is two or more times, which means that the average volume increment ratio of the trees growing in them will be more than five times. The results of the study reveal the advantages of early fellings, repeated at least every 15 years, the expediency and allow justifying programmes of growing medium-sized stems for a period of 50–70 years by purposefully increasing productivity in pine and spruce plantations with higher than above-average productivity.

▲ Spruce tree forest

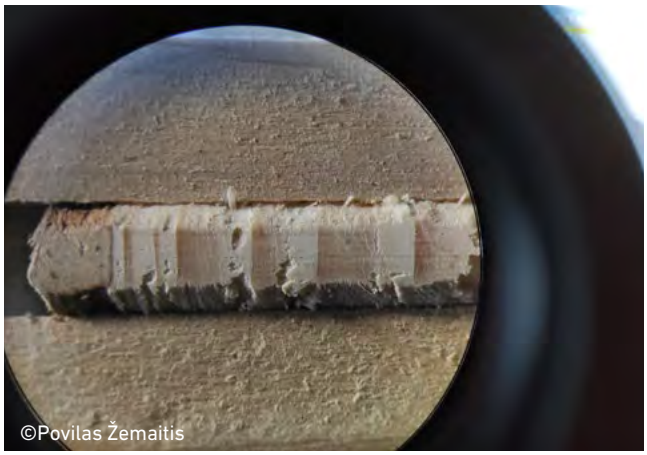
2. Butt rot impact assessment on sustainability and productivity of Norway spruce stands.

Project leader Dr Povilas Žemaitis. 2020–2022.

The **aim** was to assess the sustainability and productivity of different age and species composition Norway spruce stand damaged by root rot, and to

provide recommendations for forest management to reduce root rot risk and damage intensity.

The results showed the negative impact of root rot on Norway spruce stands vulnerability, sustainability, and productivity. Among wind-damaged stands, root rot increased the odds ratio (OR) to windthrows by an average of 30.1-fold. The highest OR for spruce windthrows to occur was in mixed spruce-deciduous species stands, while OR decreases in pure spruce stands and mixed spruce-conifer stands; this indicates, that root rot-damaged spruce are more vulnerable to the wind in deciduous stands and non-decayed trees are less affected by wind. The stand thinning intensity increases the root rot incidence rate, the risk of wind damage increases. During the medium-intensity wind, mostly root rot-damaged trees are affected (OR = 83.6), while in the case of hurricane winds when trees are blown in groups, the OR for non-decayed trees to be damaged increases (OR = 30.1). The crown defoliation of root rot-damaged trees increased by an average of 8.9 percentage points, and the radial increment decreased by 7.2 ones. The root rot incidence rate and main factors – forest type, soil humidity, and fertility, stand species composition, and stand age – were identified; recommendations for forest management to reduce root rot incidence rate and the damage caused to stands were provided.



▲ Estimation of the radial increment of spruce

▲ Wind damage in spruce stands affected by stump rot

3. The influence of initial stand density and early selective thinning on the spruce tree stems quality.

Project leader Dr Marius Aleinikovas. 2020–2022.

The **aim** was to investigate the influence of stand density and early thinnings on the quality of tree stems in medium and high productivity spruce plantations. The results of the study showed that tree branch diameters increase steadily with decreasing tree planting density. The smallest average branch diameter in the lower stem log (of the 6 m) was 1.25 cm in the densest stands. In the rarest stands, the average branch diameter was 1.4 times larger. The trees grown in the densest stands also had fewer branches in the lower stem log (on average 52 pcs.), i.e., 1.7 times less than in the rarest stands. The stems of the densest and usually thinned stands were the most affected by the damage. In total, 22.5% of trees in spruce forests were damaged. Damage was up to 8% higher in stands established on agricultural land. The results of the study showed that in 36–43-year-old spruces stand, the best parameters and the highest quality stems can be obtained by forming an initial density of 1100–1200 trees ha^{-1} at an early age and thinning in 32–35 years of growth, leaving 800–1000 trees ha^{-1} after thinning.

▲ Object of research

4. Study of possibility to use aspen symbiotic bacteria for biological control of tree-damaging pathogenic fungi.

Project leader Dr Jonas Žiauka. 2020–2022.

The **aim** was to evaluate the possibilities of using aspen symbiotic bacteria for the biological control of pathogenic fungi that damage trees.

It was found that the *Paenibacillus* sp. and *Pseudomonas* sp. Bacteria were grown best at room temperature (23°C). Evaluating the studied acidity values of the medium, it was found that bacteria grew most intensively on a nutrient medium with pH 6.4, and the weakest on pH 4.8.

The obtained data showed that *Pseudomonas* sp. had a twice stronger antagonistic effect on the growth of all pathogenic fungi used in the research, compared to *Paenibacillus* sp. The antagonistic effect of individual bacteria is influenced by the composition of the selected medium and its acidity. *Pseudomonas* sp. the antagonistic effect of the bacterium is 6 times stronger on the growth of *H. fraxineus in vitro* on LB medium with ash leaves (pH 4, pH 5, and pH 7), and on the growth of *L. seditiosum* on LB medium (pH 5.5). *Paenibacillus* sp. stronger antagonistic effect of the bacterium was determined on the growth of *P. tremulae* on MS medium at all acidity variants (pH 4, pH 5, pH 6, and pH 7). Both tested bacteria: *Paenibacillus* sp. and *Pseudomonas* sp., inhibited the growth of the fungus *H. annosum in vitro* (from pH 5 to pH 7).

A stronger negative influence on the growth of the mycelium *H. fraxineus* was found after *Pseudomonas* sp. interactions between bacteria and gibberellin and auxin phytohormones. Meanwhile, the fungi *P. tremulae* and *H. annosum* had a negative influence on *Paenibacillus* sp. interaction between bacteria and abscisic acid.

It was also found that *Paenibacillus* sp. the bacterium had a stronger positive effect on the variation of growth parameters for a greater part of different ash genotypes and Scots pine semi-sibs' families on morphometric indicators *in vitro* and Scots pine growth and development *ex vitro*. Meanwhile, *Pseudomonas* claimed a stronger effect on the growth of individual aspen genotypes and two out of five ash genetic families *ex vitro*.

▲ Distribution of the fungus *Phellinus tremulae* and bacteria *Pseudomonas* sp. on the nutrient medium

5. Preparation of aspen seed plantation project by identifying the sex of aspen plus trees and establishing the most optimal scheme for crossbreeding.

Project leader Dr Rita Verbylaitė. 2020–2022.

The **aim** was using molecular methods to assess the gender of the aspen plus trees selected in Lithuania, to evaluate the morphological health parameters of these trees, and to prepare the project of the aspen seed plantation and the individual planting scheme, taking into account the gender of the selected aspen genotypes.

During the project, the health status and gender of all aspens plus trees growing in Lithuania were assessed, additional potentially plus aspen trees were selected in the forests and their gender was also assessed. The TOZ19 gene marker was used to determine the sex of plus aspen trees. A fragment specific to this gene is found only in male genotypes and is absent in females. According to this marker, out of 92 trees, only 14 are female and all the others are male. The theoretical need for aspen seeds for Lithuania has been calculated, the aspen clonal plantation project has been prepared, and the seed plantation scheme has been drawn up.

▲ The fruiting body (basidiocarp) of the aspen bracket (*Phellinus tremulae*)

6. Identification of black alder and grey alder F1 generation hybrids and preparation of forest propagating material for field trials.

Project leader Dr Virgilijus Baliuckas. 2020–2022.

The **aim** was (1) to prepare seedlings of F1 generation of grey alder (Bt), black alder (J) and hybrids for breeding test plantations, (2) to develop a methodology for the identification of naturally growing alder hybrids (H) with phenolic compounds. The amount of hybrid alders in natural alder habitats was determined. For this study, 12 temporary sites were selected in different Lithuanian forests. According to morphological characteristics, it was found that about 2.7 percent of hybrid alders grow in forests. The artificial crossbreeding works were conducted in the Radviliškis regional division, Josvainiai enterprise quarter 70(1) in the seed plantation of Black alder, hybrid alder and grey alder forest seed plantation and in the 2nd generation black alder forest plantation.

The 107 different crossing combinations were performed: 10 combinations J♀×J♂, 8 J×Bt, 9 J×H, 28 Bt×J, 9 Bt×H, 1 H×H, 15 H×J, 13 H×Bt, 4 J×control, and 1 Bt×control. Of all these combinations, no seeds were obtained from 14.02% (15 variants), 34.58% (37 variants) – up to 1 g of seeds, 31.77% (34 variants) – 1–3 g, and over 3 g – 19.63% (21 variant) of all combinations. When crossing alders, most of the seedlings sprouted: H♀×J♂ (24.9% of sown seeds), Bt×J (13.04%), and Bt×H (10.12%). Grown seedlings were planted in quarter 134 of Vilkija enterprise, a total of 1,560 trees. For the identification of hybrids with the help of phenolic compounds, three sites were selected in natural alder habitats in Latveliai, Vaineikiai and Birbiliškės forests.

Recommendations for the identification of naturally growing hybrid alders using flavonoids have been prepared.

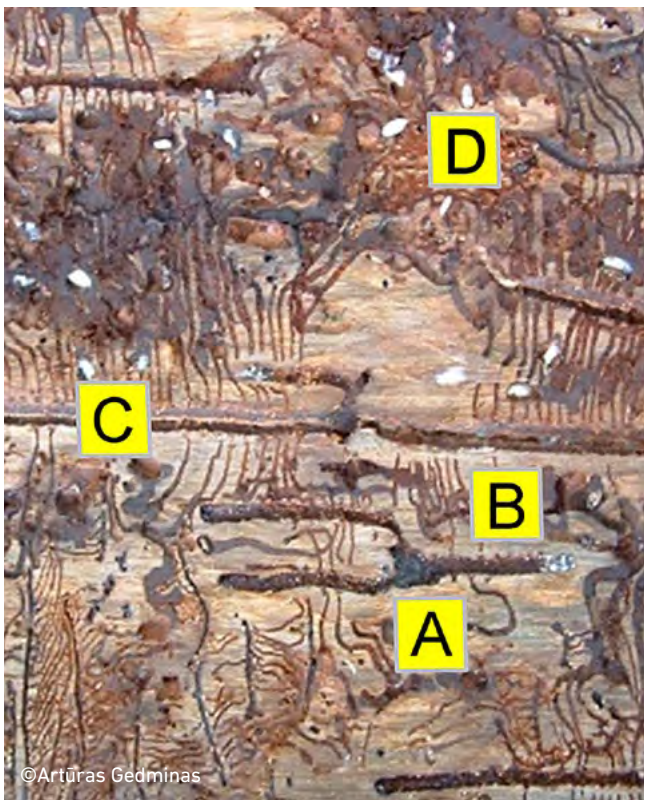
▲ Alder seeds obtained by artificial crossing are sown in prepared containers in the greenhouse of the Dubrava Regional Unit of the State Enterprise "Valstybinių miškų urėdija"

▲ Planting of container-grown seedlings in the experimental plantation of the Kulautuva Forestry of the Dubrava Regional Unit of the State Enterprise "Valstybinių miškų urėdija"

7. Compilation of a model for the bark beetle development.

Project leader Assoc. Prof. Dr Artūras Gedminas. 2022.

The **aim** was to calculate the parameters bark beetle phenology using easily available meteorological data (daily temperature, mean multi-year temperature, etc.) in Lithuania. The prevailing stage of beetle development and the beginning, maximum, and end of each stage was assessed. The timing of generations: I, Ia, II, and IIa of the bark beetle were determined according to the model and were calibrated according to the field data of bark beetle monitoring during 2016 at SFE, Dubrava RU). Therefore, the replication of the real time monitoring is required to obtain significant results. The final aim of the presented model was the compilation of the topographic and climate study maps for all Lithuanian municipalities / districts where Norway spruce stands are grown. This requires the application of ESRI ArcMap or similar apps. Phenology indicators, i.e., the sum of effective temperatures (K = 557 Ld) and the lower development threshold (VTa = 8.3°C), are variable and by changing them it is possible to calibrate the model of the bark beetle development more accurately according to the climate data in our country. The climate data from the Dubrava Meteorological Station showed that during the 2019, 2020, and 2021 from April 1 to October 31, an average of daily effective air temperatures (Σt°C) of 1300 were accumulated, when VTa = 8.3°C. This showed that the selected data of 2016 were sufficient for the initial calibration of the model.



▲ Mating chambers (A), queen trails (B), larval trails (C), and pupae (D) of the European spruce bark beetle

8.4. PLANT BREEDING

LAMMC conducts breeding programmes for the major field crops, vegetables, pomefruits, stonefruits, and berries. In 2022, the following **5** varieties were included in the National List of Plant Varieties and in the EU Common Catalogue of Varieties of Agricultural Plant Species: winter wheat 'Ekas' and 'Semba', small naked oat 'Agoda DS', common bent 'Buka', and tomato 'Alvita'.

Winter wheat EKAS

Breeders: Assoc. Prof. Dr Vytautas Ruzgas and Dr Žilvinas Liatukas.

The winter wheat variety **'Ekas'** was developed at the Institute of Agriculture, LAMMC. During 2019–2021, the mean grain yield was 8.13 t ha^{-1} in the official state variety testing. The variety is developed for growing under organic conditions due to tall plants (130–140 cm) and high resistance to common bunt. Under favourable conditions, hectolitre weight was very high 835 g L^{-1} as well as 1000 kernel weight 50–55 g. Other grain quality traits under intensive growing conditions were very high, meeting the standards of the extra plus quality class.

