

**LITHUANIAN
RESEARCH CENTRE
FOR AGRICULTURE
AND FORESTRY**



**ANNUAL REPORT
2018**



MAJOR FACTS

- ⊙ In 2018, the Lithuanian Research Centre for Agriculture and Forestry (hereinafter LAMMC): employed a total staff of **545**, including **187** research workers, and had **56** doctoral students.
- ⊙ Carried out **27** international, **56** national research projects funded by the Research Council of Lithuania, Ministry of Agriculture, Ministry of Environment, fulfilled **100** contract orders for national and foreign economic entities.
- ⊙ Implemented **6** long-term institutional research programmes.
- ⊙ **4** agricultural crop varieties were included in the EU Common Catalogue of Varieties of Agricultural Plant and Vegetable Species and in the Lithuanian National List of Plant Varieties, **5** apple varieties were included in the Lithuanian National List of Plant Varieties.
- ⊙ LAMMC researchers published **75** scientific publications in the journals indexed in the *Clarivate Analytics Web of Science* (hereinafter *CA WoS*), **11** chapters in books published by the internationally acclaimed publishing houses and **1** book, **28** scientific publications in peer-reviewed periodical publications.
- ⊙ **28** LAMMC publications among the top 10 % most cited in the world over the past 10 years.
- ⊙ **12** LAMMC doctoral students defended dissertations.
- ⊙ Science Board approved a strategy of LAMMC activities for 2018–2030.
- ⊙ International evaluation of the R&D activities of Lithuanian science and studies institutions, arranged by the Research and Higher Education Monitoring and Analysis Centre (MOSTA) was conducted. The evaluation included LAMMC units: Institute of Agriculture and regional branches, Institute of Forestry, Institute of Horticulture.
- ⊙ Arranged **2** international, **10** national conferences, more than **20** workshops and field days.

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DIRECTOR'S FOREWORD



The year 2018 was full of new challenges. We are pleased that the LAMMC community's focus, competence and efforts have yielded excellent results.

This year, international evaluation of the R&D activities of Lithuanian science and studies institutions, arranged by the Research and Higher Education Monitoring and Analysis Centre (MOSTA) was conducted for the second time. The three LAMMC units: Institute of Agriculture and regional branches, Institute of Forestry and Institute of Horticulture were included in the evaluation. According to the results of the international expert evaluation, LAMMC is a leader among the agricultural science and studies institutions in Lithuania.

In 2018, LAMMC had as many as 56 doctoral students, which is the highest number over the 9 years' period of its existence. The number of doctoral students from foreign countries is increasing. Currently we have six doctoral students who come from Syria, Egypt, Ukraine, and Nigeria.

Like every year, research and experimental development activities were being successfully implemented: national high-level R&D (SMART), international "Horizon 2020", "INTERREG" and other projects, services were provided to Lithuanian and foreign economic entities.

In 2018, LAMMC researchers published 75 publications in international scientific journals indexed in the *Clarivate Analytics Web of Science* database. It is gratifying to note that as many as 28 LAMMC research papers published over the last 10 years fall within the top 10 % of the most-cited scientific publications in the world.

4 agricultural crop varieties were included in the EU Common Catalogue of Varieties of Agricultural Plant and Vegetable Species and in the Lithuanian National List of Plant Varieties, 5 apple varieties were included in the Lithuanian National List of Plant Varieties. Not only Lithuanian but also foreign markets are interested in the varieties developed by LAMMC.

In recent years, LAMMC researchers and doctoral students have been particularly active in deepening their knowledge by doing internships of various lengths at Swedish, Finnish, Czech, Polish, United Kingdom's, Chinese and Japanese institutions.

In 2018, 2 international conferences and as many as 10 national conferences were arranged, workshops and field days were held nearly monthly.

I sincerely believe that in 2019, the LAMMC community will also rise to the new challenges, remain united and focused, capable of generating new knowledge and successfully applying it.

Director Dr. Gintaras Brazauskas

A handwritten signature in blue ink, which appears to be "Gintaras Brazauskas".

1. LAMMC VISION, MISSION AND VALUES

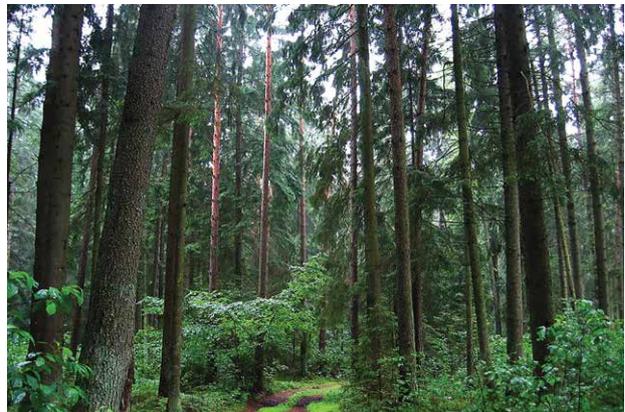
VISION

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



MISSION

Generate, garner and disseminate new scientific know-how geared to awareness of sustainable land, forest and environment 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 activities;
- Proactiveness, creativity and continuous improvement;
- Community-driven open-mindedness.



2. STRATEGIC DIRECTIONS

LAMMC priorities:

1. development of high-level research;
2. enhancement of international collaboration;
3. development of doctoral studies;
4. cooperation between science and business;
5. commitment to community;
6. enhancement of public services.

3. LAMMC ASSESSMENT RESULTS

In 2018, a comparative assessment of Lithuanian research and studies institutions was organized by the Research and Higher Education Monitoring and Analysis Center (MOSTA). Comparative expert assessment of R&D is an integral part of the new science assessment system. Comparative assessment is carried out every five years. This qualitative assessment is conducted by foreign experts. The assessment takes into account the criteria for the quality of R&D activities (weighting factor 0.65), economic and social impact (weighting factor 0.2) and viability (weighting factor 0.15) of the units of assessment (see Table 1).

Assessment results are used while allocating basic funding for research and experimental development (R&D), for performance of artistic activities in state-owned Lithuanian science and studies institutions. Sixty percent of the funds for research will be allocated according to the qualitative parameters of the comparative expert assessment, 40 % of the funds will be allocated according to the quantitative indicators of formal assessment.

According to the results of the international expert assessment of R&D carried out in 2018, LAMMC is a leader among Lithuanian agricultural science and studies institutions.

Table 1. LAMMC expert assessment results (5-point scale)

Unit of assessment	Number of researcher positions	Quality of R&D activities	Economic and social impact of R&D activities	Viability of/ prospects for R&D activities	Weighted average	LAMMC points
Institute of Agriculture and regional branches.	73.93	3	4	5	3.5	3.27
Institute of Horticulture	35.06	3	4	5	3.5	
Institute of Forestry	19.33	2	2	2	2	
Total::	128.32					

4. HUMAN RESOURCES

4.1. Research Board

The Research Board is a collegial management body of LAMMC. The Board consists of 15 members with a term of service of 5 years.

The Board sets the key directions for the research activities, approves activity plan of LAMMC submitted by the director, annual reports, sets forth qualification requirements for researchers and other employees, as well as 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.



Members of the Research Board

Dr. Virginijus Feiza	Head of Soil and Crop Management Department, Institute of Agriculture, Chairperson of Research Board
Dr. Marius Aleinikovas	Director of Institute of Forestry, Deputy Chairperson of Research Board
Dr. Audrius Sasnauskas	Director of Institute of Horticulture, Deputy Chairperson of Research Board
Dr. Sigitas Lazauskas	Head of Department of Plant Nutrition and Agroecology, Institute of Agriculture, Secretary of Research Board
Dr. Gintaras Brazauskas	Director of Lithuanian Research Centre for Agriculture and Forestry
Dr. Zita Duchovskienė	Head of Technology and Innovation Division, Ministry of Education Science and Sport
Prof. Dr. habil. Pavelas Duchovskis	Head researcher of Plant Physiology Laboratory, Institute of Horticulture
Rimantas Krasuckis	Chief advisor of Ministry of Agriculture
Dr. Virgilijus Mikšys	Senior researcher of Department of Forestry, Institute of Forestry
Dr. Rimantas Prūsaitis	Advisor of State Forest Enterprise
Assoc. Prof. Dr. Steponas Raudonius	Head of Group for Quality of Studies, Department of Studies, Aleksandras Stulginskis University
Dr. Vidas Stakėnas	Head of Ecology Department, Institute of Forestry
Prof. Dr. habil. Vidmantas Stanys	Head of Orchard Plants Genetics and Biotechnology Department, Institute of Horticulture
Prof. Dr. habil. Gediminas Staugaitis	Director of Agrochemical Research Laboratory
Prof. Dr. habil. Rimantas Velička	Professor of Institute of Agroecosystems and Soil Sciences, Aleksandras Stulginskis University

4.2. Works council

The Works Council of LAMMC is a collegial body representing employees, which defends the professional, labour, economic and social rights of the employees of LAMMC and its branches and represents their interests.

The works council consists of 9 members, whose term of office is 3 years..

Members of works council

Dr. Rasa Karklelienė	Head of Sector of Vegetable Breeding, Institute of Horticulture. Chairperson of Works Council
Dr. Antanas Ronis	Senior Researcher of Plant Pathology and Protection Department, Institute of Agriculture. Deputy Chairperson of Works Council
Aušra Vabalienė	Personnel Inspector-Secretary, Agrochemical Research Laboratory. Secretary of Works Council
Dr. Rita Asakavičiūtė	Senior Researcher of Department of Light Soils and Crop Production Sciences, Vokė Branch
Agnė Jankauskienė	Head of Communication and Project Administration Group
Dr. Darius Kviklys	Head of Department of Horticulture Technologies
Giedrė Šeškauskaitė	Chief economist of LAMMC
Dr. Rita Verbylaitė	Researcher of Forest Genetics and Breeding Department, Institute of Forestry

4.3. Personnel

As of December 31, 2018, LAMMC employed a total staff of 545 of which researchers accounted for 34%, specialists and other employees – 31%, laboratory assistants, technicians – 23%, administration – 12% (Figure 1).

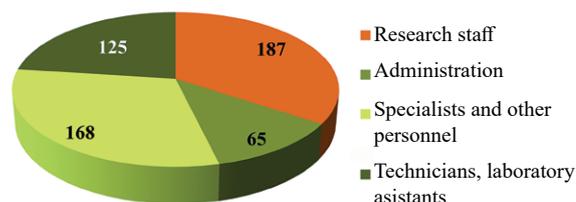


Figure 1. Number of employees by position in LAMMC

Chief researchers – 17%, senior researchers – 36%, researchers – 22%, junior researchers – 25% (Figure 2).

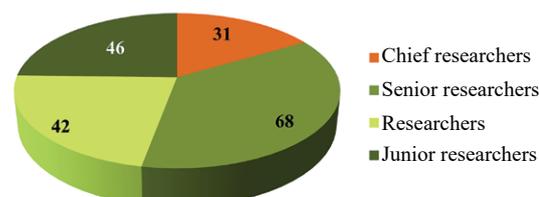


Figure 2. Distribution of researchers according to position

In 2018, LAMMC had a total of 56 doctoral students in the fields of agronomy, forestry, ecology and environment, and biochemistry sciences (Figure 3).

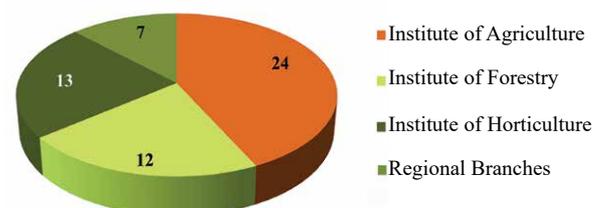


Figure 3. Distribution of doctoral students in LAMMC Branch Divisions

5. DOCTORAL STUDIES

Based on the order of LR Minister of Education and Science, in 2011 LAMMC was granted the right for doctoral studies in 4 science fields:

- **Agromy** (jointly with Aleksandras Stulginskis University),
- **Forestry** (jointly with Aleksandras Stulginskis University),
- **Ecology and environmental science** (jointly with Vytautas Magnus and Aleksandras Stulginskis University),
- **Biochemistry** (jointly with Vytautas Magnus University and Lithuanian University of Health Sciences).

The four-year PhD programs provided by LAMMC conform to the problematics of the contemporary agriculture and forestry, the latest methods are used in research, studies and research activities are led and supervised by experienced scientists.

5.1. Students enrolled in the PhD programmes in 2018 and their research topics

Agricultural Sciences, Agronomy (01 A)

1. **Vytautas Abukauskas**. “Complex evaluation of new generation of apple rootstocks”. Supervisor Dr. Darius Kviklys.
2. **Mohamed Allam**. “Genotypic and phenotypic analysis of wheat for adaptation to abiotic stresses”. Supervisor Dr. Kristina Jaškūnė, scientific advisor Dr. Rita Armonienė.
3. **Paulius Astrauskas**. “Winter wheat crops condition and productivity prediction according to digital maps dimensional soil features, crops aerial photo and plant chemical composition data”. Supervisor Prof. Dr. habil. Gediminas Staugaitis.
4. **Vilma Gudynienė**. “The usage of native plants species creating flowering meadows”. Supervisor Dr. Vaclovas Stukonis, scientific advisor Dr. Jonas Šlepetys.
5. **Arnoldas Jurys**. “The influence of biopreparations on soil qualitative properties”. Supervisor Dr. Dalia Feizienė.
6. **Ana Dovilė Juškytė**. “Genetic control of resistance to Blackcurrant reversion virus”. Supervisor Prof. Dr. habil. Vidmantas Stanys.
7. **Algirdas Kazlauskas**. “Epigenetic and biochemical short and long-term changes in plants caused by stressors”. Supervisor Dr. Giedrė Samuolienė, scientific advisor Dr. Perttu J. Haimi.
8. **Danutė Kvasovienė**. “Changes in the chemical composition and technological properties of cereal grains and in the quality of soil as influenced by different fertilization systems”. Supervisor Dr. Jurgita Cesevičienė, scientific advisors Dr. Aušra Arlauskienė and Dr. Alvyra Šlepetienė.
9. **Rūta Paulauskaitė**. “Environmental factors inducing oxidative stress in Fabaceae plants and tools for its management”. Supervisor Dr. Jurga Miliauskienė, scientific advisor Dr. Lina Ragelienė.
10. **Kazimieras Poškus**. “Optimization of nitrogen and sulfur fertilization in winter wheat”. Supervisor Prof. Dr. habil. Gediminas Staugaitis, scientific advisor Dr. Zita Brazienė.
11. **Renaldas Ruzgas**. “The impact of crop management on the qualitative and quantitative values of phytocannabinoids and other constituents of industrial hemp (*Cannabis sativa* L.)”. Supervisor Dr. Vita Tilvikienė, scientific advisor Dr. Akvilė Viršilė.
12. **Paulina Štreimikytė**. “Optimisation of biochemical composition and functionality of plant-based products produced using enzymatic hydrolysis”. Supervisor Dr. Ramunė Bobinaitė.
13. **Karolina Verikaitė**. “The epidemiology of septoria tritici blotch causal agent *Zymoseptoria tritici* and optimization of its control in winter wheat”. Supervisor Dr. Jūratė Ramanauskienė, scientific advisor Dr. Rita Armonienė.
14. **Vilma Živatkauskienė**. “Value of natural and cultural pastures for animal husbandry farms”. Supervisor Dr. Vaclovas Stukonis, scientific advisor Dr. Jonas Šlepetys.

Agricultural Sciences, Forestry (04 A)

1. **Marius Šilingas**. “Regularities of the self-regeneration of the high-fertility forest sites under soft-deciduous stands”. Supervisor Dr. Vytautas Suchockas.
2. **Dorotėja Vaitiekūnaitė**. “Identification of endophytic microorganisms in the tissue cultures of genetically different long-lived oak trees (*Quercus robur*) and analysis of their interaction”. Supervisor Dr. Sigutė Kuusienė.

Biomedical Sciences, Ecology and environmental science (03 B)

Gintarė Šidlauskaitė. “Legumes and grasses interspecies compatibility for perennial swards productivity and for sustainability of the agro-ecosystem functions”. Supervisor Dr. Ž. Kadžiulienė.

Physical Sciences, Biochemistry (04 P)

Elena Andriūnaitė. “Effect of plant-endophyte interaction on plant adaptation and development *in vitro*”. Supervisor Dr. Danas Baniulis.

5.2. Doctoral dissertations defended in 2018

Agricultural Sciences, Agronomy (01 A)

1. **Loreta Aleknavičienė.** “Spring wheat nutrition optimization assessment of soil and plants macro and microelements concentrations”. Supervisor Prof. Dr. habil. Gediminas Staugaitis, scientific consultant Dr. Zita Brazienė.
2. **Karolina Barčauskaitė.** “Amount of polychlorobiphenyls and polycyclic aromatic hydrocarbons in Lithuania produced composts and their effect for soil and plants”. Supervisor Dr. Romas Mažeika.
3. **Ieva Narutytė.** “Influence of biodegradable waste composts on variations of chemical elements in soil and plants in four-field crop rotation”. Supervisor Prof. Dr. habil. Gediminas Staugaitis.
4. **Eglė Norkevičienė.** “Agrobiological potential of switchgrass (*Panicum virgatum* L.) in the nemoral zone of Europe”. Supervisor Dr. Bronislava Butkutė, scientific consultant Dr. Nijolė Lemežienė.
5. **Žygimantas Staugaitis.** “The composition and changes of organic carbon and nitrogen compounds, important soil quality indicators, as influenced by the cultivation of perennial herbaceous energy crops”. Supervisor Dr. (HP) Alvyra Šlepetienė.
6. **Karina Stumbrienė.** “Distribution of *Fusarium Graminearum* fungi, structure of chemotypes, pathogenicity and control in wheat grown in Lithuania”. Supervisor Dr. Skaidrė Supronienė, scientific consultant Dr. Roma Semaškienė.
7. **Donata Tomchuk.** “Grassland belowground biomass and organic carbon accumulation in different terrain ecosystems”. Supervisor Dr. Regina Skuodienė, scientific consultant Dr. Jonas Šlepetys.
8. **Viktorija Vaštakaitė.** “The photophysiological aspects for the management of metabolites and mineral elements in *Brassicaceae* microgreens”. Supervisor Dr. Akvilė Viršilė.
9. **Jonas Viškelis.** “The impact of apple-tree (*Malus × domestica* Borkh.) management technologies and biological factors on fruit quality in intensive orchards”. Supervisor Dr. Darius Kviklys.
10. **Renaldas Žydėlis.** “The effects of organic and mineral fertilisers on maize N status under water and cold stress conditions in nemoral climate”. Supervisor Dr. Sigitas Lazauskas.

Agricultural Sciences, Forestry (04 A)

1. **Sinilga Černiulienė.** “Spreading and ecological peculiarities of the black locust (*Robinia pseudoacacia* L.) in Lithuanian conditions”. Supervisor Dr. Vidas Stakėnas.
2. **Aušra Juškauskaitė.** “Dependence of phenotypic plasticity of forest tree species on genetic polymorphism”. Supervisor Dr. Virgilijus Baliuckas.

6. RESEARCH AND DEVELOPMENT

6.1. Scientific publications

The year 2018 was very productive: a total of 75 scientific articles were published in the journals with an impact factor (IF) indexed in *CA WoS* database, the highest citation index of the journal in which LAMMC researchers published their research findings is 5.742. In 2018, about 70 popular science articles were written. The main scientific publications of LAMMC are presented in Figure 4.

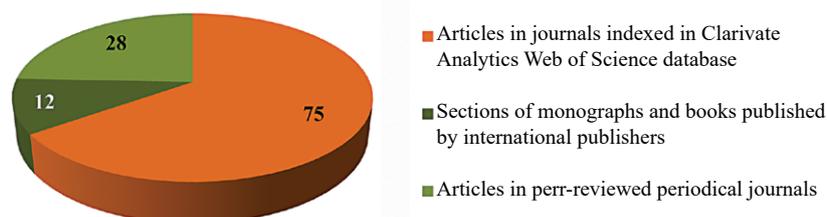


Figure 4. Scientific publications of LAMMC published in 2018

6.2. Long-term research programmes, 2017–2021

LAMMC is involved in six long-term R&D programmes. The results for the year 2018 of the ongoing long-term research programmes are presented below.

“Biopotential and quality of plants for multifunctional use”

Leader Dr. Žydrė Kadžiulienė

Development of the bio-economy concept is focused on the most innovative and diversified use of plant-derived raw materials for the production of value-added products. It is therefore important to gain a deeper insight into the qualitative parameters of plant biomass production technologies. **The aim of the programme** is to develop and sophisticate the scientific foundations of the crop production, necessary for a stable, sustainable and competitive agricultural development under the changing market and climate conditions, for various farming systems, to develop innovative agronomic practices of cultivation technologies enabling preservation of sustainable soil and healthy environment and contributing to the development of the bio-economy.

2018 is the second year of the long-term (5-year) programme. During this period, research into plant-derived organic fertilizers and their effects on soil fertility and vitality enhancement in the organically managed agro-systems was summarised as well as research on the impacts of strips of flowering herbaceous plants on the formation of pollinator habitats under intensive cropping conditions. Investigation of the 2nd generation energy plant intended for biofuel, silky bentgrass, for possible resistance to acetyl coxylase and acetolactate synthesis inhibitors, research into phenological regularities of plants and other phenomena as influenced by the climate change were completed and summarised.

Ten new investigations covering a wide range of issues regarding plant biopotential and use have been started. Some of these investigations are aimed at enhancement of the multi-functionality of agroecosystems and address the aspects of productivity potential and stability of the crop rotation in the systems of varying intensity under changing climate conditions. Other newly started research examines the interaction among the sward productivity-environment-sward management factors; the effects of digestate, by-product of biogas production, used as an organic fertilizer on plants, soil and micro-organisms; the long-term impact of sewage sludge on the biopotential of energy crops and changes in the properties of acid soils. Research is being continued on the nitrogen use efficiency of legumes in the organic cropping system, biomass formation of Arbor wormwood, the influence of symbiotic nitrogen on nitrogen leaching in a sandy loam *Luvisol*. The research results of the programme topics are published in various scientific



Experiment on the crop rotation productivity potential and stability in the systems of different intensity



Experiment on soy cultivation technologies in an organic crop rotation



Measurement of GHG emissions in field experiments

publications. The latest research results have been published in 5 articles in the journals indexed in the database *CA WoS*, 8 oral presentations have been made at international conferences, practical aspects of research have been presented in workshops and 8 popular science articles.

“Sustainable forestry and global changes”

Leader Dr. Virgilijus Mikšys

The aim of the program is to obtain and systematize the new scientific knowledge necessary for the development of sustainable forest management in the context of global natural, economic and social changes and to prepare recommendations for applying this knowledge in practice.

Growing demand for wood (the world's wood demand grows by about 1.7% every year) and negative impact of climate change highlight the needs to enhance capacity of environmental ecosystem services and to preserve forests for current and future society.

Results. The ground-level O₃ concentration and vegetation damage dynamics were investigated during the period 2007–2017. The research on heterotrophic respiration was conducted. More intensive heterotrophic respiration was in the forest soils than in perennial grasses and crops soils. For studies of phenogenetic plasticity and epigenetic effects, the reciprocal factorial experiment on vegetative propagation and growing of clones of hybrid poplars under contrasting conditions was carried out in a phytotrone; the biometric parameters of poplar hybrid trees were not influenced by more intensive UV radiation and increased ground ozone concentrations. The growth of containerized Silver birch seedlings in forest plantations show better survival and fast initial growth, because of better root system contact with the soil. The peculiarities

of internal phytohormone concentrations were determined for the *in vitro* explants in genotypes of *Populus* and *Betula*, which is important for the more effective application of microvegetative propagation for the prospective establishment of short rotation plantations of forest trees. The evaluation of the pine genotypes resistance to root rot in experimental plantations was performed. The property rights of the private forest owner were analysed. The experience gained by several countries estimating carbon storage in Harvesting Wood Product (HWP) was reviewed and carbon storage was estimated in HWP by applying different methods.