The variety is characterised by good winter hardiness, sufficiently resistant to the germination of grain in the ears, and resistance to lodging during intensive cultivation. It belongs to the group of late varieties. The variety is moderately resistant to diseases of the leaves, ears, and root rots.

Recommended sowing time – in the second half of September. In productive soils, moderately intensive fertilisation and intensive use of pesticides are recommended.

Winter wheat SEMBA

Breeders: Assoc. Prof. Dr Vytautas Ruzgas and Dr Žilvinas Liatukas.

The winter wheat variety **'Semba'** was developed at the Institute of Agriculture, LAMMC. During 2019–2021, the mean grain yield was 8.95 t ha^{-1} in the official state variety testing. Under intensive cultivation, grain quality traits correspond to E or 1st grain quality class standards. Hectolitre weight was high – 787 g L^{-1}, 1000 kernel weight was small – 41 g. The mean protein content was 12.7%, sedimentation 43.6 ml, gluten 24.7%, and hectolitre weight 787 g L^{-1}. Other qualitative indicators of grains exceeded many varieties of the research period. The variety has a very good winter hardiness, plants of medium height (avg. 92.4 cm), resistant to lodging (avg. 8.2 points), moderately resistant to germination of grains in ears. The variety is moderately resistant to leaf spots, ears Fusarium and root rot, resistant to powdery mildew and brown rust.

Recommended sowing time in the second half of September. In productive soils, moderately intensive use of fertilisers and pesticides is recommended.

Small naked oat AGODA DS

Breeders: Dr Vida Danytė and Dr Andrii Gorash.

The oat variety **'Agoda DS'** was developed at the Institute of Agriculture, LAMMC. The variety was registered in 2022. In 2020, the highest yield was 7.14 t ha^{-1} at Kaunas PVTS (Plant Variety Testing Station). At Plungė, Kaunas and Kaišiadorys PVTS average yield was 5.20 t ha^{-1}. The average plant height was 101.1 cm (similar to the standard variety 'Milija DS', 100.5 cm). In 2020–2021, vegetative period lasts on average 78 days. The length of the vegetative period is similar to the standard variety. 'Agoda DS' has good resistance to logging – in 2020, the logging was evaluated by 7.7 points; it was 1.9 points better comparing with the standard variety. In 2021, tested variety resistance to login was evaluated by 9 points. Grain contains on average16.5% of proteins and 6.6% of fat. The average hectolitre weight was 635 g L^{-1} (60 g L^{-1} higher compared with the average standard variety). The highest hectolitre weight was 677 g L^{-1} at Plungė PVTS in 2020. The average of 1000 kernel weight was 26.0 g, husk content was 3.3%. The variety is resistant to downy mildew, crown rust and moderately resistant to dreschlera.

Common bent BUKA

Breeders: Dr Vaclovas Stukonis, Dr Vilma Kemešytė, and Dr Eglė Norkevičienė.


©Eglė Norkevičienė

The common bent (*Agrostis capillaris* L.) variety **'Buka'** was developed at the Institute of Agriculture, LAMMC and is intended for the lawn mixtures and distinguished as one of the most suitable grasses for landscaping. The variety was created by mass selection from a wild population collected in the Ignalina district. It is a relatively late flowering, dwarf variety characterised by medium wide leaves tolerating low-height mowing. The variety is winter hardy and sufficiently resistant to adverse climatic conditions as well.

Tomato ALVITA

Breeder Dr Audrius Radzevičius


©Audrius Radzevičius


©Audrius Radzevičius

'Alvita' is a medium-late indeterminate variety of tomato (*Solanum lycopersicum* L.), developed at the Institute of Horticulture, LAMMC. Fully ripened fruits are a nice red colour, have a little flat shape with smooth skin and have four or five seed sockets. The average weight of one tomato fruit is about 100–120 g. Tomato plants are resistant to fungal diseases and suitable for growing in heated and not-heated polyethylene greenhouses. Depending on the growing year conditions, the average yield is around 20.0 ± 1 kg m^{-2}.


©Juozas Lanauskas

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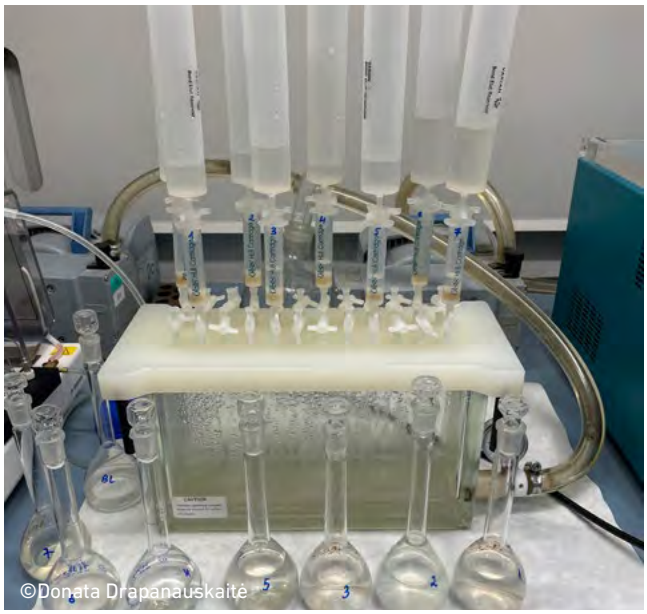
9. SCIENTIFIC INTERNSHIPS

Jaume I University, Spain

▲ Dr D. Drapanauskaitė (second from right) with the LARP scientists

February 7 – March 4. Dr Donata Drapanauskaitė, a senior researcher at the Agrobiology Laboratory of the Institute of Agriculture, did an internship at the Research Institute for Pesticides and Water, Jaume I University, Castellon de la Plana, Spain. The **title** of the internship – "Determination of pharmaceutical and pesticide residues in wastewater using liquid chromatography with a mass detector". The **aim** – to determine the concentrations of pesticides and pharmaceutical residues in influent wastewater using UPLC-MS/MS.

During the internship, the researcher deepened her theoretical knowledge and practical skills in the field of mass spectrometry. Dr Drapanauskaitėanalysis methods and the method for wastewater samples preparation for the purpose of determining residues of pesticides and pharmaceuticals using UPLC-MS/MS. During the internship, samples of 5 influent wastewaters from five different locations of Lithuania (Panevėžys, Pasvalys, Kėdainiai, Raseiniai, and Šiauliai) were analysed.



▲ Preparation of wastewater samples for analysis

In all of them, the residues of pharmaceuticals such as Naproxen, Ketoprofen, and Diclofenac were detected. In the larger cities like Panevėžys and Šiauliai, a greater number of adifferent types of pharmaceutical residues were detected compared to Raseiniai, Kėdainiai and Pasvalys. Only few pesticide residues (Thiabendazole and Propamocarb) were detected in influent wastewater, and not in all locations sampled.

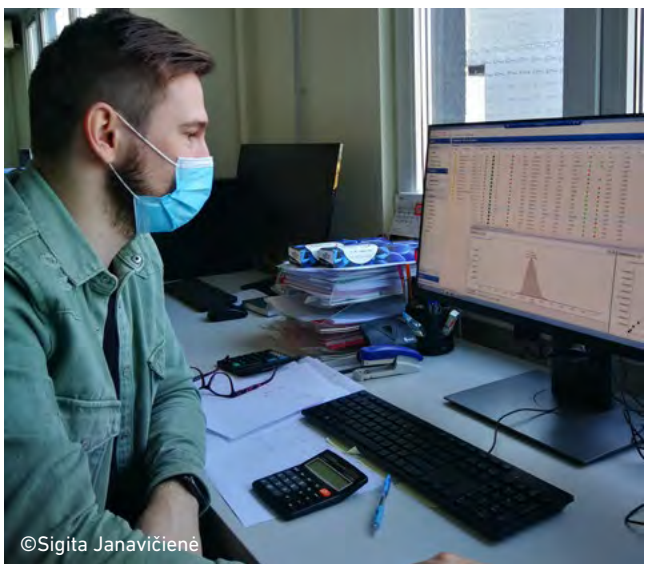
The internship was financed by the LAMMC support fund for academic internships.

Institute of Food Safety, Animal Health and Environment (BIOR), Latvia

March 1–15. Eimantas Venslovas, a PhD student and a junior researcher at the Department of Plant Pathology and Protection of the Institute of Agriculture, did an internship at the Institute of Food Safety, Animal Health and Environment (BIOR), Riga, Latvia.

The **title** of the internship – "Mycotoxins determination in barley with high performance liquid chromatography – mass spectrometry". The **aim** – to gain experience with different mass spectrometry technologies (QqQ, Orbitrap, TOF, etc.) in liquid chromatography and to broaden the spectrum of mycotoxins investigated in the the doctoral dissertation work by analysing the barley samples that were brought.

Examination of the samples with a high-performance liquid chromatography system combined with mass spectrometry, which allowed the simultaneous determination



▲ Working with the software Thermo TraceFinder EFSLC: evaluation of the chromatograms obtained during the analyses

of a wider spectrum of mycotoxins. During the internship, spring barley grains were analysed for thirteen mycotoxin concentrations. The scientist learned about different methods of standard and samples preparation for analysis, optimisation of liquid chromatography coupled to mass spectrometry methods for quantitative and qualitative determination of mycotoxins in different matrices, learned and mastered the basics of the Thermo TraceFinder EFSLC computer program and upgraded his qualifications as a scientist in the field of chromatography.

The internship was financed by the LAMMC support fund for academic internships.

Institute of Plant Physiology and Genetics, Bulgary

▲ Moment from the internship

March 28 – April 15. Martynas Urbutis, a PhD student at the Laboratory of Plant Physiology of the Institute of Horticulture, did an internship at the Institute of Plant Physiology and Genetics, Bulgary.

The **title** of the internship – "Physiological and molecular mechanisms of phytohormones-mediated drought stress tolerance". The **aim** of the project trip – to gain new knowledge about the basis of plant phytohormones' effects acting as regulators on morphology, metabolic, enzymatic activity, and nutrient uptake during drought stress.

The internship was financed from a project of Lithuanian-Bulgarian Academies of Sciences.

Vienna University of Natural Resources and Life Sciences (BOKU), Austria

▲ Experiment on the control of fungal diseases with plant extracts on tomatoes

April 6 – May 30. Dr Lina Dėnė, a researcher at the Laboratory of Plant Protection of the Institute of Horticulture, did an internship at BOKU.

The **title** of the internship – "Control of fungal diseases with plant extracts and determination of qualitative parameters of extracts". The **aim** – in the greenhouses of the Plant Protection Institute, is to conduct experiments on fungal disease control with plant extracts with tomatoes and collect samples for further biochemical analyses.

During the internship in BOKU, experiments with the control of fungal diseases with plant extracts were conducted with tomatoes in the Plant Protection Institute's greenhouse, moreover, samples for further biochemical analysis were collected.

The obtained data on the possibilities of fusariosis control of tomatoes with plant extracts will be used for further experiments. Meanwhile, in VetMedUni gas chromatography, various analyses of plant extracts and essential oils were performed. The researcher gained experience with the methods of qualitative and quantitative analysis of plant extracts and essential oils, preparation of samples, the differences between the identification of volatile compounds in CO2 extracts and essential oils. The main volatile compounds in essential oils and extracts were determined. During the internship, contacts were established with scientists in the fields of alternative plant protection and the identification of volatile compounds in plants and their extracts.

The internship was financed by the LAMMC support fund for academic internships.

▲ Vienna University of Natural Resources and Life Sciences (BOKU)

April 6 – May 30. Simona Chrapačienė, a PhD student at the Laboratory of Plant Protection of the Institute of Horticulture, had an internship on the **topic** "Molecular identification of pathogenic fungi from horticultural plants" at the Vienna University of Natural Resources and Life Sciences (BOKU), Tulln, Austria.

The **aim** of the internship was to gain experience in molecular diagnostic methods used to identify pathogenic fungi isolated from vegetables. PhD student was supervised by head of BOKU Institute of Plant Protection Prof. Dr Siegrid Steinkellner.

During the internship, theoretical and practical knowledge in the molecular identification of microscopic fungi was deepened, and the selection of reagents and PCR reaction conditions according to the analysed pathogen

were learned. The collected data on the identified isolates of different fungal pathogenic species brought from Lithuania will be used in further studies of their prevalence and development in vegetables and will significantly complement the PhD thesis.

The internship was financed by the LAMMC support fund for academic internships.

Institute of Natural Sciences (LUKE), Finland

▲ Internship at the Institute of Life Sciences (LUKE), Finland

April 22 – May 7. Dovilė Gustienė, a PhD student at the Department of Silviculture and Ecology of the Institute of Forestry, had an internship at the Institute of Natural Sciences (LUKE), Finland. The **title** of the internship – "New methods of data collection, analysis and innovative instrumentation in forest green cover, litter and soil research". The **aim** was to gain new knowledge in conducting research on ground vegetation, forest floor and soil, to acquire skills in new methodologies, and the use of innovative devices.

During the internship, there were visits to the laboratories of the institute; the studies on ground vegetation, roots and mycorrhisa conducted there were introduced. In the Suonenjoki unit, there was an opportunity to carry out some activities in the assessment of the negative effects of climate change on vegetation. During the internship, practical experience in conducting seedling stress monitoring, work with Dualex Leaf clio Sensor, Pocket fluorometer PSI FluorPen FP100 and other devices were gained; practical skills in applying NMDF analysis to vegetation data were improved.