Root systems of 2 year-old Silver birch seedlings grown on open ground (a) and in containers (b) and transplanted in forest plantations

“Harmful organisms in agro and forest ecosystems”

Leader Dr. Roma Semaškienė

The aim of the programme is to investigate the peculiarities of behaviour of dominant and newly-emerging pests in the agro-forest ecosystems and to develop the scientific basis for managing their destructive effects in a manner that maintains economic benefits without compromising environmental and human safety, biodiversity conservation. To achieve the objective of the programme, the following three tasks have been set:

1) to study the crop-destroying phytopathogens and phytophagous populations and to determine the peculiarities of their behaviour (interaction between host plants and pathogens or pests and the environment, factors affecting the spread of harmful organisms and outbreaks) in various agro-forest ecosystems of Lithuania;

2) to investigate and assess the occurrence of pathogenic and toxic fungi, pest insects in arable, garden and orchard crops and the abundance and spread of soil microbiota as influenced by natural and anthropogenic factors;

3) to examine and evaluate the effect of harmful organisms on crop productivity and quality and to identify measures for their prevention and control.

The program implementation encompasses research within the framework of 4 thematic topics.

A total of 12 research studies were done in 2018, 7 scientific publications were published in the journals indexed in *CA WoS* database. The research findings were presented in 15 international and national conferences and published in the conference proceedings. 6 recommendations for users (farmers, advisers and other stakeholders) were prepared. In 2018, one PhD student defended a dissertation, 6 PhD students are actively involved in the research activities.



Research into species composition of pests and thresholds of harmfulness

“Horticulture: agrobiological foundations and technologies”

Leader Dr. Giedrė Samuolienė

The research in horticulture is carried out in various aspects – fundamental and applied – in Lithuania. Developing the principles of horticulture, in order to ensure the safe and competitive production, taking into account changing climatic and market conditions, it is important to develop and improve ecological, integrated and intensive horticultural technologies; to carry out the breeding, physiological, genetic and biochemical aspects. In order to achieve competitive horticultural production, which would be important for growers and manufacturers, a special attention is paid to yield, diversity of horticultural products, chemical composition and technological properties. It is necessary to create and optimize storage processes, which would allow preservation of natural biochemical composition.

The purpose of the programme is to create scientific basics for the development of modern horticulture in changing climatic and economic conditions; ensuring qualitative, safe and competitive production for the local market and export.

Results achieved in 2018: 11 articles in the journals indexed in *CA WoS database*, 22 publications in peer-reviewed periodical publications, 2 recommendations and 15 popular science articles.



Presentation of research results in a conference

“Productivity and sustainability of agricultural and forest soils”

Leader Dr. Virginijus Feiza

Relevance of the Programme – EC Directive (COM(2006) 232) sets out common principles for Soil Thematic Strategy to protect soils across the EU. The document sets out that the EU Member State will be in a position to decide how best to protect soil and how to use it in a sustainable way on their own territory.

The goal of the programme is to evaluate soil fertility potential in agricultural and forest ecosystems, to highlight the factors which affect their degradation and to choose the measures to maintain soil sustainability, to optimize carbon cycle in the soil, to reduce greenhouse gas emission and plant nutrient losses from the soil in different regions of the country.

The research is focused on three basic directions:

- 1) Productivity improvement and reduction of degradation processes in soils of morainic and limnoglacial origin;
- 2) Rational use of natural soil resources, organic and mineral materials of local origin;
- 3) To evaluate productivity potential of agricultural and forest soils.

To gain a deeper understanding of the processes taking place in the soil, the scientists of different

scientific branches (agriculture, biomedicine, physical science) are involved.

In 2018, the participants of the programme published 12 papers in journals having IF, 5 papers are under revision, 11 articles were published in popular press, 2 chapters were published in monographs, 3 recommendations for practical farming were published, 21 oral presentations and 7 poster presentations were made in national and international conferences.



Lodged and emerged wheat

“Genetic determination of the traits of agricultural and forest plants, development of modern cultivars, 2017–2021”

Leaders: Prof. Dr. Habilitatus Vidmantas Stanys, Assoc. Prof. Dr. Vytautas Ruzgas

Objective: To develop molecular markers for abiotic and biotic stress resistance, plant productivity and quality parameters; to create new breeding material for the development of new commercially successful plant varieties; to identify genotypes of forest plants beneficial for the development of the national economy.

Relevance: Agricultural and forest plants can provide economic revenue only if competitive lines, varieties or populations are being used. Natural and agricultural ecosystems are in perpetual fluctuations because of various environmental factors, such as climate change, hydrological regime, pest and pathogen infestation. New techniques and products are constantly being developed for the plant cultivation; quality parameters for the plant production are constantly changing in the processing industry. Therefore the genotypes and population structures of agricultural and forest plants have to be continuously improved and adapted to meet current economic and environmental needs.

Results: In 2018, the programme was continued by the departments of Cereal and Grass Breeding, Laboratory of Genetics and Physiology of Institute of Agriculture, Department of Orchard Plant Genetics and Biotechnology of Institute of Horticulture and Institute of Forestry.

Genetic factors governing plant phenotype and stress response were investigated; new breeding material superior in productivity and quality was created and new varieties were developed, evaluation of progeny of selected trees, development and assessment of breeding populations was carried out.

In 2018, the results were published in: 9 articles in the journals indexed in Clarivate Analytics Web of Science database; 11 articles in other scientific journals; 120 new breeding lines were developed; 10 new varieties were submitted for registration; 4 varieties were registered. The results were presented in 16 scientific conferences.



Plant genetic studies under artificial climate conditions

6.3. Projects

In 2018, LAMMC implemented 27 international, 56 national research projects, funded by the Research Council of Lithuania, Ministry of Agriculture, Ministry of Environment, and fulfilled over 100 contract orders for Lithuanian and foreign economic entities (Table 2). A list of national and international research projects conducted in 2018 is presented in the appendices.

Table 2. Projects implemented by LAMMC in 2018

	International	Research Council of Lithuania	Ministry of Agriculture, Ministry of Environment, etc.	Lithuanian economic entities	Foreign economic entities	Total
Institute of Forestry	8	6	12	5	-	31
Institute of Horticulture	5	9	4	10	10	38
Institute of Agriculture	12	7	16	23	35	93
Regional Branches	2	-	2	27	2	33
Total:	27	22	34	65	47	195

6.3.1. National projects started in 2018

Other projects funded by the Research Council of Lithuania

Sub-activity “Research done by students during the non-study time”

1. “Enhancement of student competence in research on the effective use of biomass for bioenergy”. Leader Dr. Vita Tilvikienė. 2018 October 1 – 2019 April 30.
2. “The response of orchard and garden plants’ photosynthesis and antioxidant system to *Botrytis spp.* pathogenesis under light exposure”. Leader Dr. Viktorija Vaštakaitė-Kairienė. October 1, 2018 – 2019 April 30.
3. “Bio-response-based vegetable greens growing in indoor systems”. Leader Dr. Giedrė Samuolienė. 2018 October 1 – 2019 April 30.

Research funded by the Ministry of Agriculture

Support for applied research

1. “Preparation of Guidance Notes on Integrated Pest Management for main field and horticultural crops in Lithuania”. Project leader Dr. Roma Semaškienė. 2018–2019.
2. “Development of the Code for Good Agricultural Practice, whose application would mitigate negative effects of agriculture on soil, water, air and climate”. Project leader Dr. Virginijus Feiza. 2018–2019.

Support for projects of the measure “Knowledge transfer and information activities” (Program for the Lithuanian rural development 2014–2020)

1. “Diversification of crop rotation and optimization of biodiversity for restoration the agrotechnology and agro-ecosystem functions”. Project leader Dr. Lina Šarūnaitė. 2018–2020.

EIP activity group project (Program for the Lithuanian rural development 2014–2020)

1. “Targeted introduction of integrated pest control under intensive farming conditions”. Project leader Dr. Antanas Ronis. 2018–2020.
2. “Improvement and dissemination of innovative technologies for larch, spruce, birch and alder tree species plantation forestry breeding and maintenance”. Project leader Dr. Gediminas Čapkauskas. 2018–2020.

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

1. “Adjustment of the provenance regions of black alder, small-leaved lime and Norway maple based on DNA markers”. Project leader Dr. Virgilijus Baliuckas. 2018–2020.

6.3.2. National ongoing projects in 2018

Research funded by the Research Council of Lithuania

High level R&D projects (SMART)

1. “Development of wood modifying eco-friendly technology for higher value products”. Project leader Dr. Marius Aleinikovas. 2017–2021.

Despite good characteristics, wood also has disadvantages, such as resistance to the atmospheric effect, anisotropy and instability of dimensions, which limit wood use. To eliminate these defects,

wood is modified. **The aim of the project** is to create an environmentally friendly technology for the modification of wood properties, based on the reaction of wood bioactive compounds with the

modification reagent, and ensuring the rational use of ligno-cellulosic material and giving higher added value to the products.

In 2018, the modifier, on a basis of iron oxide solution, and technological parameters for impregnation applied for different tree species was investigated.

Five tree species (*Picea abies*, *Pinus sylvestris*, *Pseudotsuga menziesii*, *Juglans Regia*, *Acer platanoides*) were chosen.

The parameters of the process of modification of the wood process (temperature and time) required for a successful process for each tree species were analyzed.



Fir samples before and after modification

2. “Closed plant cultivation system for production of raw materials for peptide nanoengineering applications”. Project leader Dr. Danas Baniulis. 2017–2021.

The aim of the project is to develop a technology based on closed type plant tissue cultivation system that is dedicated for production of raw materials for preparation of peptides mimicking the extracellular matrix proteins (PMEM). There are no published reports on production of PMEM in plants, so far. New peptides mimicking functional domains of fibronectin and laminin are being used. At the first stage of the project, DNA constructs for selected PMEM is developed, transformation of tobacco plants performed and PMEM expression levels assessed. The developed tobacco lines are being used to establish closed type cultivation conditions that ensure production cost- and peptide function-efficient plant raw material preparation. Plant shoot, root and dedifferentiated cell tissues were employed. PMEM coated surfaces were constructed and quantitative characterization of the surfaces and their suitability

for the high-throughput assay applications using eukaryotic cells were assessed.



Dr. Rytis Rugienius and Jurgita Vinskienė. Preparation of the bioreactor for production of peptides in plant tissue suspension

3. “UV-A lighting strategies for controlled environment horticulture: upgrade to sustainable, high-value production”. Project leader Dr. Akvilė Viršilė. 2017–2021.

The objective of the project is to create the research result-based UV-A lighting application strategy for the improvement of phytochemical value and taste properties in different green vegetables, herbs for high-value production in closed environment horticulture systems. In 2018, the technological assumptions were explored and UV-A LED wavelengths and properties were selected for their installation in lighting system. Vegetative experiments were performed, analysing the effects of different LED wavelengths and doses on green vegetables and herbs, seeking for higher phytochemical content, internal and external quality, balanced growth and development. Effects were evaluated by performing biochemical analysis and measurements.



Additional UV-A lighting is potentially useful in increasing the yield of medicinal components from vegetable raw material

4. “Quality diagnostics of biogas production by-product (digestate) for innovative use as a biofertilizer”. Project leader Dr. Alvyra Šlepetienė. 2017–2021.

Anaerobic digestion of plant-derived biomass in biogas plants generates not only energy-efficient product, biogas, but also a waste product, digestate, which has the potential to be used as a biofertilizer. This, in turn, has triggered the need for rapid and accurate diagnostic methods for quality assessment of the biofertilizer. However, there are still few methods developed and little research done on this issue. This poses some problems regarding analysis of bioproducts. As a result, **the key objective of the project** is to develop new methods which would enable rapid and very accurate analyses of the biofertilizers. One of such methods to be used in the project is NIR spectrometry for which new equations will be developed. The method will enable evaluation of the specific instant chemical composition of the product. Based on the indicators of chemical composition, it will be possible to predict its impact on crops and the environment.

In 2018, samples of digestate and plant-derived raw materials were collected from the main regions of the country and were analyzed by chemical methods and spectrometrically.



Different types of bio-fertilizers

5. “Development of winter wheat varieties for amylose-free starch and vital gluten processing”. Project leader Dr. Gintaras Brazauskas. 2017–2021.

Largely automated, non-destructive and precise phenotyping system was constructed and implemented to evaluate autumn growth rate and de-hardening in early spring for eighteen winter wheat breeding lines and varieties. The experiment under field conditions is ongoing and the data is being collected.

Thirteen winter wheat cultivars of contrasting autumn growth rate were chosen for evaluation of LT50 determining freezing tolerance. 360 seeds were sown for each of genotype for 6 different temperature points at the artificial freezing test. Wheat plants were cold acclimated in natural conditions for 6 weeks. The freezing test is ongoing at the moment.

Genomic DNA was extracted from young leaves of 96 wheat breeding lines and cultivars. The composition of high- and low-molecular-weight glutenin subunits encoded in Glu-A1, Glu-B1, Glu-D1, Glu-A3 and Glu-B3 loci was evaluated by the means of PCR with allele-specific primers. Glu-B3f allele was detected in 70% of the tested lines; and approximately half of them contained Glu-A3c, Glu-B1c and Glu-D1d alleles

Grain chemical composition, technological properties and starch quality have been studied in 10 promising lines of winter wheat harvested in 2018 intensive (N200) and medium intensity (N130) fertilization backgrounds. Differences of fertilization backgrounds were more evident in the analyses of protein content and quality. First data from the collection of 34 waxy wheat lines show that

25 lines have sufficiently low falling number values (62–79 s) and that has led to the assumption these lines having low amylose content.

Promising winter wheat breeding lines and cultivars (79 genotypes) were investigated under 3 different cultivation conditions. Collection of amylopectin wheat (41 genotypes) was investigated under 1 cultivation system. Four breeding lines were tested in State Plant Variety Testing Centre. According to test results, 3 lines were sent for further testing in State Plant Variety Centre as well as for DUS testing to Poland.



Evaluation of wheat leaf growth rate during cold acclimation

6. “Enhancement of the multifunctional properties of legumes in feed and food value chain”.

Project leader Dr. Žydrė Kadžiulienė. 2017–2021.

In order to take advantage of the multifunctional properties of legumes, ecological benefits of the ecosystem, and increase confidence in legumes, it is important to evaluate all the benefits associated with the production of legumes in agro-ecosystems for feed and food value chains. Therefore, it is very important to have as many new research data as possible about common legumes, such as peas, but also about lentils and chickpeas, which are less common for the northern pedo-climatic conditions. It is important not only to develop new cultivars of legumes but also to comprehensively study their biopotential and utility, by combining biotic and abiotic factors with the eco-efficiency of agro-ecosystems, highlighting their added value in feed and food chains. Novel cultivars and innovative technologies will help to boost and provide more secure and high quality plant-derived raw material for feed and food value chains.

The aim of the project is to develop innovative legume-growing systems based on their multifunctional value and to enhance their use as more environment- friendly plant-derived raw materials in feed and food chains. The project has 2 tasks: i) to investigate the agronomic and technological properties of the new cultivars and breeding lines of peas, lentils and chickpeas and their value in the conventional and organic production systems as influenced by the interaction of biotic and abiotic factors; ii) to develop pea cultivar-specific cultivation technologies and to design tentative soil and crop management schemes for lentil and chickpea cultivation.

In the first year of the project a total of 72 lines of peas have been investigated in the organic and conventional crop rotations. 28 pea breeding lines in the conventional crop rotation and 32 pea breeding lines in the organic crop rotation were selected for further testing. Several field experiments have been

launched, the results of which will contribute for the development of pea cultivation technologies for conventional and organic farming systems, and the tentative management schemes in the northern pedo-climatic conditions for the production of lentils and chickpeas.



Technological experiments of legumes and “SmartLegume” project team



Development of new varieties of peas “SmartLegume” project

Grant for high-level researchers’ group project

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

Project leader Dr. Audrius Menkis. 2017–2020.

The overall objective is 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

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.

Project aims are:

1. To enhance competence and research skills of researchers by studying and modelling possible impact of climate change on forest microorganisms as one of the principal components of forest biodiversity responsible for tree diseases and their biocontrol, and nutrient, carbon and water cycling in forest ecosystems;

2. To enhance competence and research skills of researchers by investigating interactions among individual components of forest biodiversity and host trees while determining their practical importance to health of the trees, which currently are severely devastated by invasive diseases;

3. To enhance competence and research skills of researchers by investigating how and to what extent closely-related and threat-tolerant, but non-native tree species can constitute alternative hosts to different components of indigenous forest biodiversity, which otherwise can be lost due to rapid decline of disease-devastated native tree species.

Ongoing work: selection of sample plots, field sampling, sample preparation for DNA extraction, sample preparation for sequencing, the growth of microorganisms, grouping of pure culture and their morphological identification.



Sample taking

6.3.3. National projects completed in 2018

Research funded by the Lithuanian Research Council

**Projects of the national research programme
“Sustainability of agro-, forest and water ecosystems”**

1. “The influence of long-term contrasting intensity resource management on soils of different genesis and on other components of agroecosystems” (AGROTVARA).

Partners: LAMMC, ASU, VU. Project leader Dr. Virginijus Feiza. 2015–2018.

Relevance of the Programme – EC Directive (COM(2006) 232) sets out common principles for Soil Thematic Strategy to protect soils across the EU. The document sets out that the EU Member State will be in a position to decide how best to protect soil and how to use it in a sustainable way on their own territory.

The goal of the programme is to evaluate soil fertility potential in agricultural and forest ecosystems, to develop the factors which affect their degradation and to choose the measures to maintain soil sustainability, to optimize carbon cycle in the soil, to reduce greenhouse gas emission and plant nutrient losses from the soil in different regions of the country.



High yield can be produced only on fertile soils

The research is focused on three basic directions:

- 1) Productivity improvement and reduction of degradation processes in the soils of morainic and limnoglacial origin;
- 2) Rational use of natural soil resources, organic and mineral materials of local origin;
- 3) To evaluate productivity potential of agricultural and forest soils.

To gain a deeper insight into the processes taking place in the soil, scientists of different scientific branches (agriculture, biomedicine, physical sciences) are involved.

2. “Establishment and diversity of a newly emerging cereal pathogen in the agroecosystem due to changing climate and farming practices” (EDNEPA).

Partners: LAMMC, NRC. Project leader Dr. Gražina Kadžienė. 2015–2018.

In recent years, there have been observations of rearrangement of causal agents of Fusarium Head Blight in Northern Europe. Previously dominating *Fusarium avenaceum*, *F. poae*, *F. sporotrichioides* and *F. culmorum* species are being replaced by more harmful *F. graminearum*. This change causes new ecological and economic issues like increased levels of mycotoxin deoxynivalenol in grain and overall poor seed quality. No-tillage, the successive growing cereals after cereals and climate warming create favourable conditions for this pathogen to thrive, which, in turn, may cause epidemic outbreaks.

The aim of the project was to investigate the establishment of *F. graminearum* in crop rotations by analysing physiology and population structure of the pathogen. *F. graminearum* presence in agroecosystem, genetic diversity, cross pathogenicity and soil fungistatic activity against the pathogen were investigated.

It was established that *F. graminearum* has a high genetic diversity and is present in all investigated elements of the agroecosystem: segetal and non-cereal plants of crop rotation (potato, spring oilseed rape, pea and sugar beet), soil and plant residues. This fungus was isolated from 41 weed species, 27 (dicotyledonous) of which were identified as alternative hosts for this fungus for the first time.

In 2018, the participants of the programme published 12 papers in journals having IF, 5 papers are under revision, 11 articles were published in popular press, 2 chapters were published in monographs, 5 recommendations for practical farming were published, 21 oral and 7 poster presentations were made at national and international conferences.

F. graminearum isolates showed a cross pathogenicity, suggesting that alternative hosts, identified in cereal crop rotations, may act as the additional sources of FHB infection and non-cereal plants grown in rotation cannot create a safe biological barrier between pathogen and its primary hosts.

The soil of all investigated fields showed high (on average 80 %) suppression effect against *F. graminearum* growth. The strongest antifungal activity was exhibited by *Bacillus amyloliquefaciens* strain Hy7 (GenBank no.: JN382250).



Project team

3. “Response and plasticity of different tree species & juvenile-stage forest communities under impact of climate change and other environmental stressors” (MIŠKOEKOKAITA).

Partners: LAMMC and GTC. Project leader Prof. Dr. Alfars Pliūra. 2015–2018.

Increasing frequency and amplitude of abiotic and biotic disturbances driven by climate change affect forest regeneration, and may compromise

genetic and species diversity, persistence of natural successions, productivity and sustainability of forest ecosystems.

The aim of the project was therefore to study response, plasticity and competition of seven most important in Lithuania forest tree species – pine, spruce, oak, ash, birch, alder and aspen, their populations under increased temperature, CO₂ concentration and a complex of stressors such as frost, heat, drought, increased UV radiation and ozone concentration. Response and plasticity of tree species and populations in simulated mono- and multi-species communities was investigated in phytotrone based on a complex of growth, physiological and biochemical parameters. Significant general, species-specific and population-specific reactions to the applied complex treatments were found. Most species, except for spruce and pine, benefited from increased temperature and CO₂ in all treatments. However, drought reduced performance of birch, alder and aspen. Additional exposure to increased UV-B radiation and ozone concentrations even more negatively affected deciduous tree species.

Studies of regeneration, competition, species and genetic (DNA) diversity of regenerating tree communities in ecologically sensitive natural habitats affected by various disturbances (e.g. clear cuts, wind throws, etc.) showed increased spatial and temporal structurization and domination of deciduous pioneer tree species, which leads to species and ecosystems successions from hemiboreal to temperate forests. If regeneration is abundant, the DNA genetic diversity

of regenerating ecosystems does not decrease and is supplemented by long distant gene flow. This contributes to change of genetic structure and features of new forming ecosystems.

The obtained new scientific information was presented in 7 scientific papers in *CA WoS* IF journals and in presentations in international conferences in Tokyo, Riga and Vilnius. Forecast of forest ecosystems development under climate change was prepared as well as recommendations for maintenance of sustainability of forest ecosystems.



Phytotron tests of offspring of 7 tree species' populations

4. “Study of impact of clear cuttings on biodiversity dynamics in forest ecosystems”.

Partners: LAMMC, VDU, VU. Project leader Dr. Remigijus Daubaras (VDU).

Project leader of LAMMC part Dr. Vidas Stakėnas. 2015–2018.

During clear cuttings, the ecological balance of forest ecosystems is suddenly disturbed, resulting in the changes in ecosystem components. The structures of plant and insect populations, as well as permanent processes in the soil are changing.

The objective of the project is to identify the impact of clear cuttings on forest ecosystem components (ground vegetation, entomofauna and soil), and to propose measures for the conservation

of ecosystem biodiversity and the sustainable use of resources.

The concentrations of nitrate and ammonium nitrogen increased in the mineral soil of clear cuttings compared with the control forest, especially during the second year after the clear cutting. This is due to more intensive decomposition of the logging residues and forest litter in the cutting sites.



Collection of logging residues in the cutting sites



Collection of soil samples

The decomposition of logging residues and forest litter in the cutting sites increases the mineralization (ammonification) and nitrification of organic nitrogen, especially in the mineral topsoil (0–10 cm). This indicates that soil microbiota (mainly bacteria, micromycetes and actinomycetes) decompose the organic carbon and nitrogen more intensively. The mass of ground vegetation (mosses, grasses and shrubs) in the sandy clear cuttings decreased by 2–3 times during 1–3 years after cutting compared with the control forest. The largest decrease was found for

the mosses mass, i.e. it decrease 2.4 times. Although the mass of grasses increased by 50 times in the cutting sites, their mass represented only a small part of the total vegetation mass.

On average $10.37 \pm 3.9 \text{ t ha}^{-1}$ of biomass remain at the clear cuttings of Na and Nb forest sites, when logging residues are harvested for biofuel. It amounts to about $21.1 \text{ m}^3 \text{ ha}^{-1}$ of wood. It was found that about 25% of the potential of logging residues are left in the cutting sites due to technological capacity.

5. “Integrated impact of climate and environmental changes on the productivity, biodiversity and sustainability of agro-ecosystems” (KLIMAGRO).

Partners: LAMMC (Dr. Sandra Sakalauskienė, Dr. Jurga Miliauskienė), VDU, ASU.

Project leader Prof. Dr. habil. Romualdas Juknys (VDU). 2015–2018.