The internship was financed from Dovilė Gustienė's doctoral fund.

April 22 – June 7. Dr Valda Gudynaitė-Franckevičienė, a junior project researcher of the Institute of Forestry, deepened her professional knowledge in Joensuu unit Natural Resources, Natural Resources Institute Finland (Luke).

The **title** of the internship – "New methods of ecogenetic and ecophysiological research in plants". The **aim** was under the leadership of Dr Timo Domisch, scientific researcher from the Natural Resources Institute to learn new methodologies for studying the ecogenetic and ecophysiological response of plants to various stressors, evaluating their role in short- and long-term adaptation to the effects of climate change.

The research was funded by the European Social Fund under the auspices of "Development of Competences of Scientists, other Researchers and Students through Practical Research Activities" (project No. 09.3.3-LMT-K-712).

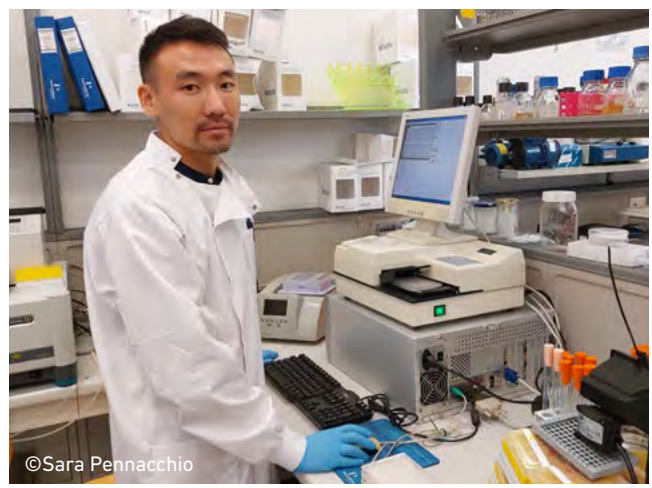
▲ Dr Valda Gudynaitė-Franckevičienė in Koli National Park, Finland

Florence University, Italy

May 1 – June 29. Arman Shamshitov, a PhD student at the Microbiology Laboratory of the Institute of Agriculture, had an internship at the Genexpress Laboratory, Department of Agriculture, Food, Environment and Forestry (DAGRI), Florence University (Italy).

The **title** of the internship – "Molecular identification and characterisation of cellulolytic bacteria isolated from the soil of cereal-based cropping system". The **aim** was to perform molecular identification of 64 bacterial isolates, master and perform sequence data analysis of all soil bacterial isolates as well as phenotypic characterisation of bacterial strains using ten different carbon sources. After receiving the results of all the experiments, a statistical analysis of the data and the phylogenetic tree and heat map required for the manuscript were performed.

The internship was financed by the LAMMC support fund for academic internships.



▲ Internship of PhD student Arman Shamshitov at the University of Florence, Italy

Norwegian Institute of Bioeconomy Research (NIBIO), Norway

May 1–25. Ieva Čėsnienė, a PhD student and a junior researcher at the Laboratory of Forest Plant Biotechnology of the Institute of Forestry, had an internship at Norwegian Institute of Bioeconomy Research (NIBIO).

The **title** of the internship – "Effects of defence priming on Norway spruce needle microbiome and pest resistance". The **aim** was to affect tree seeds with chemical compounds, in order to increase Norway spruce resistance for pests. It was performed seeds treatment with chemical stressors (methyl jasmonate, pipecolic acid). Moreover, the seeds were planted in different types of soils (sterile, inoculated with *Amphinema* fungal, and forest soil).

Funded by SNS project PROTECT No. 131 and LAMMC support fund for academic internships.

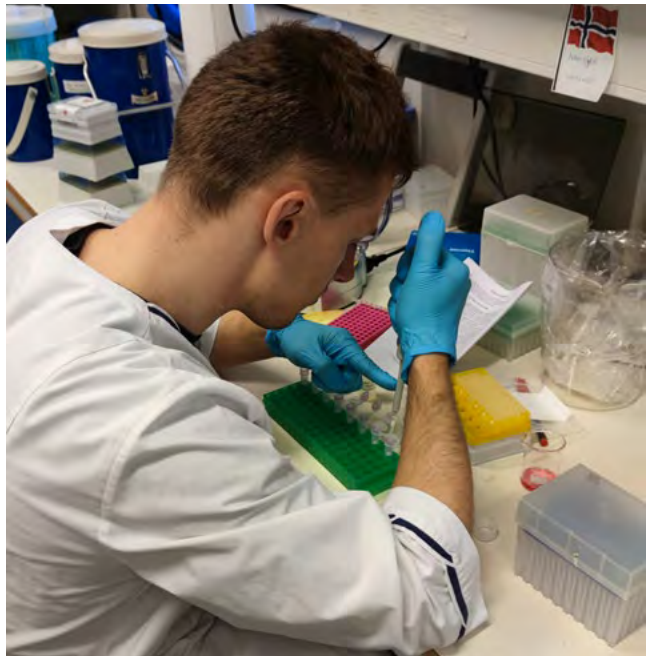
▲ Sowing seeds in prepared soils of different soil types

May 1–25. Vytautas Čėsna, a PhD student at the Department of Forest Protection and Game Management of the Institute of Forestry, had an internship at the Norwegian Institute of Bioeconomy Research (NIBIO), Ås, Norway.

The **title** of the internship – "Defence priming" as a mechanism behind induced resistance". The **aim** was to learn "defence priming" as a mechanism behind induced resistance.

During the internship, high potential plant defence mechanism "defence priming" was conducted. Norway spruce seeds were affected by chemicals, such as methyl jasmonate, β-aminobutyric, hexanoic, and pipecolic acids. It was planted affected tree seeds both in Petri dishes using *in vitro* screening, and in cones with three different soil types. The forest soil was sterilised using a new steam technology (https://soilsteam.com/). Moreover, using DNA extraction, it was identified pathogenic fungal species and evaluated quality of soil steaming.

Funded by SNS project PROTECT No. 131 and LAMMC support for in-service training sessions.



▲ DNA extraction from soil samples by modified CTAB method

University of Padua, Italy

▲ Internship of Dr Viktorija Vaštakaitė-Kairienė at the University of Padua, Italy

May 1 – June 30. Dr Viktorija Vaštakaitė-Kairienė, a senior researcher at the Plant Physiology Laboratory, Institute of Horticulture, had an internship at the Department of Agronomy, Food, Natural Resources, Animals and Environment of the University of Padua, Italy.

The **title** of the internship – "Dr Viktorija Vaštakaitė-Kairienė internship at the University of Padua in Italy". The **aim** of research work – "Effects of oxidative stress conditions caused by ultraviolet radiation on plants" in collaboration with Prof. Antonio Masi and other university researchers.

The researcher performed vegetative experiments with different genotypes of alfalfa plants, deepened practical knowledge in modern biochemical analysis methods using chromatography with mass detection equipment, and prepared research methodologies for experiments with other plants. Contributions have been made to the research conducted in the Department, during which the influence of perfluoroalkyl and polyfluoroalkyl substances, which contaminate underground and surface

water and soil, on the growth, photosynthetic response, and chemical composition of plants was evaluated. After the internship, the researcher will continue cooperation by conducting part of the research in Lithuania and preparing publications and international projects.

The internship was financed from the LAMMC support fund for academic internships.

University of Turin, Italy

May 18–31. Samar Swify, a PhD student at the Agrobioly Laboratory of the Institute of Agriculture, had an internship "Scientific Exchanges about Mineral Nitrogen Fertilizers Used Under Different Soil Types and Maize Cultivation" at the University of Turin, Italy.

In the context of the European Joint Programme "Towards climate-smart sustainable management of agricultural soils". S. Swify got invited as a PhD student to visit the platform of Tetto Frati, University of Turin, Italy by Associate Prof. Laura Zavattaro (Department of Veterinary Sciences – environmental agronomy unit) the scientific supervisor of the Tetto Frati platform. The visit was dedicated to scientific exchanges about mineral nitrogen fertilisers used under different soil types and Maize cultivation. On a final note, the visit benefits strengthened future cooperation in my research work about using mineral nitrogen fertilisers with one of the PhD students in the Agriculture Department at Turin University. As well, enhanced the cooperation to do future work between LAMMC and colleagues at the Turin University.

▲ PhD student Samar Swify and colleagues at the University of Turin, Italy

Swedish University of Agricultural Sciences (SLU), Sweden

July 9 – August 11. Dr Adas Marčiulynas, a senior researcher at the Department of Forest Protection and Game Management of the Institute of Forestry, had an internship at the Department of Forest Mycology and Plant Pathology, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden.

The **title** of the internship – "Counteracting decline in biodiversity hotspots: conservations ecology and management of wood-inhabiting fungi of oak habitats". The **aim** was to carry out research related to the implementation of the project, to deepen knowledge, and to develop international cooperation.

During the internship, propagation of *Fistulina hepatica* pure fungi cultures grown in Lithuania and somatic compatibility tests were conducted, using new methods of working with fungi cultures. Different fungi individuals identified during the internship were prepared for further DNA genotyping and data analysis. During the internship, new fungi cultivation and molecular methods were used, which helped to acquire new molecular biology skills and strengthen professional development.

The internship was implemented as part of the project (No. 09.3.3-LMT-K-712-23-0029), which was co-financed by the European Social Fund under the grant agreement with the Lithuanian Science Council (LMTLT).

▲ Sample collection for fungal diversity studies in Sweden

University of Tartu, Estonia

July 31 – August 7. Valeriia Mishcherikova, a PhD student at the Department of Forest Protection and Game Management of the Institute of Forestry, had an internship in Tartu, Estonia.

The **title** of the internship – "Tartu International Summer University course: Metabarcoding: from Lab to Bioinformatics". The **aim** was to acquire knowledge and understand methods of bioinformatics and sequence analysis.

Main result: processed large-scale dissertation data using PipeCraft 2.

▲ Sampling for sequencing

Federal Department of Economic Affairs, Education and Research (Agroscope), Switzerland

September 18 – October 5. Dr Agnė Veršulienė, researcher at the Department of Soil and Crop Management of the Institute of Agriculture, had an internship at the Research Division Agroecology and Environment of the Federal

Department of Economic Affairs, Education and Research (Agroscope), Zürich, Switzerland.

The **title** of the internship – "A study of mycorrhizal colonisation in different genotypes of winter wheat". The **main aim** – to master the methods for determination mycorrhizal colonization in different genotypes of winter wheat root (which was evaluated within the framework of the EJP Soil project "Optimizing roots for sustainable crop production in Europe – pure cultures and cover crops" (MaxRoot-C).

During the internship, I delved into the methods and methodology for the determination of mycorrhizal colonization of plant roots as well as in quantification and calculation of the intensity of mycorrhizal colonies in winter wheat roots (120 samples collected from Switzerland, Germany, France, and Lithuania). In internship I, had the opportunity to exchange knowledge on automated root washing and root scanning methods (using the software RhizoVisionExplorer) also the quantification of root system architecture traits. I visited long-term field experiments of Agroscope and laboratory of soil physics.

The internship was financed from the LAMMC support fund for academic internships.

▲ Dr Agnė Veršulienė and Juliane Hirte analysing the intensity of mycorrhizal colonisation in winter wheat roots

New Mexico State University, USA

October 4, 2022 – January 10, 2023. Muhammad Ayaz, a PhD student at the Department of Plant Nutrition and Agroecology of the Institute of Agriculture, had an internship at the College of Engineering Department of Chemical and Materials Engineering, New Mexico State University, in the United States.

The experimental design consists of two soils (sandy loam, clay loam), three biochar treatments (no biochar, manure biochar, wood biochar), and four metals addition treatments (water only, micronutrient addition, heavy metal addition, and micronutrient + heavy metal addition) with 4 replicates each = 2 × 3 × 4 × 4 = 96. Each jar will contain 100 g dried/sieved soil, 5 g biochar (if adding), and 8 ml solution (to approximate a ~16 wt.% soil moisture content, one would add 4 ml of the micronutrient or heavy metal solution with any remaining being a water addition). Jars would be weighed after assembly and water added to maintain the weight ~once a week during the incubation.

The internship was financed from the LAMMC support fund for academic internships.

▲ Internship of PhD student Muhammad Ayaz at the New Mexico State University, USA

Catholic University of Portugal, Centre of Biotechnology and Fine Chemistry (CBQF)

▲ Preparing for the study of prebiotic potential

September 15 – December 15. Viktorija Puzerytė, a PhD student at the Laboratory of Biochemistry and Technology of the Institute of Horticulture, had a research

internship at the Centre of Biotechnology and Fine Chemistry (CBQF), Catholic University of Portugal.

The **title** of the internship – "Determination of prebiotic activity in plant fermented extracts". The **aim** was to investigate the influence of the parameters of fermented plant materials on the prebiotic potential on plant extracts selected by different fermentation technologies.

Prebiotic potential studies were performed using selected probiotic strains of *Bifidobacterium* and *Lactobacillus*. To monitor metabolic processes, high-performance liquid chromatography (HPLC) methods were used. The active components (sugars, organic acids, phenolic compounds, etc.) were evaluated quantitatively and qualitatively. The obtained data were processed using special-purpose programmes adapted to analyse biologically active components. The scientific research data obtained during the internship will significantly expand the doctoral dissertationand will have an impact on the evaluation of the use of selected extracts of fermented plants in the functional food, cosmetic, and/or pharmaceutical industries.

The internship was financed with support from the Lithuanian Science Council for academic visits and LAMMC support fund for academic internships.

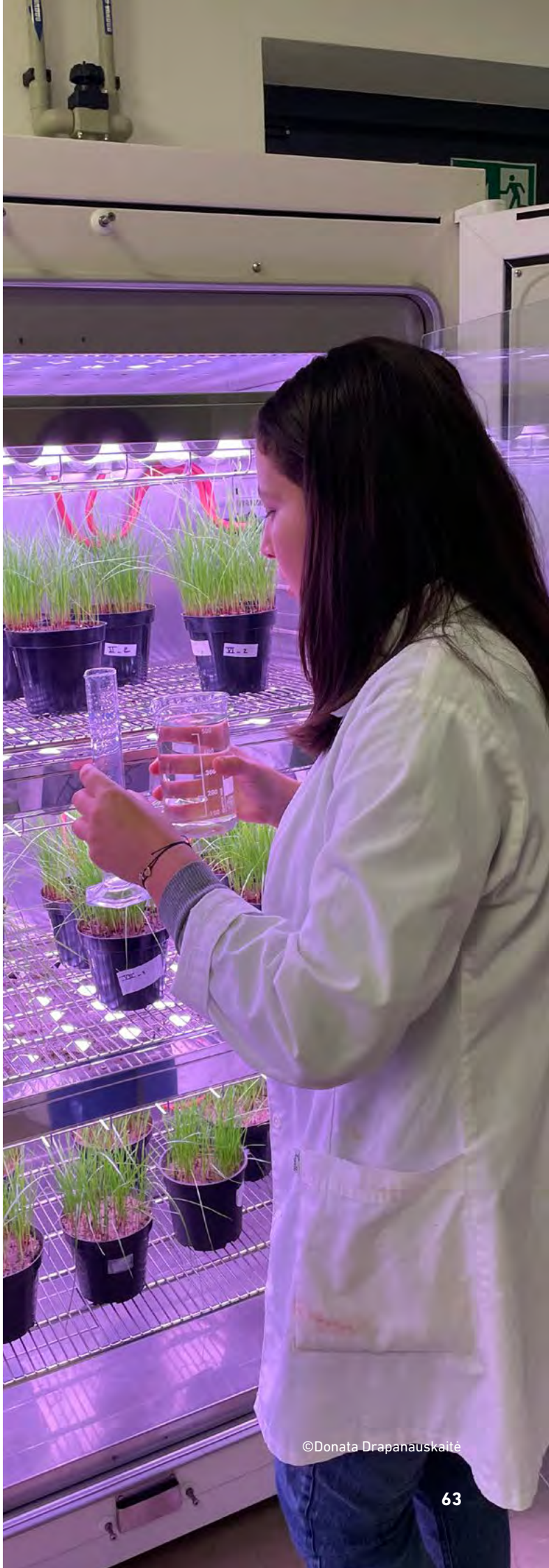
Institute of Agrophysics of the Polish Academy of Sciences, Poland

November 6–18. Agnė Buivydienė, a PhD student at the Department of Soil and Crop Management of the Institute of Agriculture, did an internship at the Institute of Agrophysics of the Polish Academy of Sciences in Lublin, Poland.

The **aim** of the internship – to master soil environmental research using gas chromatography (methane emission and oxidation and CO_2 emission from soil) and measurement of soil dehydrogenase activity. Soil environmental studies using gas chromatography and measurements of soil dehydrogenase activity. PhD student needed to master and perform measurements using gas chromatography (methane emission and oxidation and CO_2 emission from soil), to determine soil dehydrogenase activity. Get to know the soil environment research conducted at the institute, the application of molecular biology methods in the study of soil microorganisms.

Funded by LAMMC PhD fund.

▲ PhD student Agnė Buivydienė at the Institute of Agrophysics, Polish Academy of Sciences



10. RECOGNITION OF RESEARCH ACTIVITIES

In 2022, scientists and PhD students of LAMMC actively participated in research activities and did not go unnoticed: they were awarded with letters of appreciation and certificates of merit and became winners of competitions and recipients of scholarships.

Officer's Cross of the Order of the Lithuanian Grand Duke Gediminas

On February 16, the President of the Republic of Lithuania Gitanas Nausėda presented the state awards for merits to Lithuania and for its promotion in the world. The Officer's Cross of the Order of the Lithuanian Grand Duke Gediminas was awarded to Assoc. Prof. Dr **Vytautas Ruzgas**, a full member of the Lithuanian Academy of Sciences, chief researcher of the Cereal Breeding Department at the Institute of Agriculture of the Lithuanian Research Centre for Agriculture and Forestry.

Knight's Cross of the Order of the Lithuanian Grand Duke Gediminas

On the occasion of the State Day (Coronation of King Mindaugas of Lithuania) and the Day of the National Anthem, Prof. Dr habil. **Antanas Svirskis**, a long-time researcher of the Institute of Agriculture, plant and seed breeder, researcher of non-traditional plant varieties and ecological agriculture, was awarded the Knight's Cross of the Order of the Lithuanian Grand Duke Gediminas.

Member of the Young Academy of Lithuanian Academy of Sciences

In December, new members of the Young Academy of Sciences of the Lithuanian Academy of Sciences were elected, including Dr **Neringa Rasiukevičiūtė**.

Prizes and Certificates of Merit

On February 15, 2022, the Presidium of the Lithuanian Academy of Sciences (LAS) awarded prizes and letters of commendation to undergraduate and graduate students, doctoral students, and young scientists.

In the 2021 Young Scientists and Doctoral Students competition, a prize was awarded to a female scientist from LAMMC:

- Dr **Kristina Laužikė** for her scientific work "Optimisation of the biological potential of apple trees by agrotechnological means" (scientific supervisor Dr Giedrė Samuolienė, scientific advisor Dr Nobertas Uselis);
- Dr **Yulia Kochiieru** for the scientific work "Mycotoxins in spring cereals and their effect on the quality of grain products" (scientific supervisor Dr Audronė Mankevičienė, scientific advisor Dr Jurgita Cesevičienė).

The winner of the LAS 2021 Higher Education Students' Research Contest was a Master's student who carried out her research at LAMMC:

- PhD student **Greta Striganavičiūtė** for her research work "The influence of *in vitro* culture of aspen on the interaction with symbiotic bacteria on the formation of antipathogenic resistance in this tree" (supervisor Dr Vaida Sirgedaitė-Šėžienė).

Scholarships

The winners of the World Federation of Scientists Scholarship Competition – LAMMC scientists, will receive a scholarship in 2022–2023:

- Dr **Viktorija Vaštakaitė-Kairienė** (food area), topic "Lighting strategies for improved shelf-life of leafy vegetables" (supervisor Dr Giedrė Samuolienė);
- Dr **Karolina Barčauskaitė** (soil area), topic "Sustainable cropping of industrial hemp and their chemical composition antioxidant and antibacterial activity investigations" (supervisor Dr Vita Tilvikienė);
- Dr **Monika Toleikienė** (soil area), topic "The evaluation of decomposition of soybean residue and its effect on soil quality and soil biodiversity" (supervisor Dr Žydrė Kadžiulienė).

On June 21, 2022, the Presidium of the Lithuanian Academy of Sciences awarded 15 scholarships to the best young scientists in the humanities, social sciences, physical sciences, biomedicine, technology, and agriculture. Grants in the field of agricultural sciences were awarded to the scientists at LAMMC:

- Dr **Lina Dėnė**; conducting research on the topic "Studies on the inhibition of pathogens in garden and horticultural plants by plant extracts";
- Dr **Kristina Laužikė**; conducting research on the topic "Effect of agrotechnical measures on changes in the chemical composition of apples during storage";
- Dr **Monika Toleikienė**; research topic "Research on adaptability and productivity of non-traditional cultivars in Lithuanian climatic conditions".

Additional scholarships for 2022 have been awarded to LAMMC PhD students **Urtė Stulpinaitė** and **Aušra Bakšinskaitė** by the Order of the Chairman of the Research Council of Lithuania of 21 July 2022.

▲ Assoc. Prof. Dr Vytautas Ruzgas and the President of the Republic of Lithuania Gitanas Nausėda

▲ Prof. Dr habil. Antanas Svirskis and the President of the Republic of Lithuania Gitanas Nausėda

▲ Dr Yuliia Kochiieru, PhD student Greta Striganavičiūtė and Dr Kristina Laužikė

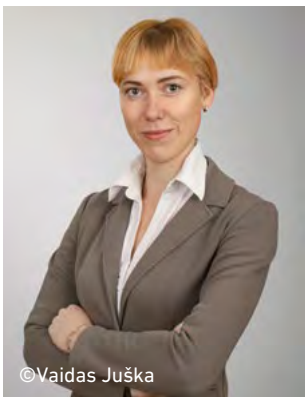
▲ Dr Neringa Rasiukevičiūtė

▲ Dr Viktorija Vaštakaitė-Kairienė

▲ Dr Karolina Barčauskaitė

▲ Dr Monika Toleikienė

▲ Dr Lina Dėnė



▲ Dr Kristina Laužikė

▲ PhD student Urtė Stulpinaitė

▲ PhD student Aušra Bakšinskaitė

11. DISSEMINATION OF SCIENTIFIC KNOWLEDGE

In 2022, LAMMC organised international and national events: conferences, seminars, training, and field days, both contact and remotely.

The international conference **"Traditional and novel tasks for plant breeding"**, dedicated to the 100th anniversary of plant breeding in Lithuania, attracted the attention of the scientific community of the plant breeding. Scientists reviewed the development of plant breeding in the Baltic States, analysed the resistance of wheat varieties of the North and Western Baltic States to diseases and pests and discussed other topics of ongoing research. In addition, LAMMC scientists presented breeding programmes in the vegetation of winter and spring wheat, spring barley, oats, peas, beans, mistletoe, and lawn grasses.

Also, of great interest to the academic community and the wider public was **"Agrovizija"** – the exhibition of agricultural technologies and innovations, which for the thirteenth time has brought together everyone who seeks and helps smart and efficient farming. The discussion forum "More with Less" on 29 June focused on the implementation of the EU Green Deal strategy, the responsible use of resources, the conservation of soil and biodiversity, and other topics of current interest to farmers in the country.

Not only events were organised, but also publications were prepared for the scientific and general public.

11.1. INTERNATIONAL CONFERENCES, SEMINARS, AND WORKSHOPS

In 2022, **4** international conferences, international Forest Genetic Monitoring Training School, **3** international seminars were organised. The most important international events are listed below.

May 24–27.
International Conference CYSENI 2022 (Conference of Young Scientists on Energy and Natural Sciences Issues). Organisers: Lithuanian Energy Institute, LAMMC, Center for Physical Sciences and Technology.

June 3.
5th **International Symposium of Soil Physics** interested researchers from Poland, Lithuania, Latvia, Hungary, Colombia. Organisers: Lithuanian Soil Science Society, Lithuanian Agricultural Advisory Service, LAMMC, Agronomy Faculty of VMU Agriculture Academy.

September 7–9.
Seminar of the international project **"Baltic Phytoremediation" (BAPR)** at Vėžaičiai Branch, Institute of Agriculture. Organisers: Klaipėda University, LAMMC.

June 8–9.
The **International Conference "Traditional and novel tasks for plant breeding" dedicated to the 100th anniversary of plant breeding in Lithuania**, where close to 150 participants from Latvia, Estonia, Norway, Sweden, and Lithuania took part in this event. Organisers: Lithuanian Academy of Sciences, LAMMC.

September 26–28.
3rd **International Conference "Scientific Actualities and Innovations in Horticulture 2022" (SAIH2022)**. Organisers: Lithuanian Academy of Sciences, LAMMC.

July 5–7.
The **Forest Genetic Monitoring Training School** was held at the Institute of Forestry, LAMMC. This Training School was funded by COST activity CA18201 ConservePlants.

11.2. NATIONAL CONFERENCES, SEMINARS, AND OTHER EVENTS

In 2022, **4** national conferences, exhibition **"Agrovizija"**, **3** national seminars, **2** public lectures, scientific afternoon-discussion were organised. The main national events of 2022 are given below.

There was active participation in team-building initiatives.

On April 8, LAMMC administrative staff, long-term programme managers, the founder of the Untouchable Forest Support Fund Remigijus Lapinskas, representatives of the organisation **"Plant a Tree"** and the company "AstraZeneca Lietuva" participated in the forest planting.

The **"Let's Work Together"** event on May 19 brought together 300 LAMMC employees.

On November 9, a donation was made to a family fleeing the war in Ukraine at the **"Cake Day"** event.

Other institutions also took an active part in the events organised by the LAMMC. LAMMC participated in the botanical summer festival **"Scents Night/2022"** held in the Botanical Garden of Vytautas Magnus University (VMU), where the Head of the Department of Forest Resources, Economics and Policy of the Institute of Forestry, Dr Benas Šilinskas presented a non-destructive study to determine the condition of trees, and Dr Paulina Martusevičė talked about increasing the biological value of fruits and berries using fermentation.

Dr Lina Dėnė, researcher at the Institute of Horticulture, LAMMC and PhD student Simona Chrapačienė participated in the annual science festival **"Spaceship Earth"**. Schoolchildren and students were introduced to how to distinguish microscopic fungi invisible to the naked eye from garden and garden products, show symptoms of fungal infection and a variety of microscopic fungi.