The aim was to study the integrated impact of climate and environmental change on crops and their competitive and symbiotic interactions, to prepare recommendations to reduce the negative impact of climate change on agro-ecosystems and their sustainability. In the study of the effects of warmed climate on the competitive interaction between crops and weeds, the increased CO_2 concentration significantly induced the photosynthesis of peas and spring barely and also increased the water use efficiency and biomass as compared to wild mustard. However, this does not mean that climate change will reduce the competitiveness of weeds in general, as weeds are more resistant to the effects of extreme climatic conditions, ground-level O_3 and other environmental factors. The investigation of barely and wild mustard competitiveness strain due to increased concentration of ground-level O_3 , demonstrated that wild mustard caused a strong competition for barley, leading to reduced accumulation of biomass and leaf area. Competitive impact of wild mustard increased as spring barley was exposed to elevated O_3 at ambient air, and especially great biomass losses and reduction of photosynthetic rate were determined under the O_3 under warmed climate. Under changing climate, it is important that agricultural technologies not only induce the productivity of plants, but also have a positive effect on soil organic carbon (OC) pool. Analysis of long-term (1999–2016) changes in soil OC pool under warming climate showed that only conventional tillage did not increase the pool of soil OC. Though, while shallow rotovating, cover cropping and no-tillage were processed, the accumulation of soil OC increased on average 1.5-fold in ploughed horizon. Due to the increase

in soil C:N ratio and lower mineralization of soil microbial biomass, minimized soil tillage system intensifies the accumulation of soil OC as well as soil humification.



Damage caused to spring barley leaves by increased levels of ground-level ozone



Competition between spring barley and wild mustard

Projects of researchers' teams

1. "Control of nitrate reduction in green vegetables: metabolic effects of light and other environmental factors". Project leader Dr. Akvilė Viršilė. 2015–2018.

The objective of project was to evaluate the effects of light spectrum, intensity and other technological parameters on nitrate, nitrite contents in green vegetables, the activities of reducing enzymes, the trends of nitrogen assimilation to amino acids and interconnections between nitrate metabolism and photosynthesis processes. The obtained results are relevant not only for evaluation of the dynamics of NO_3^- ions, as possible contaminants of vegetable production, but also are important for the modelling of nitrogen assimilation process, seeking to control productivity and quality of green vegetables and the efficiency of cultivation process. The direction of nitrate metabolism depends on technology applied (substrate type, mineral nutrition, lighting parameters) and on natural seasonality of environmental factors. However, the obtained results show high specificity of this process for different plant species, varieties and cultivars. The knowledge obtained can be applied when optimizing cultivation technologies in greenhouses and in closed environment precision horticulture systems, seeking for high productivity, quality and nutritional value of vegetable produce.



Lighting and mineral nutrition significantly change assimilation of nitrates in green vegetables



Not only light flow, but also spectrum is an important tool for controlling nitrate metabolism in green vegetables

2. "Development of molecular markers for genomic selection of adaptation in perennial ryegrass" (ADAPTGENAS). Project leader Dr. Gintaras Brazauskas. 2015–2018.

This project aims to develop molecular markers for adaptation genomic selection in perennial ryegrass. A collection of 150 perennial ryegrass populations was tested under field and artificial environment conditions. Winter survival, regrowth, earliness, plant height and dry matter yield were evaluated in a field experiment. Results showed high variability of investigated traits among the tested populations. Freezing tolerance of the tested populations was evaluated under controlled environment conditions. An LT_{50} score was estimated for each population by determining the temperature at which 50 % of plants get killed. Artificial freezing revealed substantial variation for freezing tolerance among the tested populations with LT_{50} values range of -9.81 to -5.37 °C. Diploid populations were more resistant to freezing than tetraploid, while wild populations had similar LT_{50} values in comparison to cultivated varieties. LT_{50} values were used for genome wide

association analysis (GWAS). Genotypic values were represented by more than 1 million single nucleotide polymorphisms (SNP) markers produced by T. Asp at Aarhus university (Denmark). GWAS revealed



Evaluation of freezing tolerance of perennial ryegrass

8 SNP markers significantly associated with freezing tolerance. Seven of these markers were within genes with putative functions in abiotic resistance. During the third year of the project, surviving plants from the field experiment were collected and genotyped. This facilitated identification of additional 48 SNP markers for genomic selection for adaptivity. Tetraploid perennial ryegrass genotypes were produced by application of antimitotic agent colchicine. No significant differences in gene expression were observed between diploids and induced tetraploids. Most likely larger cell size of tetraploids determines their poorer survival during exposure to freezing temperatures.



Evaluation of perennial ryegrass adaptivity under field conditions

3. “Role of lipids in low-temperature adaptation of Apple”.

Project leader Dr. Perttu Haimi. 2015–2018.

Freezing injury remains one of the main problems affecting crop yields in temperate climate zones and Lithuania. During exposure to low but non-freezing temperatures, plants have developed metabolic responses called cold acclimation. One of them is the change in membrane lipid composition.

We aimed to determine lipid composition and changes important for formation of cold hardiness in apple trees.

Liquid chromatography – mass spectrometry (LC-MS/MS) – based lipidomics platform allowed us to detect main lipid classes: monogalactosyldiacylglycerol (MGDG), digalactosyldiacylglycerol (DGDG), sulfoquinorosyldiacylglycerol, phosphatidylglycerol, phosphatidylcholine, phosphatidylethanolamine, phosphatidylserine, phosphatidylinositol (PI), phosphatidic acid, diacyl- (DG) and triacylglycerols. The major fatty acids (FA) observed were 18:3, 18:2, 18:1 and 16:0. Small amount of 16:1 was found from MGDG and DGDG. The FA profile of apple corresponds to a 18:3 plant.

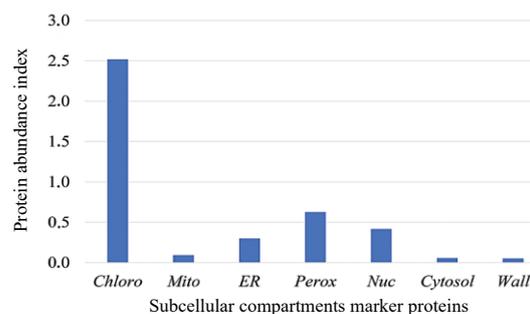
Lipid change under *in vitro* conditions shows that in apple, cold adaptation of cellular membranes may be mainly accomplished by increasing of FA unsaturation.

Lipid changes were observed in field grown plant samples collected during different vegetation periods. Lipids with the highest concentration in spring made the biggest group, containing all lipid classes except PI. High abundance of different DG species during spring implies intensive lipid

remodelling at this period. Smaller group of lipids had the highest concentration in autumn and winter. More unsaturated and longer FA is typical for this group.

FA synthesis occurs in chloroplasts, therefore we investigated proteome of the organelle. Protein analysis by LC-MS/MS revealed more than 700 proteins. Bioinformatics approach allowed us to assign 20 of the identified proteins to lipid metabolism.

Chloroplast proteome in control and acclimated plants, susceptible and tolerant apple cultivars will lead to better understanding of apple acclimation mechanisms and help in plant breeding.



Compartments labelled: *Chloro* – chloroplasts, *Mito* – mitochondria, *ER* – endoplasmic reticulum, *Perox* – peroxisomes, *Nuc* – nucleus, *Cytosol* – cytosole, *Wall* – cell wall; marker amount expressed as protein abundance index Error bars indicate the 95% confidence interval of the mean.

4. “Lycopene extraction using supercritical fluids and application of extracts in development of innovative products”. Project leader Prof. Dr. Pranas Viškelis. 2015–2018.

The aim of the project was to study, model and optimize the extraction of lycopene, other carotenoids and biologically active compounds using supercritical fluids from tomatoes and tomato processing byproducts, ensuring rational and

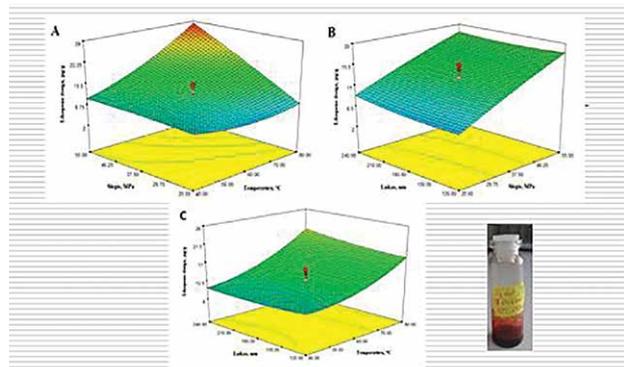
sustainable processing of vegetable raw material into high-value and diverse functional food ingredients.

The research carried out and the results obtained can be the basis for the development of rational, environmentally friendly, non-perishable, wasteless

processing technologies aimed at obtaining high value biologically active components. The valorization of raw tomatoes contributes to the development of sustainable production technologies, with the possibility of recycling tomato secondary raw materials and creating food supplements and / or functional high-value food products. To rationally use raw materials, various extraction parameters were optimized for use of vegetable raw material, such as the degree of crushing of the material (particle size), solvent polarity, extraction temperature, pressure, duration, solvent flow. It has been determined that selecting appropriate raw material processing technologies and evaluating the chemical-physical parameters of the raw material can selectively distinguish useful plant materials and concentrate their bioactive compounds. It was found that using the smallest fraction of lyophilized tomatoes and tomato cake with a particle size ≤ 0.2 mm reduces the CO₂ diffusion distance to the particle matrix during supercritical extraction and therefore increases the extraction rate and yields of the oil fraction. Isomerized lycopene extracts can be used as food additives, food supplements and cosmetic ingredients with anti-inflammatory effects. Lipophilic extracts with cis-lycopene isomers (60%), extracted with supercritical carbon dioxide from processed tomato materials have been adapted to the cosmetics industry. The blend of tomato juice with isomerized lycopene extract has been introduced into production.



Supercritical carbon dioxide extraction of lycopene



3D response surface plots of SC-CO₂ showing the effects of independent variables on extraction yield of the tomato by-product oleoresin and cis-lycopene isomers in oleoresin: (A) effect of extraction temperature and pressure (time 180 min); (B) effect of extraction time and temperature (pressure 37,5 MPa); (C) effect of extraction time and pressure (temperature (60 °C)

Applied research funded by the Lithuanian Ministry of Agriculture

Support for applied research

1. **“The dynamics of grain contamination with mould fungi as influenced by climate, grain storage facilities and conditions”**. Project leader Dr. Audronė Mankevičienė. 2017–2018.

The aim of the project was to determine the effect of microscopic fungi infection level on grain harvested under different conditions on grain quality and mycotoxin production during storage and to prepare visual illustrations for the identification of fungal damage on grain.

Of the total wheat samples analysed during the period 2016–2017, 79 % were black-dot infection positive (with infected grain constituting more than 1 % in a sample). The abundance of black dots on grain did not have any effect on the increase in deoxynivalenol (DON) concentrations in wheat grain samples. Higher concentrations were detected in the samples where fusarium-infected grain accounted for more than 1 %. The level of black-dot infection on grain, higher moisture (16.2–19.5 %), and storage temperatures (+4°C, +16°C, +20°C, +28°C) did not exert significant effect on the variation of DON concentrations.



Black-dotted grain

It is dangerous to store grain with higher moisture content when fusarium-infected grain is higher than 1 % in a sample. DON concentration increased to 25 %. No significant correlations were found between black-dotted grain and main quality indicators.

Both wheat and barley grain samples collected from different grain purchasing companies in 2016–2017 were found to be heavily infected with *Aspergillus* and *Penicillium* spp. fungi, while higher concentrations of aflatoxin (AFL) were detected in barley grain. Although AFL concentrations in most grain samples did not exceed the allowable limits

laid out in EC regulations, this is a warning about the drawbacks in the grain production chain. Fusarium infection was identified in all malting barley grain samples inspected, and the infection level ranged from 0.5 to 6.1 %. According to the requirements of IST121738915-01:2016 standard (Malting barley. Purchasing and supply requirements), such grain cannot be used in the process of malt production. According to the mycotoxin infection level, only 42 % of the analysed malting barley samples were suitable for being used for malt production.

2. “Optimizing the nutrition of garden plants and vegetables using natural biostimulants”. Project leader Dr. Ona Bundinienė. 2017–2018.

The latest agri-environment requirements promote reduction of use of synthetic fertilizers and chemical plant protection products in the cultivation of agricultural produce. In recent years, various biologically active substances of natural origin – biostimulants have been developed. They are used to increase the crop yield and improve its quality and may partly replace synthetic materials. **The study aimed** to assess the impact of biostimulants of natural origin on the yield and quality of the main field vegetables, potatoes, berries and garden plants.

Biostimulator Ferbanat L increased biometric indicators and yield of the main field vegetables (onion, carrot, beetroot and white cabbage) and potato compared with the control treatment without biostimulants or with the treatment applied with the biostimulant Delfan Plus. Income and profit were also increased. After harvesting, higher contents of organic matter, humus, and organic carbon and less mineral nitrogen remained in the soil.

Higher apple yield was produced having applied 1.0% concentration of Ferbanat L solution and Delfan Plus 2 l ha⁻¹. The effect of biostimulants on strawberry yield was not observed. Biostimulants

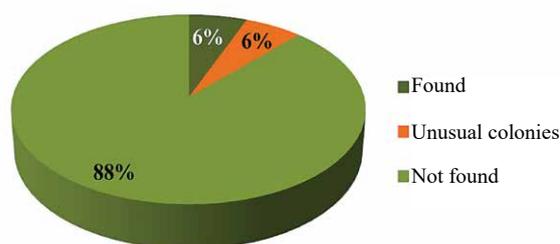
influenced mineral nutrition of apple and strawberry. The amounts of nitrogen, phosphorus, potassium, iron and manganese in apple leaves increased. The highest content of dry soluble solids in strawberry berries was found in the treatments applied with the solution of 1.0% concentration of Ferbanat L.



Application of biostimulants in onion, beetroot and carrot cultivation

3. “Research and methodological recommendations for the risk factors of primary plant products grown in Lithuania”. Project leader Prof. Dr Pranas Viškelis. 2017–2018.

The aim of the work is to develop methodological recommendations for the risk factor management of primary plant products (fruits, berries, vegetables, cereals, mushrooms, sprouts, spices and wild plants) grown in Lithuania and in the country’s farms. The legislation on the hygiene, safety and quality of primary plant products, as well as the use of plant protection products has been analyzed and the essential requirements for the management of risk factors have been formulated; biological, chemical and physical risk factors for primary plant products grown in Lithuania were



Detection of pathogenic microorganisms in the tested primary plant products

identified; laboratory analysis of biological and chemical risk factors of primary plant products grown in Lithuania were carried out; methodological recommendations for the management of risk factors of primary plant products grown in Lithuania were prepared (identification of risk factors and tools for their management, selection of plant production areas, water irrigation, use and control of plant protection products, proper preparation conditions (premises, facilities, tanks, vehicles), primary harvesting, loading, transporting, storing, packaging, harvesting, post-harvest treatment, procedures and tools for self-monitoring and traceability systems, ensuring safety of products on the market, ensuring quality requirements).



Use of pesticides is an important part of horticulture

4. “Pest risk analysis for *xylella fastidiosa* (wells et al.)”.

Project leader Dr. Artūras Gedminas. 2016–2018.

The aim of the project is to analyze the origin and risks of distribution of bacterium *Xylella fastidiosa* (Wells et al.) The phytosanitary condition and distribution in Lithuania’s territory (65 study sites) of the main host plants (27 species) of this hazardous bacterium were assessed. The number of assessed host plants totals 6800, while plants of the worst condition were detected in Panevėžys and Telšiai regions, in the garden communities and city parks. During the project course, the complex of potential carriers (vectors) for this bacterium was determined. The complex was composed of 58 species of insects of Cicadoidea from the 6 families: Aphrophoridae, Cicadellidae, Membracidae, Delphacidae, Cixiidae and Cercopidae. In total, 7000 insects were identified. It was determined that the phytosanitary risk of the alien prejudicial plant pathogen *X. fastidiosa* is possible (4th category), therefore it is a suitable candidate for performing the 3rd stage as “selection of pest phytosanitary

risk feasibility management”. The guidelines for preventive monitoring of bacterium *X. fastidiosa* and methodology for monitoring of possible carriers were prepared.



Possible vector of the disease – *Centrotus cornutus* L.

5. “The state of crop stands and yielding forecast of agricultural crops in Lithuania”.

Project leader Dr. Virginijus Feiza. 2016–2018.

The goal of the project was to evaluate the crop stands’ situation and provide the yielding forecast for agricultural crops for different agro climatic zones (Western, Central and Eastern Lithuania) 4 times per vegetation period.

May and June of 2018 were unfavourable for cereal growing due to water shortage and poor nutrient availability. Winter and spring oil-seed rape growing becomes complicated due to high infestation of insects and strong restriction of insecticide application by the law. The area occupied by this crop is expected to decrease, while the area cultivated with maize and its yielding are expected to increase. With the climate change (climate becoming more arid), less damage will be done to grass leys consisting of deep rooting leguminous plants

(red clover, alfalfa) because they are less sensitive to dry climatic conditions. The area cultivated with spiked grasses is expected to decrease.



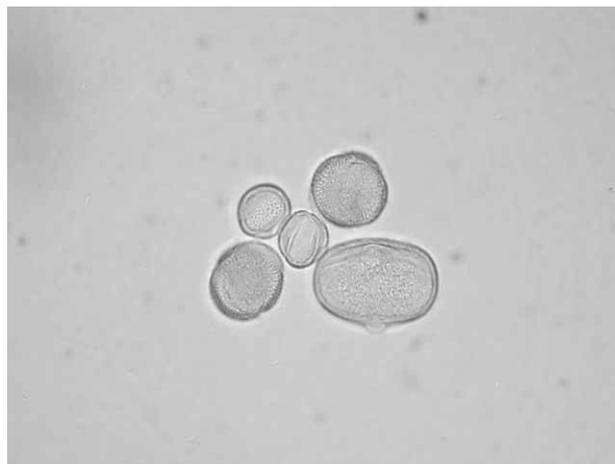
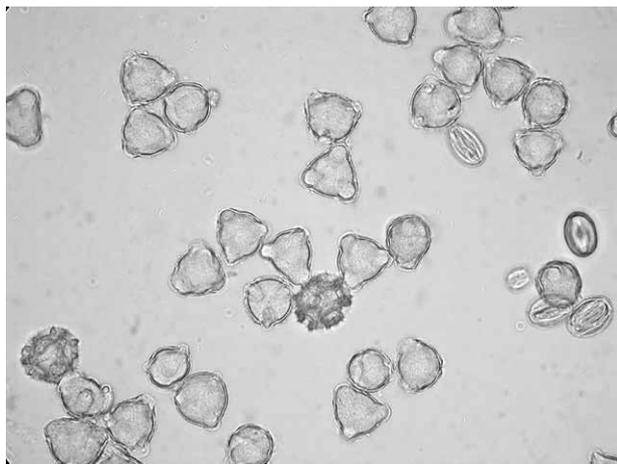
Experimental fields in Dotnuva

6. “Qualification and quantification of pollen, extracted from honey and their correlation with the flight distance of the honey bee”. Project leader Dr. Kristina Jaškūnė. 2016–2018.

The study was aimed to determine the mean flight distance of honey bees in order to prevent introduction of GMO into production of apiaries by using pollen species identification in honey of Lithuanian origin.

Output: total content of pollen in honey accessions was evaluated, the percentage of oilseed rape pollen,

as one of the most nectar producing plant species, was 0.008 %. The mean flight distance of the honey bees to highly nectar producing crop fields was 1.37 km; however, it did not influence the content of oilseed rape pollen in the total weight of honey.



Determination of botanical origin of honey by identification of pollen present in it: dandelion and fruit trees (on the left), bean, oilseed rape and willow (on the right)

7. “Estimation of Phytosanitary Condition of New Garden Plant Varieties and Creation of Highest Category Propagating Material”.

Project leader Ingrida Mažeikienė. 2016–2018.

The aim of the work is to ensure the health of new varieties of garden plants for which the application for DUS (distinctness, uniformity, stability) testing has been submitted.

The phytosanitary health of the newly created varieties of garden plants was confirmed according to the pathogens indicated in the EPPO certification standards for *Malus* spp., *Prunus* spp., *Ribes* spp. and *Rubus* spp. Molecular and bioassay methods have shown that the planting material of newly developed varieties is free from pathogenic infections according to EPPO certification standards. The adaptation of shoots of new varieties of garden plants ‘Poema’, ‘Alemanda’, ‘Lauda’, ‘Bosanova’, ‘Verknė’, ‘Domino’, ‘Viktor’, ‘Ritmo’, ‘Aldoniai’, ‘Didikai’, ‘Mistika’ and ‘Vizija’ ranges from 40 to 85% in the *in vitro* system and multiplication index of 4.7 to 8.7 was obtained. 66.7–93.3 % of microplants of black currant (‘Domino’, ‘Viktor’, ‘Ritmo’, ‘Aldoniai’, ‘Didikai’) and 93.2–95.4 % of raspberries (‘Mistika’, ‘Vizija’) were rooted *in vitro*. It was shown that genomic variability during manipulation *in vitro* is characteristic of black currant

and raspberry plants. Morphological descriptors and genetic passports have been created of new varieties of garden plants: ‘Poema’, ‘Alemanda’, ‘Lauda’, ‘Bosanova’, ‘Verknė’, ‘Domino’, ‘Viktor’, ‘Ritmo’, ‘Aldoniai’, ‘Didikai’, ‘Mistika’ and ‘Vizija’ for identification and protection against the plagiarism of these genotypes.



Studies of orchard plants

Support for beekeeping sector

1. “Investigation of the *Apis mellifera carnica* bee lines, consolidation and conservation of the gene pool”. Project leader Dr. Violeta Čeksterytė. 2018.

The long-term aims of development of Carnica (Carniolan) bee race are: high adaptability of bees to the conditions of Lithuania, efficient use of all the honey-flows, good *overwintering* and acceptance by beekeepers. A short-term task is to apply crossing of Carniolan bee lines and create different bee lines with the highest indicators of viability and development. According to research data, all surveyed bee colonies meet the *Apis mellifera* Carnica bee standard.

Output: morphological characteristics were assessed for 102 bee colonies of Carnica race and their biological, economic characteristics were evaluated in 2018. In the spring, bee colonies developed well and quickly. Bees of Carnica line L3-Cslov produced on average 36.21 kg of spring honey per colony. The incidence of swarming was low, bees kept the nests clean and exhibited minimal aggressiveness.

Of the total 102 colonies tested, 28 showed very high hygienic behaviour. The latter colonies uncapped and removed from comb cells 81–100% of killed pupae. Colonies exhibiting enhanced hygienic behaviour were selected for queen rearing

and formation of parent colonies. All the tested bee colonies were infected with the Black Queen Cell Virus (BQCV). Sacbrood virus (SBV) of the honeybee (*Apis mellifera*) was detected in 12 samples collected from different colonies. No clinical signs of the diseases were determined in the bee colonies, bees were only carriers of viruses.



Carniolan (*A.m.carnica*) bees and bee queen (marked by a yellow dot)

2. “Application possibility and effectiveness of the veterinary medical products Api Life VAR and Api-Bioxal for the control of *Varroa* mites”. Project leader Dr. Violeta Čeksterytė. 2018.

Project leader Dr. Violeta Čeksterytė. 2018.

The project was aimed to investigate the effect of the veterinary medical products Api Life Var and Api-Bioxal on bee ectoparasites *Varroa destructor*, to determine their efficacy in laboratory and field conditions, possibilities of their use for honeybee treatment against varroosis under Lithuanian climate and honey flow conditions.

Output: the overall efficacy of Api-Bioxal was 81.34 %. About 20.0% of *Varroa* mites remain in the bee colonies after treatment, therefore treatment should be performed at least twice per rotation of the brood (within 21 days). No adverse effects of Api-Bioxal on bees, hives, bee queens, or colony development were observed. Due to the high ambient air temperature and the reaction of bees to it, Api Life Var effect was not established in the bee colonies without and with brood. An overall efficacy of Apivar was 98.20 % in the laboratory conditions. *Varroa* mites have not developed resistance to this product yet, therefore it is sufficient to use two strips, as is recommended by the manufacturer of the product.

The average efficacy of Apivar in bee colonies without brood was 98.13 %. Almost 2% of mites remain unaffected, therefore, when there is no brood, additional treatment with oxalic acid is recommended.



Preparation for testing of hygienic behaviour of bees



Test of hygienic behaviour of bees

Research funded by the Lithuanian Ministry of Environment and subordinate institutions

1. “The services for level II forest monitoring”.

Project leader Dr. Vidas Stakėnas. 2018.