LAMMC scientists delivered presentations at the exhibition **"Choose a Lithuanian Product"**, and the companies of the "National Food Farm Cluster" presented innovative food products developed in cooperation with the Biochemistry and Technology Laboratory, Institute of Horticulture, LAMMC.

The following are the highlights of the national events.

March 7.

Webinar "Grasslands with varying longevity: their establishment and use for forage diversification", aimed at beef and dairy farmers, attracted over 70 participants.

March 24.

LAMMC organised a **scientific report conference "Agrarian and Forestry Sciences: Recent Research Results and Innovative Solutions"** discussed sustainable solutions in agriculture and forestry.

May 11.

Remote seminar on "IPM solutions to enhance crop protection against pests" focused on Integrated Pest Management (IPM) and introduced the Decision Support Systems (DSS) platform.

September 29.

Scientific conference "Quo vaditis, silvae?" was organised to commemorate the centenary of university forestry studies and the origins of forest science in Lithuania, as well as to discuss the prospects of forest science and the forest sector. Organisers: Lithuanian Academy of Sciences, Ministry of Environment of the Republic of Lithuania, Vytautas Magnus University, Institute of Forestry of LAMMC.

December 9.

Conference "Joint European Soil Programme (EJP SOIL) – Allows More Soil Research". Organisers: Lithuanian Research Centre for Agriculture and Forestry, Lithuanian Academy of Sciences, Lithuanian Soil Science Society.

May 13.

Conference "Current Issues and Solutions in the Science of Horticulture" at the LAMMC Institute of Horticulture and the Garden Flowering Festival focused on the issue of food quality and quantity assurance, which is particularly topical nowadays.

June 29 – July 1.

"Agrovizija 2022", the 13th **exhibition of agricultural technologies and innovations** in Lithuania, invited farmers, agricultural specialists, and business consultants – all those who seek and help to farm in an advanced and efficient way. Organisers: LAMMC, Lithuanian Plant Protection Association (since 2023 CropLife Lietuva).

11.3. PUBLICATIONS

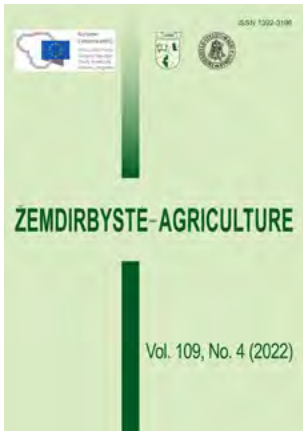
Together with partners, LAMMC publishes the following scientific journals: **Zemdirbyste-Agriculture** (IF 2021/2022 – 1,281), **Baltic Forestry** (IF 2021/2022 – 0,686), and **Agronomy Research**.

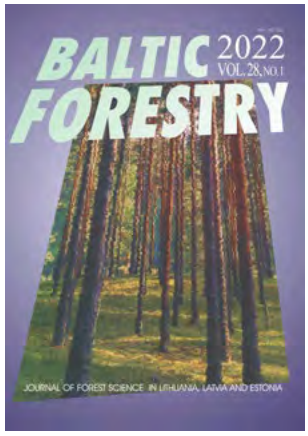
The publishing of **Zemdirbyste-Agriculture** is supported by the project "Publishing of Periodical Scientific Publications and its Coordination" of the Lithuanian Academy of Sciences, which is funded by the EU Social Fund.

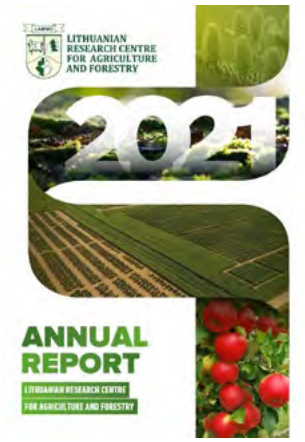
In 2022, 100th anniversary of Plant Breeding in Lithuania was celebrated. In this occasion was prepared monography The **Lithuanian Plant Breeding on Interface of Centuries**. Other publications issued in 2022: **Annual Report for 2021**, **The Latest Recommendations for Agriculture and Forestry**, Recommendations **Studies of Soil Organic Carbon (humus) in Agricultural Land**.

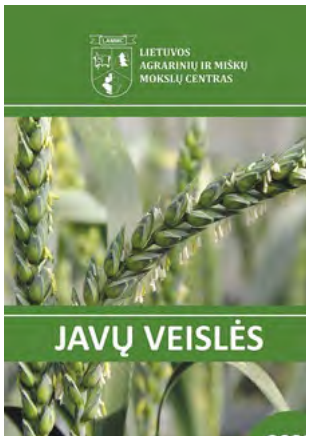
Brochures **Crop Varieties** and **Varieties of Legumes and Grasses** were published for the exhibition of agricultural technologies and innovations "Agrovizija".

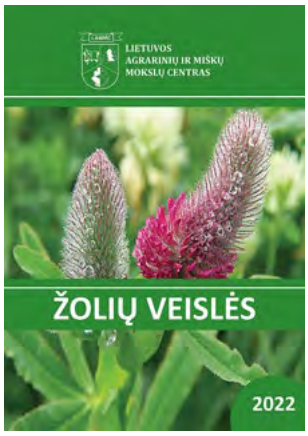
Electronic publications of the conferences abstracts' also have been prepared: plant breeding conference abstracts **Traditional and Novel Tasks for Plant Breeding, dedicated to the 100th Anniversary of Plant Breeding in Lithuania** (in English), the publication of summaries of scientific works completed in 2021 **Agrarian and Forestry Sciences: Latest Research Results and Innovative Solutions**.

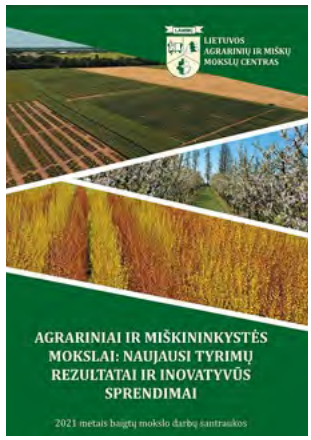










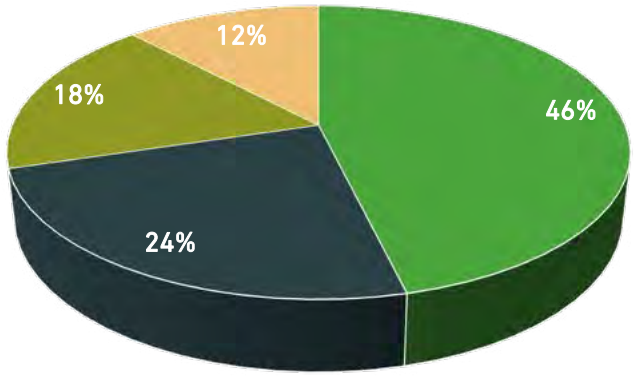


12. FUNDING

12

The financing for LAMMC's activities consists of central government funding target agreements, project financing revenues (grants and other funds received from national and international projects), funds from contract work outsourced to LAMMC by Lithuanian and foreign entities, and other operating revenues (e.g., sales of agricultural products, lease of assets) (*Figure 13*).

In 2022, LAMMC's revenue totalled 13834.5 thousand euros.



▲ *Figure 13*. **Funding amounts**

The main costs in 2022 were: wages and social security contributions (70%), goods and services (13%). The remaining expenditure was allocated to utilities and communications, business trips, transport maintenance costs, professional development, scholarships for doctoral students, royalties, and other needs.

13. APPENDICES

13.1. INTERNATIONAL PROJECTS

"Horizon Europe" projects

1. "A holistic approach to sustainable, digital EU agriculture, forestry, livestock and rural development based on reconfigurable aerial enablers and edge artificial intelligence-on-demand systems" (CHAMELEON). Coordinator in the Institute of Forestry Dr Vaida Sirgedaitė-Šėžienė. 2022–2025..
2. "The NUTRI-CHECK NETwork to maximise site-specific precision in managing the nutrition of European arable crops" (NUTRICHECK-NET). Coordinator in the Institute of Agriculture Dr Dalia Feizienė. 2022–2025.

"Horizon 2020" projects

1. "The development of methodological tool kits to evaluate selected genotypes of strawberry fruits in Lithuania" (LTtraining). Coordinator in the Institute of Horticulture Dr Neringa Rasiukevičiūtė. 2022–2024.
2. "Optimizing roots for sustainable crop production in Europe – pure cultures and cover crops" (MaxRoot-C). Coordinator in the Institute of Agriculture Dr Monika Toleikienė. 2022–2025.
3. "External organic matters for climate mitigation and soil health" (EOM4SOIL). Coordinator in the Institute of Agriculture Dr Karolina Barčauskaitė. 2022–2024.
4. "Are mixed species systems fostering belowground C inputs and C sequestration?" (MIXROOT-C). Coordinator in the Institute of Agriculture Dr Monika Toleikienė. 2022–2025.
5. "Soil Ecosystem seRvices and soil threats modElling aNd mApping" (SERENA). Coordinator in the Institute of Agriculture Dr Virginijus Feiza. 2022–2024.
6. "AGROECOlogical strategies for an efficient functioning of plant – soil biota interactions to increase SOC sequestration" (AGROECOseqC). Coordinator in the Institute of Agriculture Dr Skaidrė Supronienė. 2022–2024.
7. "Mapping and alleviating soil compaction in a climate change context" (SoilCompaC). Coordinator in the Institute of Agriculture (Vėžaičiai Branch) Dr Danutė Karčauskienė. 2022–2024.
8. "Promotion of sustainable and innovative farming based on soil organic carbon knowledges" (FairShare). Coordinator in the Institute of Agriculture (Agrochemical Research Laboratory) Dr Aistė Masevičienė. 2022.
9. "A holistic fire management ecosystem for prevention, detection and restoration of environmental disasters" (TREEADS). Coordinator in the Institute of Forestry Dr Vaida Sirgedaitė-Šėžienė. 2021–2025.
10. "Mechanisms underlying TRAde-offs between Carbon sequestration, greenhouse gas Emissions and nutrient losses in Soils under conservation agriculture in Europe" (TRACE-Soils). Coordinator in the Institute of Agriculture Dr Dalia Feizienė. 2021–2024.
11. "Stimulating novel technologies from earth remote observation to predict European soil carbon" (STEROPES). Coordinator in the Institute of Agriculture Dr Renaldas Žydelis. 2021–2024.
12. "Sensor data for downscaling digital soil maps to higher resolutions" (SensRes). Coordinator in the Institute of Agriculture Dr Renaldas Žydelis. 2021–2024.
13. "Soil organic carbon sequestration potential of agricultural soils in Europe" (CarboSeq). Coordinator in the Institute of Agriculture (Vėžaičiai Branch) Dr Ieva Mockevičienė. 2021–2024.
14. "Innovative soil management practices across Europe" (i-SoMPE). Coordinator in the Institute of Agriculture Dr Lina Šarūnaitė. 2021–2022.
15. "Stocktaking for agricultural soil quality and Ecosystem Services Indicators and their Reference values" (SIREN). Coordinator in the Institute of Agriculture Dr Dalia Feizienė. 2021–2022.
16. "Towards climate-smart and sustainable soil management" (EJP SOIL). Coordinator in the Institute of Agriculture Dr Žydrė Kadžiulienė, deputy coordinator Dr Virginijus Feiza. 2020–2024.
17. "Stepping-up IPM decision support for crop protection" (IPM Decisions). Coordinator in the Institute of Agriculture Dr Roma Semaškienė. 2019–2024.

LIFE Programme projects

1. "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt). Coordinator in the Institute of Forestry Dr Kęstutis Armolaitis. 2019–2023.
2. "Nutrient recycling circular economy model for large cities water treatment sludge and ashes to biomass to bio-energy" (NutriBiomass4LIFE). Coordinator in the Institute of Agriculture (Agrochemical Research Laboratory) Dr Lina Žičkienė. 2018–2023.

EUREKA Programme project

1. "Developing of novel symbiotic functional drink with different plant-based fractions using *Medusomyces gisevii* culture". Coordinator in the Institute of Horticulture Prof. Dr Pranas Viškelis. 2020–2023.

Baltic Research Programme projects

1. "Improving adaptability and resilience of perennial ryegrass for safe and sustainable food systems through CRISPR-Cas9 technology" (EditGrass4Food). Coordinator in the Institute of Agriculture Dr Kristina Jaškūnė. 2021–2024.
2. "Sustainable use of soil resources in the changing climate" (SUCC). Coordinators: in the Institute of Forestry Dr Kęstutis Armolaitis, in the Institute of Agriculture (Vokė Branch) Dr Jelena Ankuda. 2020–2023.
3. "NOBALwheat – breeding toolbox for sustainable food system of the NOrdic BALtic region". Leader Dr Gintaras Brazauskas. 2021–2023.

INTERREG Programme projects

1. „Nutrients cycling for sustainability" (NUTCY). Coordinator in the Institute of Agriculture (Vėžaičiai Branch) Dr Danutė Karčauskienė. 2022.
2. "Baltic Phytoremediation" (BAPR). Coordinator in the Institute of Agriculture (Vėžaičiai Branch) Dr Danutė Karčauskienė. 2019–2023.