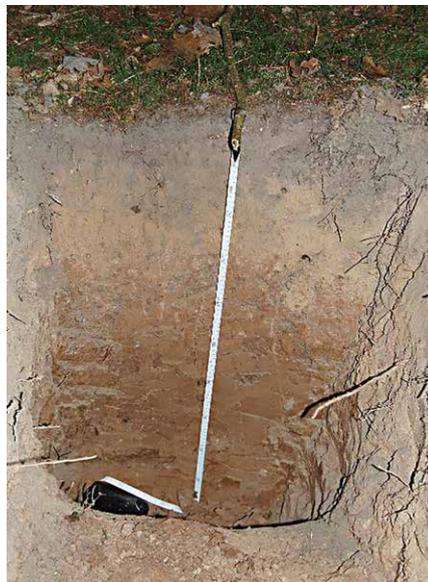
The resolution of European Commission (EC, 1995) of April 29, 1994 obliged EU countries to implement Forest Monitoring (Level II) program.

The goals of the Intensive Forest Monitoring Program are: 1) to collect and evaluate information on the impact of environmental pollution and other stressors on the most common (typical) forest ecosystems; 2) to investigate the causal relationship between the condition of trees and air pollution and other stressors that could affect the condition of forest ecosystems.

In 2018, the tasks of Intensive Forest Monitoring (Level II) were carried out in accordance with the planned and successfully functioning scheme for many years, in line with the requirements and methodology of the ICP-Forests program. In 9 observation plots, the following parameters were assessed: the tree crown condition was evaluated according to the morphological parameters; air pollution, soil solution quality, amount of pollutants (deposition) open field and under tree crown, amount of litterfall, intensity of ozone-induced damage.

According to the long-term data of the Forest Monitoring (Level II) program, the average atmospheric deposition amounts found annually (2000–2017) are as follows: 4.8 kg/ha of S; 8.5 kg/ha of N; 4.9 kg/ha of K. The negative and most often statistically significant correlation between atmospheric deposition and the amount of precipitation was determined. Investigations of chlorine and sodium concentrations in open field precipitation showed that depending on the distance from the Baltic Sea, the concentration of these elements is reliably reduced.

After analyzing the trends of ground-level ozone concentrations, it was found that the ozone-induced damage to the leaves increased by 0.17% during the 2007–2017 period.



Soil profile description in the newly established intensive forest monitoring (ICP Forest) plot



The newly established plot of the intensive forest monitoring program (ICP Forest) in Dubrava forest enterprise

2. “Dependence of wood properties of Norway spruce and silver birch on growing conditions and genotype”.

Project leader Dr. Virgilijus Baliuckas. 2016–2018.

The aim of the study was to investigate wood properties of the progeny of Norway spruce and silver birch Lithuanian populations in field trials, to select populations and families with the best quality of wood.

Wood density of spruce and birch was slightly higher in less fertile sites with normal soil moisture.

The average heritability for wood hardness in field trials was high and similar for both investigated tree species. A high heritability for wood density was calculated in different field trials. The genetic correlation between the wood hardness and the ring width for the spruce was moderate negative, and higher correlation was found in the less wet sites. The

correlation between these traits was close to zero for silver birch and it was higher in less fertile sites. The genetic correlation between the wood hardness and density for the spruce was low negative in wet sites and low positive in dry sites. The genetic correlation between the ring width and wood density was insignificant and positive. The site effect was much higher for spruce wood hardness than for the other wood properties. The site effect was insignificant for all investigated wood traits of silver birch. The population effect was insignificant for all wood traits of the investigated tree species. The family effect was significant for all the wood traits of both species. Genotype x environment interaction was significant for all the wood traits of spruce and birch, but the family effect in the model remained significant only for the wood hardness.



Collection of wood increment cores in field trials of silver birch

3. “The potential damage of natural enemies to capercaillie nests in the Varėna district forests”.

Project leader Dr. Rytis Zizas. 2017–2018.

Forests grouse birds capercaillie (*Tetrao urogallus*) as well as Black grouse (*Tetrao tetrix*) and Hazel grouse (*Bonasa bonasia*) populations in Lithuania and worldwide are declining. Nest predation is an important determinant of breeding success, but the relative role of predators is poorly known, at least in Lithuania. During the nesting seasons of 2017 and 2018, an experiment using more than 700 artificial ground nests was performed. Artificial ground nests, imitating capercaillie nests, were placed in clear-cuts and in mature forests around capercaillie mating places and in random plots. Wildlife cameras (n=10) were used for identifying potential predators. Results indicate that the destruction is threatened to approximately 1/3

capercaillie and other forests grouse birds nests. The potential predators in the mature forest are Red foxes and Common ravens in the clear-cuts.



Destroyed capercaillie natural (left) and artificially installed ground nest (right) by common raven (*Corvus corax*)



The red fox (*Vulpes vulpes*) found artificially installed capercaillie ground nest at mating place

Other projects funded by the Research Council of Lithuania

Sub-activity “Research done by students during the non-study time”

1. “Morphological and photosynthetic response, distribution of nitrogen in lettuce under assimilative light”. No. 09.3.3-LMT-K-712-03-0009. Leader Dr. Giedrė Samuolienė. 2017 October 2 – 2018 April 30.
2. “Metabolic interrelations between nitrates and ascorbic acid: the control of nutritional value indices in green vegetables in controlled environment agriculture”. No. 09.3.3-LMT-K-712-03-0024. Leader Dr. Akvilė Viršilė. 2017 October 2 – 2018 April 30.

Sub-activity “Development of students’ competences through participation in scientific summer practice”

1. “Development of students’ competences through participation in scientific summer practice at LAMMC”. No. 09.3.3-LMT-K-712-09-0206. Leader Dr. Vita Tilvikienė. 2018 July 1 – 2018 August 31.
2. “Value of flower-rich margins for wild pollinators’ habitat formation in the fields under intensive agriculture”. No. 09.3.3-LMT-K-712-09-0262. Leader Dr. Lina Šarūnaitė. 2018 July 1 – August 31.

6.3.4. International projects started in 2018

Other projects of the programmes supported by the EU

1. 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”.

Coordinator in the Institute of Agriculture Dr. Norkevičienė Eglė; Dr. Kemešytė Vilma. 2018–2021.

The project activity aims to use information collected in the frame of FACCE-JPI ERA-NET+ project GrassLandscape to help the commitment of the ECPGR Working Group in meeting the Objectives 1 and 2 of the ECPGR phase IX. Only part of the accessions used in GrassLandscape were previously flagged to enter the EFC (European Forage Collection) in the frame of AEGIS. The Activity will first list accessions used in the GrassLandscape project that were not yet included in the EFC and will contribute to promotion of their inclusion. The phenotypic data recorded in the frame of GrassLandscape will be uploaded to the EURISCO database as C&E data, as well as additional information about the sites of origin of the accessions. Furthermore, the analysis of the GrassLandscape data will enable us to define several

nested levels of core collection that could be flagged as additional information in EURISCO to help the choice of accessions for future projects.



Natural habitat of perennial ryegrass in South Lithuania

2. LIFE programme project “Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy”.

Coordinator in the Agrochemical Research Laboratory Dr. Lina Žičkienė. 2018–2022.

Relevance. A model of the utilisation of integrated circular economy wastes containing nutrients – the final use of sewage sludge and the corresponding amount of biomass ash for biomass production has not yet been developed and implemented in the countries of the European Union. So far, the use of sewage sludge in EU countries for the cultivation of plantations has been limited to research and episodic

pilot/demonstration trials. The project is also innovative, since dried anaerobically treated sewage sludge will be used for the fertilisation of energy plants, which is more environmentally friendly than sewage sludge treated in other ways.

The main objective of the project is to create and demonstrate the first of its kind on the EU level full scale sustainable closed loop circular economy

model for large cities nutrient from nutrient rich waste – municipal water treatment sludge and biomass ashes – recycling into renewable energy for city’s needs via environment friendly biomass plantation phytoremediation filter.

Tasks performed. Soil samples were taken from a certain part of the demonstration model area (900 ha), and chemical analyses are performed to

prepare plans of fertilisation with sludge according to the requirements of LAND 20-2005 and the use of wood fuel ash.

Soil and groundwater monitoring systems were started to be installed in dried sludge and ash-fertilised areas in order to assess the environmental impact of the application of sewage sludge and biomass ash.



Experimental field of sewage sludge application as fertilizer for poplars



Fertilization with sewage sludge in the field of 4 year-old poplars

3. The Nordic Council of Ministers project “Pre-breeding for future challenges in Nordic fruit and berries”.

Coordinator in the Institute of Horticulture, LAMMC Dr. Audrius Sasnauskas. 2018–2020.

The focus of this project is to strengthen pre-breeding cooperation of apple and strawberry, validate available germplasm resources by genetic and phenotypic characterization in order to widen the parental pool aimed at genetic resources enhancement by increasing diversity for targeted traits. The NORDFRUIT project includes 7 countries focused on 4 thematic areas: a) networking and dissemination, b) phenotyping, c) genomics and resistance, d) germplasm development.

Outcome of this project – standardized phenotyping protocols and genomic tools on the well-defined and genetically characterized germplasm will enable conversion from phenotype-based selection into genome-informed selection. Marker-assisted breeding, complemented with the

global genomic prediction will help to reduce the number of breeding cycles, making the breeding progress more efficient.



Meeting of the project participants

6.3.5. Ongoing international in 2018

Projects of the “Horizon 2020” programme

1. “A thematic network to design the penetration PATH of Non-food Agricultural Crops into European Agriculture” (PANACEA).

Coordinator in the Institute of Agriculture Dr. Vita Tilvikienė. 2017–2020.



Non-food Crops (NFC) are used to produce a wide range of bio-products and bioenergy. In spite of considerable investment in R&D and the increasing

need of bio-based industries for feedstock, NFCs are not widespread in EU agriculture. PANACEA aims to set up a thematic network to foster the effective exchange between research, industry

and the farming community in order to design the penetration path of NFC into European agriculture. To achieve this goal, an inventory of long-term scientific results on the NFC sustainable production should be created (WP1). Combining the farmers' and bio-based industries' needs and interests (WP2) with the NFC ready to practice potential role of NFC in the rural renaissance will be analysed. A strong and interactive multi-actor forum will be established with actors from science, industry and agricultural practice to facilitate capturing and spreading of innovative ideas (WP3). Practice-oriented knowledge on specific value chains easily accessible and available in the long term will be assured through training courses and relevant educational material (WP4). Knowledge sharing on technical, economic and environmental aspects of NFC, extensive communication and networking, matching between the supply and demand sides will be facilitated by the PANACEA Platform (WP5). The project findings

will be disseminated at large following an extended exploitation and dissemination plan that will be active during the project and beyond and ensure the sustainability of the 'Thematic Network on Non-food Crops' through its link with EU wide initiatives, the EIP-AGRI and its Operational Groups (WP6).



Meeting of PANACEA project participants in Madrid

2. "Fostering sustainable legume-based farming systems and agri-feed and food chains in the EU" (LEGVALUE).

Coordinator in the Institute of Agriculture Dr. Žydrė Kadžiulienė. 2017–2021.



The project LEGVALUE is broken down into five R&D workpackages (WP1 to WP5), all of them strongly interacting with one another. We participate in the activities of several WPs; however, we focus on WP1 (on-farm assessment of innovative legume crop management practices and ecosystem services: from field to European scales) and WP2 (development of legume value chains). The aim of WP1 is to assess the economic performance and environmental impacts of the current and innovative legume based systems. The on-farm networks (OFN) have been identified and roughly characterized. We established 2 OFN including farmers cultivating faba beans and peas in conventional and in organic farming systems. We organized several interviews with farmers from our OFN in order to ascertain what knowledge farmers lack regarding cultivation of legumes, started collecting basic information about cropping system, legume management, etc. The main task of WP 2 is to identify technological, organisational and institutional levers to support the development of legume-based feed and food value chains, considering the different streams of the supply chains, from harvest to consumer markets. Despite legume benefits in agriculture and growing interest, their use on the local market is too little, therefore assessment in the context of the value chain is very important. Since the area of peas and beans has been growing in recent years, we chose these plants for more detailed analysis. We reviewed very general information about the legume sector in the country and collected the information by interviewing mainly farmers, but also we conducted several interviews with actors in legume value chain, collected information from seed producers,

purchasers of pea and faba bean grains, contacted several processors using legumes in production for case studies on "Pea value chain: how it increases domestic use of pea (Lithuania)" and "Developing faba bean value chain". We organized a workshop "Legumes for sustainable farming". The aim of the workshop was to provide farmers with new knowledge about the benefits of legumes in agroecosystems and about the benefits of protein and its potential uses. With OFN farmers and others we discussed about the agroecosystem services, the shortcomings in the legume value chain and farmers' expectations.