COST Actions

1. CA20118 "Three-dimensional forest ecosystem monitoring and better understanding by terrestrial-based technologies" (3DForEcoTech). Coordinator in the Institute of Forestry Dr Povilas Žemaitis. 2021–2025.
2. CA20132 "Urban Tree Guard – Safeguarding European urban trees and forests through improved biosecurity" (UB3Guard). Coordinator in the Institute of Forestry, Management committee member and leader of WG2 "Innovations" Dr Diana Marčiulynienė. 2021–2025.
3. CA19116 "Trace metal metabolism in plants" (PLANTMETALS). Coordinators in the Institute of Agriculture Dr Karolina Barčauskaitė and Dr Renaldas Žydelis. 2020–2024.
4. CA19125 "EPIgenetic mechanisms of crop adaptation to climate change" (EPI-CATCH). Coordinator in the Institute of Agriculture Dr Kristina Jaškūnė. 2020–2024.
5. CA19128 "Pan-European network for climate adaptive forest restoration and reforestation" (PEN-CAFoRR). Coordinators in the Institute of Forestry Dr Valda Gudynaitė-Franckevičienė and Dr Alfas Pliūra. 2020–2024.
6. CA18134 "Genomic biodiversity knowledge for resilient ecosystems" (G-BIKE). Coordinators in the Institute of Forestry Dr Olgirda Belova and Prof. Dr habil. Alfas Pliūra. 2019–2023.
7. CA18111 "Genome editing in plants – a technology with transformative potential" (PlantEd). Coordinators: in the Institute of Horticulture Dr Danas Baniulis, in the Institute of Agriculture Dr Andrius Aleliūnas. 2019–2023.
8. CA18201 "An integrated approach to conservation of threatened plants for the 21st century" (CONSERVE PLANTS). Coordinators in the Institute of Forestry Dr Rita Verbylaitė and Dr Diana Lukminė. 2019–2023.

Projects of other research supporting by the European Union programmes

1. Swedish Institute (SI) project "Portfolio of technology transfer for acceleration and improvement of wheat breeding activities in Ukraine". Coordinator in the Institute of Agriculture Dr Rita Armonienė. 2022–2024.
2. ERA-NET project "Connecting sustainable agroecosystems and farming with circular bioeconomy and new technologies" (ConnectFarms). Leader in the Institute of Agriculture Dr Virmantas Povilaitis. 2022–2024.
3. Nordic Forest Research Co-operation Committee (SNS) project "PROTECT: Effects of defence priming on Norway spruce needle microbiome and pest resistance". Head of LAMMC part in the Institute of Forestry Dr Vaida Sirgedaitė-Šėžienė. 2022–2024.
4. European Institute of Innovation and Technology (EIT) project "Innovation Laboratories for Climate Actions" (ILCA). Coordinator in the Institute of Forestry Dr Diana Lukminė. 2022–2023.
5. Nordic Forest Research Co-operation Committee (SNS) project "Development of ash reproductive material for forestry and nature conservation". Coordinator in the Institute of Forestry Dr Diana Marčiulynienė. 2022–2024.
6. SNS (Nordic Forest Research Co-operation Committee) project "Biochar in forestry". Coordinator in the Institute of Forestry Dr Iveta Varnagirytė-Kabašinskienė. 2022.
7. European Food Safety Authority (EFSA) project "Wildlife: collecting and sharing data on wildlife populations, transmitting animal disease agents" (EOW). Coordinator in the Institute of Forestry Dr Olgirda Belova. 2022.
8. Lithuanian–French programme "Gilibert" for Bilateral Cooperation. "Impact of urban trees on air pollution and human health". Coordinator in the Institute of Forestry Dr Valda Araminienė. 2021–2022.
9. European Cooperative programme for Plant Genetic Resources project "Facilitating use on the European perennial ryegrass collection: improving access to genetic resources and C&E data". Coordinators in the Institute of Agriculture: Dr Eglė Norkevičienė (2018), Dr Gražina Statkevičiūtė (2019–2022), and Dr Vilma Kemešytė. 2018–2022.
10. "Biofortified and climate-resilient food and fodder production on marginal soils" (BioFoodOnMars). Leader in the Institute of Agriculture Dr Virmantas Povilaitis. 2020–2023. Support for international research and technology development projects funded by the Ministry of Agriculture of the Republic of Lithuania.
11. SNS (Nordic Forest Research Co-operation Committee) project "Conservation of resistant ash (Fraxinus excelsior) genotypes in Nordic and Baltic regions to maintain the full range of ecosystem-services provided by this keystone species". Coordinators in the Institute of Forestry D. Diana Marčiulynienė and Prof. Dr habil. Alfas Pliūra. 2019–2023.
12. European Food Safety Authority (EFSA) project "European Network of Wildlife" (ENETWILD). Coordinator in the Institute of Forestry Dr Olgirda Belova. 2017–2023.
13. "The European forest genetic resources programme EUFORGEN VI". Coordinator in the Institute of Forestry Dr Virgilijus Baliuckas. Since 2010.
14. Nordic Forest Research Co-operation Committee (SNS) project "Northern European database of long-term forest experiments". Coordinator in the Institute of Forestry Dr Marius Aleinikovas. Since 2008.
15. "Winter wheat breeding, variety testing and marketing in Estonia". Coordinator in the Institute of Agriculture Assoc. Prof. Dr Vytautas Ruzgas. Since 2000.
16. "European plant genetic resources conservation programme". Coordinator in the Institute of Agriculture Assoc. Prof. Dr Vytautas Ruzgas. Since 1998.

13.2. NATIONAL PROJECTS

Research funded by the Research Council of Lithuania

Projects of researchers' teams

1. "Optimisation of legume nitrogen fixation and use in the organic farming ecosystem". Project leader Dr Monika Toleikienė. 2022–2025.
2. "Biodiversification of plant species and explication of corresponding precision agriculture technologies within nutrition-based approach". Project leader Dr Giedrė Samuolienė. 2022–2025.
3. "Cellular redox balance and protein expression-based phenotyping of plant-endophyte interactions for development of plant biostimulant consortia". Project leader Dr Danas Baniulis. 2022–2025.
4. "The potentialities of metallic nanoparticles application for leafy greens: biophysiochemical response and risk assessment". Project leader Prof. Dr habil. Pavelas Duchovskis. 2021–2024.
5. "Environmental and genotype impacts on plant exosome characteristics and potential applications for cosmetics and pharmacy". Project leader Dr Akvilė Viršilė. 2021–2024.

6. "Light as a tool of biofortification: photophysiological aspects of essential trace elements management in leafy vegetables". Project leader Dr Aušra Brazaitytė. 2019–2022.

Projects implemented by world-class researcher groups aimed at developing results in line with R&D topics relevant to the economic sectors which could then be commercialised, funded by the European Union funds

1. "Management of target metabolites of industrial hemp for the development of COVID-19 symptom relief products" (TerpenCoTech). Project leader Dr Vita Tilvikienė. 2021–2023.
2. "Biological plant protection strategies: boosting sustainability-orientated competitiveness in controlled environment horticulture" (BIOCLED). Project leader Dr Aušra Brazaitytė. 2020–2023.
3. "Development of wood modifying eco-friendly technology for higher value products". Project leader Dr Marius Aleinikovas. 2017–2022.
4. "Closed plant cultivation system for production of raw materials for peptide nanoengineering applications". Project leader Dr Danas Baniulis. 2017–2022.
5. "UV-A lighting strategies for controlled environment horticulture: upgrade to sustainable, high-value production". Project leader Dr Akvilė Viršilė. 2017–2022.
6. "Quality diagnostics of biogas production by-product (digestate) for innovative use as a biofertilizer". Project leader Dr Alvyra Šlepetienė. 2017–2022.
7. "Development of winter wheat varieties for amylose-free starch and vital gluten processing". Project leader Dr Gintaras Brazauskas. 2017–2022.
8. "Enhancement of the multifunctional properties of legumes in feed and food value chains" (SmartLegume). Project leader Dr Žydrė Kadžiulienė. 2017–2022.

Grant for high-level researchers group project, financed by the European Union funds

1. "Insights into future forests: challenges of climate change and diseases, and possible measures for saving biodiversity and ecosystem functioning". Project leader Dr Audrius Menkis. 2017–2022.

Post-doctoral internships, financed by the European Union funds

1. "Counteracting decline in biodiversity hotspots: conservation ecology and management of wood-inhabiting fungi in oak habitats". Research supervisor Dr Audrius Menkis, post-doc Dr Adas Marčiulynas. 2021–2023.
2. "Toxigenicity of *Fusarium graminearum* residing in alternative host-plants to wheat as influenced by the environmental conditions". Supervisor Dr Skaidrė Supronienė, post-doc Dr Sigita Janavičienė. 2020–2022.
3. "Epigenetic and genetic variation of trees, ecogenetic plasticity and adaptation possibilities in climate change". Supervisor Dr Alfas Pliūra, post-doc Dr Valda Gudynaitė-Franckevičienė. 2020–2022.
4. "Adaptation potential of *Alnus glutinosa* in future forests under climate change: genetic monitoring in natural distribution extremes" (ALNUSGENMON). Supervisor Prof. Dr Filippos A. Aravanopoulos, post-doc Dr Rita Verbylaitė. 2020–2022.
5. "Evaluation of phytocomponents on the functional and physical properties of silicone caoutchouc composite". Supervisor Prof. Dr Pranas Viškelis, post-doc Dr Aistė Balčiūnaitienė. 2020–2022.
6. "The influence of agrotechnological measures on fibre hemp (*Cannabis sativa* L.) morphological parts phytochemical composition". Supervisor Dr Vita Tilvikienė, post-doc Dr Karolina Barčauskaitė. 2020–2022.

Post-doctoral internship, financed by the state budget

1. "Research and development of a bacterial nanocellulose biocomposite with broad and long-term antimicrobial activity". Research supervisor Prof. Dr Pranas Viškelis, post-doc Dr Aistė Balčiūnaitienė. 2022–2024.

Project of the national research programme "Sustainability of agro-, forest and water ecosystems"

1. "Dynamic changes and restoration of soil properties, fungal and insect communities following clearcutting and biomass utilization in pine ecosystems". Project leader Assoc. Prof. Dr Artūras Gedminas. 2020–2022.

Development of scientific competence of scientists, other researchers, and students through practical scientific activities funded by the European Union funds

Sub-activity "Development of students' abilities in scientific research during semesters"

1. "Assessment of the biopolymer chitosan impact on the Scots pine (*Pinus sylvestris*) early development and formation of antipathogenic resistance". Supervisor Dr Vaida Sirgedaitė-Šėžienė, student Milana Augustauskaitė. 1 September 2021 – 31 March 2022.

2. "Plant and endophytic bacteria interaction analysis using *in vitro* model system". Supervisor Dr Danas Baniulis, student Edgaras Tamelis. 1 September 2021 – 31 March 2022.

Sub-activity "Development of students' abilities through participation in scientific (art research) summer internships"

1. "The optimization of *Pinus sylvestris* L. growth and induced systemic resistance using jasmonic acid *ex vitro*". Supervisor Dr Vaida Sirgedaitė-Šėžienė, student Emilija Beniušytė. 1 July – 31 August 2022.

Applied research funded by the Ministry of Agriculture of the Republic of Lithuania

Agricultural, food, and fisheries research and development projects

1. "Development of integrated pest management guidelines for horticultural crops". Project leader Dr Neringa Rasiukevičiūtė. 2020–2023.
2. "Long-term monitoring studies of soil agrochemical properties". Project leader Prof. Dr habil. Gediminas Staugaitis. 2022–2023.
3. "Development of integrated pest management guidelines for harmful organisms' control in main greenhouse crops". Project leader Dr Neringa Rasiukevičiūtė. 2021–2023.
4. "Research on the development of a functional model of the agricultural knowledge and innovation system in Lithuania". Project leader Dr Rasa Pakeltienė (VMU), coordinator Dr Roma Semaškienė (LAMMC). 2021–2022.
5. "Evaluation and preparation of fibre hemp products as organic carbon accumulators in long-term products and soil for their application according to IPCC methodology in GHG inventory". Project leaders Dr Egidijus Zvicevičius (VDU) and Dr Vita Tilvikienė (LAMMC). 2020–2022.
6. "Evaluation of factors limiting the yield of beans and peas and their management with IPM tools". Project leader Dr Roma Semaškienė. 2020–2022.
7. "The state of agricultural crop stands and yield forecast in Lithuania". Project leader Dr Virginijus Feiza. 2020–2022.
8. "Demonstrating the potential for climate change mitigation in nutrient rich organic soils through research-based national values for greenhouse gas (GHG) emissions from lowland peatlands". Project leader Dr Kęstutis Armolaitis. 2020–2022.
9. "Development of cultivation technologies for quinoa (*Chenopodium quinoa*), chickpea (*Cicer arietinum*) and amaranth (*Amaranthus*)". Project leader Dr Lina Šarūnaitė. 2020–2022.
10. "Evaluation of effectiveness and perspectiveness of different agricultural practices from economic, energy-efficient and environmental viewpoint". Project leader Dr Dalia Feizienė. 2020–2022.

Support for measures of the Lithuanian Rural Development Programme 2014–2020

Support for projects of the measure "Knowledge transfer and information activities" (Lithuanian Rural Development Programme 2014–2020)

1. "Consulting service for forest owners". Project leader Dr Benas Šilinskas. 2022–2025.

EIP activity group projects (Lithuanian Rural Development Programme 2014–2020)

1. "The implementation of innovation for the elimination of soil compaction and the renovation of productivity in tramlines". Project leader Dr Vidas Damanauskas. 2022–2024.
2. "Innovative post-harvesting technologies to restore soil sustainability". Project leader Dr Lina Šarūnaitė. 2022–2024.
3. "Independent application of good agricultural practice on the farm – a virtual assistant to farmers". Project leader Daiva Gurauskienė (LAAS), coordinator Dr Roma Semaškienė (LAMMC). 2020–2023.

Applied research projects funded by the Ministry of Environment of the Republic of Lithuania and its subordinate state institutions

1. "CO_2 emissions from drained and undrained forested peatlands and dead wood left in forests with different degrees of decay". Project leader Dr Kęstutis Armolaitis. 2022–2024.
2. "Beaver as bioindicator for assessing contamination of riparian forest buffer". Project leader Dr Olgirda Belova. 2022–2025.

3. "Changes in organic carbon stocks in forest floor and mineral topsoil layers in Scots pine stands of different age". Project leader Dr Iveta Varnagirytė-Kabašinskienė. 2022–2024.
4. "Monitoring methods of the socio-economic development of Lithuanian private forest owners". Project leader Dr Benas Šilinskas. 2022–2024.
5. "Voluntary conservation of biodiversity and ecosystems in private forests: good practice of the European Union countries, priorities and motivations of Lithuanian private forest owners, possible financial incentive mechanisms". Project leader Dr Diana Lukminė. 2022–2024.
6. "Compilation of a model for the bark beetle development". Project leader Assoc. Prof. Dr Artūras Gedminas. 2022.
7. "Evaluation of European and Manchurian ash susceptibility to *Hymenoscypus fraxineus*, fungus that causes ash dieback, in Lithuania". Project leader Dr Rita Verbylaitė. 2021–2024.
8. "Selection of root rot resistant genotypes of Norway spruce". Project leader Dr Virgilijus Baliuckas. 2021–2023.
9. "Evaluation of the effectiveness of different bacterial preparations in promoting the development of systemic antipathogenic resistance in Lithuanian coniferous tree species". Project leader Dr Vaida Sirgedaitė-Šėžienė. 2021–2023.
10. "Increasing the overall resistance of Lithuania main forest tree species to pathogens by the innovative combination of genetic and physical methods". Project leader Dr Vaida Sirgedaitė-Šėžienė. 2021–2024.
11. "Determination of the influence of growth of young pine and spruce stands at different densities on the productivity and sustainability of stands". Project leader Dr Benas Šilinskas. 2021–2022.
12. "Evaluation of soil organic carbon sustainability in forest ecosystems". Project leader Dr Vidas Stakėnas. 2020–2023.
13. "Conservation measures for pedunculate oak, sessile oak and Wych elm gene pool". Project leader Dr Virgilijus Baliuckas. 2020–2023.
14. "Butt rot impact assessment on sustainability and productivity of Norway spruce stands". Project leader Dr Povilas Žemaitis. 2020–2022.
15. "The influence of initial stand density and early selective thinning on the spruce tree stems quality". Project leader Dr Marius Aleinikovas. 2020–2022.
16. "Study of possibility to use aspen symbiotic bacteria for biological control of tree-damaging pathogenic fungi". Project leader Dr Jonas Žiauka. 2020–2022.
17. "Preparation of aspen seed plantation project by identifying the sex of aspen plus trees and establishing the most optimal scheme for crossbreeding". Project leader Dr Rita Verbylaitė. 2020–2022.
18. "Identification of black alder and grey alder F1 generation hybrids and preparation of forest propagating material for field trials". Project leader Dr Virgilijus Baliuckas. 2020–2022.

Students' scientific practice

1. "Vegetable soil and weeds pathogens species composition and biocontrol". Supervisor Dr Neringa Rasiukevičiūtė, student Vytautas Bunevičius. 2021–2022.
2. "Storage conditions effect on industrial hemp extracts chemical composition". Supervisor Dr Karolina Barčauskaitė, student Algimanta Kundrotaitė. 2021–2022.
3. "Antioxidant properties evaluation of Winter savory (*Satureja montana* L.) plants". Supervisor Dr Karolina Barčauskaitė, student Agnė Venckutė. 2021–2022.
4. "Harvesting time influence on mugwort (*Artemisia dubia* Wall.) plants biological activity. Supervisor Dr Karolina Barčauskaitė, student Rugilė Telinskytė. 2021–2022.
5. "Prevalence of harmful organisms in bean crops depending on sowing time". Supervisor Dr Roma Semaškienė, student Žana Gulevskytė. 2022.
6. "Seed-borne diseases in summer cereal crops". Supervisor Dr Roma Semaškienė, student Erika Berenytė. 2022.
7. "Agrotechnological measures effect on biologically active compounds changes into industrial hemp (*Cannabis sativa* L.) plants" (Erasmus internship). Supervisor Dr Karolina Barčauskaitė, student Charalampia Nikolaou. 2022.
8. "Recovery of chitosan from shrimp shells". Supervisor Dr Karolina Barčauskaitė, student Cumali Yetiş. 2022.
9. "Usage of non-food plant waste for simulated wastewater treatment". Supervisor Dr Donata Drapanauskaitė, student Petr Sharygin. 2022.
10. "The use of microorganisms in the production of biofertilizers". Supervisor Dr Renata Žvirdauskienė, student Tautvydas Lopetaitis. 2022.

13.3. MAJOR SCIENTIFIC PUBLICATIONS

Articles in the journals indexed in *Clarivate Analytics Web of Science* database (impact factors for 2021/2022)

1. De Marco A., Sicard P., Feng Z., Agathokleous E., Alonso R., **Araminiene V.**, Augustaitis A., Badea O., Beasley J. C., Branquinho C., Bruckman V.J., Collalti A., David-Schwartz R., Domingos M., Du E., Gomez H. G., Hashimoto Sh., Hoshika Y., Jakovljevic T., McNulty S., Oksanen E., Khaniabadi Y. O., Prescher A. K., Saitanis C. J., Sase H., Schmitz A., Voigt G., Watanabe M., Wood M. D., Kozlov M. V., Paoletti E. 2022. **Strategic roadmap to assess forest vulnerability under air pollution and climate change**. Global Change Biology, 28 17): 5062–5085. **IF – 13,211**
2. Tedersoo L., Mikryukov V., Zizka A., Bahram M., Hagh-Doust N., Anslan S., Prylutskyi O., Delgado-Baquerizo M., Maestre F. T., Pärn J., Öpik M., Moora M., Zobel M., Espenberg M., Mander Ü., Khalid A. N., Corrales A., Ahto A., Vasco-Palacios A. M., Saitta A., Rinaldi A. C., Verbeken A., Sulistyo B. P., Tamgnoue B., Furneaux B., Ritter C. D., Nyamukondiwa C., Sharp C., Marín C., Gohar D., Klavina D., Sharmah D., Dai D. Q., Nouhra E., Biersma E. M., Rähn E., Cameron E. K., De Crop E., Otsing E., Davydov E. A., Albornoz F. E., Brearley F. Q., Buegger F., Zahn G., Bonito G., Hiiesalu I., Barrio I. C., Heilmann-Clausen J., **Ankuda J.**, Kupagme J. Y., Maciá-Vicente J. G., Fovo J. D., Geml J., Alatalo J. M., Alvarez-Manjarrez J., Põldmaa K., Runnel K., Adamson K., Bråthen K. A., Pritsch K., Tchan K. I., **Armolaitis K.**, Hyde K. D., Newsham K. K., Panksep K., Lateef A. A., Tiirmann L., Hansson L., Lamit L. J., Saba M., Tuomi M., Gryzenhout M., Bauters M., Piepenbring M., Wijayawardene N., Yorou N. S., Kurina O., Mortimer P. E., Meidl P., Kohout P., Nilsson R. H., Puusepp R., Drenkhan R., Garibay-Orijel R., Godoy R., Alkahtani S., Rahimlou S., Dudov S. V., Põlme S., Ghosh S., Mundra S., Ahmed T., Netherway T., Henkel T. W., Roslin T., Nteziryayo V., Fedosov V. E., Onipchenko V. G., Yasanthika W. A. E., Lim Y. W., Soudzilovskaia N. A., Antonelli A., Kõljalg U., Abarenkov K. 2022. **Global patterns in endemicity and vulnerability of soil fungi**. Global Change Biology, 28 (22): 6696–6710. **IF – 13,211**
3. Schröder P., Mench M., **Povilaitis V.**, Rineau F., Rutkowska B., Schloter M., Szulc W., **Žydelis R.**, Loit E. 2022. **Relaunch cropping on marginal soils by incorporating amendments and beneficial trace elements in an interdisciplinary approach**. Science of The Total Environment, 803: 149844. **IF – 10,753**
4. Byčenkienė S., Pashneva D., Uogintė I., Pauraitė J., Minderytė A., Davulienė L., Plauškaitė K., Skapas M., Dudoitis V., Touqeer G., Andriejauskiene J., **Araminienė V.**, Dzenajavičienė E. F., Sicard P., **Gudynaitė-Franckevičienė V.**, **Varnagirytė-Kabašinskienė I.**, Pedišius N., Lemanas E., Vonžodas T. 2022. **Evaluation of the anthropogenic black carbon emissions and deposition on Norway spruce and silver birch foliage in the Baltic region**. Environmental Research, 207: 112218. **IF – 8,431**
5. Andersson B., Djurle A., Ørum J. E., Jalli M., **Ronis A.**, Ficke A., Jørgensen L. N. 2022. **Comparison of models for leaf blotch disease management in wheat based on historical yield and weather data in the Nordic-Baltic region**. Agronomy for Sustainable Development, 42: 42. **IF – 7,832**
6. Adaškevičiūtė V., Kaškonienė V., **Barčauskaitė K.**, Kaškonas P., Maruška A. 2022. **The impact of fermentation on bee pollen polyphenolic compounds composition**. Antioxidants, 11 (4): 645. **IF – 7,675**
7. **Sirgedaitė-Šėžienė V.**, **Lučinskaitė I.**, Mildažienė V., Ivankov A., Koga K., Shiratani M., **Laužikė K.**, **Baliuckas V.** 2022. **Changes in content of bioactive compounds and antioxidant activity induced in needles of different half-sib families of Norway spruce (*Picea abies* (L.) H. Karst) by seed treatment with cold plasma**. Antioxidants, 11 (8): 1558. **IF – 7,675**
8. **Urbonaviciene D.**, **Bobinaite R.**, **Viskelis P.**, **Bobinas C.**, **Petruskevicius A**., Klavins L., **Viskelis J.** 2022. **Geographic variability of biologically active compounds, antioxidant activity and physico-chemical properties in wild bilberries (*Vaccinium myrtillus* L.)**. Antioxidants, 11 (3): 588. **IF – 7,675**
9. Butkeviciute A., **Abukauskas V.**, Janulis V., **Kviklys D.** 2022. **Phenolic content and antioxidant activity in apples of the 'Galaval' cultivar grown on 17 different rootstocks**. Antioxidants, 11 (2): 266. **IF – 7,675**
10. Gackiewicz B., Lamorski K., **Kochiieru M.**, Slawinski C., Hsu S. Y., Chang L. C. 2022. **Hybrid modelling of saturated water flow in percolating and non-percolating macroporous soil media**. Geoderma, 406: 115467. **IF – 7,422**
11. **Vaitkevičiūtė G., Aleliūnas A.**, Gibon Y., **Armonienė R.** 2022. **The effect of cold acclimation, deacclimation and reacclimation on metabolite profiles and freezing tolerance in winter wheat**. Frontiers in Plant Science, 13: 959118. **IF – 6,627**
12. Kyriacou M. C., Ebert A. W., **Samuolienė G.**, **Brazaitytė A.** 2022. **Sprouts, microgreens and edible flowers: Modulation of quality in functional specialty crops**. Frontiers in Plant Science, 13: 1033236. **IF – 6,627**
13. Tolpeznikaite E., Starkute V., Zokaityte E., Ruzauskas M., Pilkaityte R., **Viskelis P.**, **Urbonaviciene D.**, Ruibys R., Rocha J. M., Bartkiene E. 2022. **Effect of solid-state fermentation and ultrasonication processes on antimicrobial and antioxidant properties of algae extracts**. Frontiers in Nutrition, 9: 990274. **IF – 6,576**

14. **Barčauskaitė K.**, **Bakšinskaitė A.**, Szumny A., **Tilvikienė V.** 2022. **Variation of secondary metabolites in Cannabis sativa L. inflorescences under applied agrotechnological measures**. Industrial Crops and Products, 188, Part A: 115570. **IF – 6,449**
15. **Mažeikienė I.**, **Juškytė A. D.**, **Bendokas V.**, **Stanys V.** 2022. **De novo transcriptome analysis of *R. nigrum* cv. Aldoniai in response to blackcurrant reversion virus infection**. International Journal of Molecular Sciences, 23 (17): 9560. **IF – 6,208**
16. **Streimikyte P.**, **Viskelis P.**, **Viskelis J.** 2022. **Enzymes-assisted extraction of plants for sustainable and functional applications**. International Journal of Molecular Sciences, 23 (4): 2359. **IF – 6,208**
17. **Hosney A.**, **Ullah S.**, **Barčauskaitė K.** 2022. **A review of the chemical extraction of chitosan from shrimp wastes and prediction of factors affecting chitosan yield by using an artificial neural network**. Marine Drugs, 20 (11): 675. **IF – 6,085**
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20. **Marčiulynienė D.**, **Marčiulynas A.**, **Mischerikova V.**, **Lynikienė J.**, **Gedminas A.**, Franic I., Menkis A. 2022. **Principal drivers of fungal communities associated with needles, shoots, roots and adjacent soil of *Pinus sylvestris***. Journal of Fungi, 8 (10): 1112. **IF – 5,724**
21. **Žydelis R.**, Herbst M., Weihermüller L., **Ruzgas R.**, **Volungevičius J.**, **Barčauskaitė K.**, **Tilvikienė V.** 2022. **Yield potential and factor influencing yield gap in industrial hemp cultivation under nemoral climate conditions**. European Journal of Agronomy, 139: 126576. **IF – 5,722**
22. Luzala M. M., Muanga C. K., Kyana J., Safari J. B., Zola E. N., Mbusa G. V., Nuapia Y. B., Liesse J. M. I., Nkanga C. I., Krause R. W. M., **Balčiūnaitienė A.**, Memvanga P. B. 2022. **A critical review of the antimicrobial and antibiofilm activities of green-synthesized plant-based metallic nanoparticles**. Nanomaterials, 12 (11): 1841. **IF – 5,719**
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24. Zavistanaviciute P., Zokaityte E., Starkute V., Ruzauskas M., **Viskelis P.**, Bartkiene E. 2022. **Berry by-products in combination with antimicrobial lactic acid bacteria strains for the sustainable formulation of chewing candies**. Foods, 11 (9): 1177. **IF – 5,561**
25. **Suproniene S.**, **Doyeni M. O.**, Viti C., **Tilvikiene V.**, Pini F. 2022. **Characterization of the soil prokaryotic community with respect to time and fertilization with animal waste-based digestate in a humid continental climate**. Frontiers in Environmental Science, 10: 852241. **IF – 5,411**
26. Bartkiene E., Starkute V., Zokaityte E., Klupsaite D., Mockus E., Bartkevics V., Borisova A., Gruzauskas R., **Liatukas Ž.**, **Ruzgas V.** **Comparison study of nontreated and fermented wheat varieties 'Ada', 'Sarta', and new breed blue and purple wheat lines wholemeal flour**. Biology, 11 (7): 966. **IF – 5,168**
27. **Kaziūnienė J.**, Mažylytė R., Krasauskas A., **Toleikienė M.**, Gegeckas A. 2022. **Optimizing the growth conditions of the selected plant-growth-promoting rhizobacteria *Paenibacillus* MVY-024 for industrial scale production**. Biology, 11 (5): 745. **IF – 5,168**
28. Mažylytė R., **Kaziūnienė J.**, Orola L., Valkovska V., Lastauskienė E., Gegeckas A. 2022. **Phosphate solubilizing microorganism *Bacillus* sp. MVY-004 and its significance for biomineral fertilizers' development in agrobiotechnology**. Biology, 11 (2): 254. **IF – 5,168**
29. Klupsaite D., Kaminskaite A., Rimsa A., Gerybaite A., Stankaityte A., Sileikaite A., Svetlauskaite E., Cesonyte E., Urbone G., Pilipavicius K., Vaiginyte K., Vaisvilaite M., Prokopenko V., Stukonyte G., Starkute V., Zokaityte E., Lele V., Cernauskas D., Mockus E., **Liatukas Z.**, **Ruzgas V.**, Rocha J. M., Bartkiene E. 2022. **The contribution of new breed purple wheat (8526-2 and 8529-1) varieties wholemeal flour and sourdough to quality parameters and acrylamide formation in wheat bread**. Fermentation, 8 (12): 724. **IF – 5,123**
30. Mockus E., Starkute V., Zokaityte E., Klupsaite D., Bartkevics V., Borisova A., Rocha J. M., Ruibys R., **Liatukas Z.**, **Ruzgas V.**, Bartkiene E. 2022. **The potential of traditional 'Gaja' and new breed lines of waxy, blue and purple wheat in wholemeal flour fermentation**. Fermentation, 8 (10): 563. **IF – 5,123**
31. **Janaviciene S.**, **Suproniene S.**, **Kadziene G.**, Pavlenko R., Berzina Z., Bartkevics V. 2022. **Toxigenicity of *F. graminearum* residing on host plants alternative to wheat as influenced by environmental conditions**. Toxins, 14: 541. **IF – 5,075**

32. **Balciunaitiene A.**, **Puzeryte V.**, Radenkovs V., Krasnova I., Memvanga P. B., **Viskelis P.**, **Streimikyte P.**, **Viskelis J.** 2022. **Sustainable–green synthesis of silver nanoparticles using aqueous *Hyssopus officinalis* and *Calendula officinalis* extracts and their antioxidant and antibacterial activities**. Molecules, 27 (22): 7700. **IF – 4,927**
33. Sedbare R., Raudone L., Zvikas V., **Viskelis J.**, Liaudanskas M., Janulis V. 2022. **Development and validation of the UPLC-DAD methodology for the detection of triterpenoids and phytosterols in fruit samples of *Vaccinium macrocarpon* Aiton and *Vaccinium oxycoccos* L.** Molecules, 27 (14): 4403. **IF – 4,927**
34. **Bakys R.**, **Bajerkevičienė G.**, **Pliūra A.**, **Marčiulynas A.**, **Marčiulynienė D.**, **Lynikienė J.**, **Mishcherikova V.**, Menkis A. 2022. **Fungal communities in re-emerging *Fraxinus excelsior* sites in Lithuania and their antagonistic potential against *Hymenoscyphus fraxineus***. Microorganisms, 10 (10): 1940. **IF – 4,926**
35. **Marčiulynas A.**, **Marčiulynienė D.**, **Lynikienė J.**, Bakys R., Menkis A. 2022. **Fungal communities in leaves and roots of healthy-looking and diseased *Ulmus glabra***. Microorganisms, 10 (11): 2228. **IF – 4,926**
36. **Kolytaitė A.**, **Vaitiekūnaitė D.**, **Antanynienė R.**, **Baniulis D.**, **Frercks B.** 2022. ***Monilinia fructigena* suppressing and plant growth promoting endophytic *Pseudomonas* spp. bacteria isolated from plum**. Microorganisms, 10 (12): 2402. **IF – 4,926**
37. **Vaitiekūnaitė D.**, Bružaitė I., Snitka V. 2022. **Endophytes from blueberry (*Vaccinium*) fruit: Characterization of yeast and bacteria via label-free surface-enhanced Raman spectroscopy (SERS)**. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 275: 121158. **IF – 4,831**
38. **Ayaz M.**, **Feizienė D.**, **Feiza V.**, **Tilvikienė V.**, Baltrėnaitė-Gedienė E., Khan A. 2022. **The impact of swine manure biochar on the physical properties and microbial activity of loamy soils**. Plants, 11 (13): 1729. **IF – 4,658**
39. **Andriūnaitė E.**, **Rugienius R.**, **Tamošiūnė I.**, **Haimi P.**, **Vinskienė J.**, **Baniulis D.** 2022. **Enhanced carbonylation of photosynthetic and glycolytic proteins in antibiotic timentin-treated tobacco *in vitro* shoot culture**. Plants, 11 (12): 1572. **IF – 4,658**
40. **Balčiūnaitienė A.**, Liaudanskas M., **Puzerytė V.**, **Viškelis J.**, Janulis V., **Viškelis P.**, Griškonis E., Jankauskaitė V. 2022. ***Eucalyptus globulus* and *Salvia officinalis* extracts mediated green synthesis of silver nanoparticles and their application as an antioxidant and antimicrobial agent**. Plants, 11 (8): 1085. **IF – 4,658**
41. **Balčiūnaitienė A.**, **Štreimikytė P.**, **Puzerytė V.**, **Viškelis J.**, Štreimikytė-Mockeliūnė Ž., Maželienė Ž., Sakalauskienė V., **Viškelis P.** 2022. **Antimicrobial activities against opportunistic pathogenic bacteria using green synthesized silver nanoparticles in plant and lichen enzyme-assisted extracts**. Plants, 11 (14): 1833. **IF – 4,658**
42. **Brazaitytė A.**, **Vaštakaitė-Kairienė V.**, **Sutulienė R.**, **Rasiukevičiūtė N.**, **Viršilė A.**, **Miliauskienė J.**, **Laužikė K.**, **Valiuškaitė A.**, **Dėnė L.**, **Chrapačienė S.**, **Kupčinskienė A.**, **Samuolienė G.** 2022. **Phenolic compounds content evaluation of lettuce grown under short-term preharvest daytime or nighttime supplemental LEDs**. Plants, 11 (9): 1123. **IF – 4,658**
43. Butkevičiūtė A., Janulis V., **Kviklys D.** 2022. **Triterpene content in flesh and peel of apples grown on different rootstocks**. Plants, 11 (9): 1247. **IF – 4,658**
44. Butkeviciute A., **Viskelis J.**, Liaudanskas M., **Viskelis P.**, Janulis V. 2022. **Impact of storage controlled atmosphere on the apple phenolic acids, flavonoids, and anthocyanins and antioxidant activity *in vitro***. Plants, 11 (2): 201. **IF – 4,658**
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46. Česonienė L., **Štreimikytė P.**, Liaudanskas M., Žvikas V., **Viškelis P.**, **Viškelis J.**, Daubaras R. 2022. **Berries and leaves of *Actinidia kolomikta* (Rupr. & Maxim.) Maxim.: A source of phenolic compounds**. Plants, 11 (2): 147. **IF – 4,658**
47. **Gudynaitė-Franckevičienė V.**, **Pliūra A.** 2022. **Performance and genetic parameters of poplar hybrids and clones in a field trial are modified by contrasting environmental conditions during the vegetative propagation phase**. Plants, 11 (18): 2401. **IF – 4,658**
48. **Gustienė D.**, **Varnagirytė-Kabašinskienė I.**, **Stakėnas V.** 2022. **Ground vegetation in *Pinus sylvestris* forests at different successional stages following clear cuttings: A case study**. Plants, 11 (19): 2651. **IF – 4,658**
49. **Janušauskaitė D.**, **Kadžienė G.** 2022. **Influence of different intensities of tillage on physiological characteristics and productivity of crop-rotation plants**. Plants, 11 (22): 3107. **IF – 4,658**
50. **Juškevičienė D.**, **Radzevičius A.**, **Viškelis P.**, **Maročkienė N.**, **Karklelienė R.** 2022. **Estimation of morphological features and essential oil content of basils (*Ocimum basilicum* L.) grown under different conditions**. Plants, 11 (14): 1896. **IF – 4,658**
51. **Juškytė A. D.**, **Mažeikienė I.**, **Stanys V.** 2022. **Analysis of *R* genes related to blackcurrant reversion virus resistance in the comparative transcriptome of *Ribes nigrum* cv. Aldoniai**. Plants, 11 (22): 3137. **IF – 4,658**
52. **Juškytė A. D.**, **Mažeikienė I.**, **Stanys V.** 2022. **An effective method of Ribes spp. inoculation with blackcurrant reversion virus under *in vitro* conditions**. Plants, 11 (13): 1635. **IF – 4,658**
53. **Juškytė A. D.**, **Mažeikienė I.**, **Stanys V.** 2022. **Putative genes of *pathogenesis-related proteins* and *coronatine-insensitive* protein 1 in Ribes spp.** Plants, 11 (3): 355. **IF – 4,658**

54. **Kviklys D.**, **Viškelis J.**, Liaudanskas M., Janulis V., **Laužikė K.**, **Samuolienė G.**, **Uselis N.**, **Lanauskas J.** 2022. Apple fruit growth and quality depend on the position in tree canopy. Plants, 11 (2): 196. **IF – 4,658**
55. Mildaziene V., Ivankov A., Sera B., **Baniulis D.** 2022. Biochemical and physiological plant processes affected by seed treatment with non-thermal plasma. Plants, 11 (7): 856. **IF – 4,658**
56. **Puzerytė V.**, **Viškelis P.**, **Balčiūnaitienė A.**, **Štreimikytė P.**, **Viškelis J.**, **Urbonavičienė D.** 2022. *Aralia cordata* Thunb. as a source of bioactive compounds: Phytochemical composition and antioxidant activity. Plants, 11 (13): 1704. **IF – 4,658**
57. **Rasiukevičiūtė N.**, **Brazaitytė A.**, **Vaštakaitė-Kairienė V.**, **Valiuškaitė A.** 2022. Different LED light wavelengths and photosynthetic photon flux density effect on *Colletotrichum acutatum* growth. Plants, 11 (1): 143. **IF – 4,658**
58. **Romanovskaja D.**, **Ražukas A.**, **Asakavičiūtė R.** 2022. Influence of morphostructural elements for buckwheat (*Fagopyrum esculentum* Moench) productivity in different agricultural systems. Plants, 11 (18): 2382. **IF – 4,658**
59. **Skuodienė R.**, **Matyžiūtė V.** 2022. Soil seed bank in a pre-erosion cereal-grass crop rotation. Plants, 11 (19): 2636. **IF – 4,658**
60. **Sutulienė R.**, **Laužikė K.**, Pukas T., **Samuolienė G.** 2022. Effect of light intensity on the growth and antioxidant activity of sweet basil and lettuce. Plants, 11 (13): 1709. **IF – 4,658**
61. **Swify S.**, **Avizienyte D.**, **Mazeika R.**, **Braziene Z.** 2022. Comparative study effect of urea-sulfur fertilizers on nitrogen uptake and maize productivity. Plants: 11 (22): 3020. **IF – 4,658**
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