Cultivation of legumes and assessment of their value chain is an important part of LEGVALUE project

3. “EU Fruit Network”.

Coordinator in the Institute of Horticulture Dr. Audrius Sasnauskas. 2016–2019.



The European Fruit Network (EUFRUIT) includes 12 countries focused on 4 thematic areas critical for the competitiveness and innovation potential of the European Fruit sector: a) new cultivar development and evaluation; b) minimizing residues in fruit and the environment; c) optimizing storage and fruit quality; d) sustainable production systems. EUFRUIT coordinate and support innovation through developing a framework for relevant stakeholders and establish a systematic approach for knowledge gathering and dissemination. The physiological, biochemical, genetic, plant protection and technological aspects are evaluated in regard to vegetative and reproductive responses to fruit quality and sustainable production. The European fruit sector caters both for the industry with respect to competitiveness, sustainability and efficiency and

society through ensuring the security and safety of fruit; underpinning human health and wellbeing.



Meeting of the project participant

Projects of the “INTERREG” programme

1. “Revival of old traditional fruit, vegetable and ornamental plants and their products: Heritage Gardens Tour”.

Coordinator Dr. Darius Kviklys. 2017–2019.



There is an increasing interest in old horticultural plant cultivars and their products as natural and cultural heritage objects across Europe as well in Latvia and Lithuania. **The overall objective of the project** is to assess heritage objects of horticultural plants, identify old cultivars, to increase attractiveness and accessibility of old horticultural plant collections. The main tasks are: 1) to assess most valuable heritage objects during the expeditions; 2) to identify old plant cultivars using genetic investigations; 3) to prepare technologies in order to preserve heritage sites; 4) to propagate endangered cultivars and establish collections of gene resources; 5) together with tourism associations to develop a new tourism product – heritage garden tour aiming at awareness for preservation of natural heritage horticultural plants.



Revival of interest in the old cultivars

2. **“Advancement of non-technological innovation performance and innovation capacity in fruit growing and processing sector in selected Baltic Sea Region countries”.**

Coordinator Dr. Darius Kviklys. 2016–2019.

The “InnoFruit” project aims at developing the fruit-growing potential in the Baltic Sea Region to secure the availability of healthy, high quality fruit and fruit products through research-driven innovations, thereby increasing the competitiveness and sustainability of the fruit chain in Latvia, Lithuania, Poland, and Sweden. The specific objective of the project is to increase the number of successful SMEs in the fruit-growing sector through the use and implementation of technological and non-technological innovations via a newly created demo-farm network.



Innovative machinery and technologies for the new type of commercial orchards

3. **“Water Management in Baltic Forests (WAMBAF) of Interreg Baltic Sea Region”.**

Coordinators in the Institute of Forestry Dr. Marius Aleinikovas, Dr. Olgirda Belova. 2016–2019.

A special emphasis is placed on clear water and forestry activities, seeking to increase the efficiency of water management by reducing nutrient inflows and to decrease discharges of hazardous substances to the Baltic Sea and the regional waters. The outputs are the basis not only for wider cooperation but also for harmonization of water management in forests in the Baltic Sea Region. The main tasks are based on three priorities: forest drainage systems; riparian forests, beaver dam management in forests. The guidelines and tools on forest drainage system, riparian forests and beaver dam management were prepared. The draft version of the Beaver Handbook “Beaver as renewable resource”, the tools for assessing the necessity of drainage systems and riparian forests maintenance were developed. Beaver dam and Blue targeting tools, Drainage system management and Riparian forests management

guidelines and tools were assessed during training courses at the established Demo areas.



Project partners at Helgeå demonstration site in Sweden

Projects of the EU Framework Programme 7 (FP7)

1. **“FP7 ERA-NET “SUMFOREST”. Benchmarking sustainability performance of value chains using ToSIA, the tool for sustainability impact assessment”.**

Coordinator in the Institute of Forestry Dr. Marius Aleinikovas. 2017–2019.

BENCH VALUE



The construction sector is one of the leading sectors of the European economy and vital to the bio-economy. **The aim of the project** is to develop a versatile benchmarking method to

quantify and to compare sustainability impacts of different material use in the European construction sector. Further, we aim to show the usability of the benchmarking method to quantify the impacts and potentials of substituting non-renewable with renewable materials in the construction sector.

The production of glue laminated timber (GLT) is rapidly growing in Lithuania. Lithuanian case study compares sustainability impacts of local producers made GLT and reinforced concrete constructions throughout value chains.

In 2018, the data on reinforced concrete value chain and GLT value chain was collected



GLT building constructions produced by the project partners UAB “Jūrės medis”

considering economic, social and environmental impact indicators. The collected data was integrated into ToSIA model and the analysis of the production process of GLT and non-renewable materials was done. In addition, two buildings were designed for the comparison of structural materials.



Project partners at the conference “The Forest Bioeconomy in Lithuania” held in Kaunas

2. “IT-solutions for user friendly IPM-tools in management of leaf spot diseases in cereals”.

Coordinator in the Institute of Agriculture Dr. Antanas Ronis. 2017–2019.



“SpotIT” aims to provide locally adopted disease forecasting models via a trans-national platform allowing cost efficient development of locally adapted DSS in a native language, to facilitate the use of IPM.

The main objectives will be to:

1. Understand the motives behind farmer decision-making in relation to IPM-tools to optimize the precision and quality of pest management strategies.

2. Improve and validate risk prediction models for wheat and barley diseases based on field observations and historical data over the period 2007 to 2016.

3. Develop IPM-tools that accommodate local user needs, based on available infrastructure, locally available input data and technology resources.

Results obtained in 2018:

1. A survey of Lithuanian farmers was conducted.

2. Three field trials in winter wheat and three field trials in spring barley were carried out at Institute of Agriculture, LAMMC. In the field trials, conventional fungicide application scheme was compared with the recommendations produced by two mathematical models for leaf spot forecasting.



Meeting of the project participants in Lillehammer, Norway

6.3.6. International projects implemented in 2018

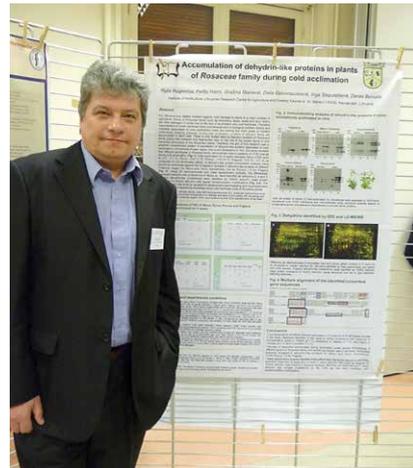
COST action programme

“The quest for tolerant varieties: phenotyping at plant and cellular level”.

Member of the Management Committee in the Institute of Horticulture Dr. Rytis Rugienius. 2014–2018.

The aim of the COST FA1306 Action is to improve and exchange scientific knowledge in plant phenotyping through the creation of a network between European interdisciplinary scientists and to use this network to map valuable gene bank collections and breeding programs in Europe, train breeders and physiologists in screening techniques and data interpretation, get insight into the genetic basis of tolerance, to characterize current biodiversity and rank it according to tolerance levels and to apply the knowledge for agricultural management. Research was carried out in relation to the tasks of Working groups 2 and 3. The studies were funded by the ongoing four LMT research projects and global grant programme, whose participants were R. Rugienius, D. Baniulis and I. Miliūtė: “Diversity, identification and links to cold acclimation of dehydrins of Rosaceae family plants”, 2013–2015, “Influence of endophytes to stress induced synthesis or reactive oxygen species *in vitro*”, 2013–2015, “Involvement of oxidative stress in molecular mechanism of seed response to cold plasma treatment” 2017–2019 The Global Grant Project “Identification of *Malus* plant genes important to pathogen-inductive hypersensitivity response”, 2011–2015. The project application has been submitted to National Programme “The sustainability of agro, forest and aquatic ecosystems”. Implementing genomic investigation of cold hardiness orchard plant cold acclimation peculiarities and regularities of dehydrin family proteins expression were characterized. Under conditions of oxidative stress regularities of accumulation of reactive oxygen species and factors decreasing the stress were characterized in apple and wild strawberry *in vitro*. Utilizing methods of molecular markers phenotyping studies of orchard plants in institute collections were performed. Dr. Rytis Rugienius,

Dr. Danas Baniulis and Dr. Inga Miliūtė participated with a poster presentation in the 2 Working Group Conference of COST FA1306 in Versailles, France on 1–2 02 2015.



Presentation at COST FA1306 action conference



Plant phenotyping Projects of other European Union support programs for research

Projects of other EU programmes supporting researche

1. “Baltic Sea Region network for sustainable wheat production” (BALTICWHEAT).

Coordinator in the Institute of Agriculture Dr. Rita Armonienė. 2017–2018.

The aim of this project funded by Swedish Institute is to identify solutions for reducing the need for the use of fertilizers and pesticides in the wheat cultivation system. The project identified and evaluated various alternative solutions both at the pre-breeding and at farm management levels such as a) increasing genetic diversity in wheat for improved nutrient use efficiency (NUE) and higher

disease resistance; b) diversifying agroecological system using mixed cropping systems and efficient crop rotations; c) speeding up plant breeding by using next generation breeding techniques and high-throughput phenotyping; and d) evaluating management practices for fungicide resistance in wheat pathogens. The planned activities are a) Kick-off workshop in Sweden; b) Pilot project

to evaluate NUE and disease resistance in selected Baltic wheat cultivars; c) Workshop on next generation breeding techniques and high-throughput phenotyping in Finland; e) Identify relevant funding calls and prepare a joint application. Two meetings-workshops were organized during the last year of the project implementation; 1) the common workshop of two projects funded by SI: “Baltic-Wheat” and “DDS-FUSARIU” was held on July 2–3 at LAMMC and “BalticWheat” meeting-workshop at National

Finish Plant Phenotyping Infrastructure, Helsinki University on October 23–24. Field experiments of 200 NordGen bank winter wheat genotypes were carried out in three participating countries: Lithuania (LAMMC), Denmark and Sweden (Lantmannen) to assess the potential of this material for resistance to biotic and abiotic stress. Dr. Rita Armonienė attended the 26th NJF Congress (Kaunas) and presented a report on the idea and goals of the “BalticWheat” project.



“BalticWheat” workshop at the National Plant Phenotyping Station, Helsinki University

2. Swedish Institute Baltic Sea Cooperation project “Cooperation in the Baltics on the development of strategies to foresee outbreaks of Fusarium damage” (DSS Fusarium). Coordinator in the Institute of Agriculture Dr. Skaidrė Supronienė. 2017–2018.

The aim is to disseminate information among the project partners on the problems with Fusarium contamination among the different partner countries and on the current status of the development of alert systems to secure that cereal crops are not damaged by *Fusarium* or other pests that can endanger crop quality.

During the project, four meetings of the project partners were organised in different countries, in which representatives of other research institutions and business enterprises, consultants and farmers participated. Experience of different countries



Meeting of participants of BALTICWHEAT and DSS Fusarium projects in Lithuania



Meeting of participants of DSS Fusarium project in Sweden



Meeting of participants of DSS Fusarium project in Poland

regarding the problems caused by *Fusarium* pathogens and the use of predictive tools was shared. The main risk factors were discussed, issues of concern for different interest groups, interfaces and possible solutions were analysed.

A comparison of *Fusarium* fungi and mycotoxins data available in different countries was performed, which is required in order to refine the key indicators

3. “Perennial ryegrass breeding research in Nordic and Baltic countries”.

Coordinator in the Institute of Agriculture Dr. Gintaras Brazauskas. 2014–2018.

The results from the multi-site (in 7 Northern European countries: Iceland, Denmark, Norway, Sweden, Finland, Estonia and Lithuania) field trials with cultivars confirm the need for more robust and stable cultivars with wider adaptations. Cultivars, locations and years showed large interactions, and local cultivars were generally better adapted than cultivars originating from other regions. Diploid cultivars were consistently more frost tolerant than tetraploid cultivars. The Norwegian cultivar ‘Falk’, which was found to be a diploid/tetraploid mixture, turned out to be the most stable cultivar across environments. This indicates that using ploidy-mixtures could be a strategy to improve persistency of perennial ryegrass grown in these northern regions. The preliminary results from the multi-site field testing of accessions indicate that none of the accessions is better than the best locally adapted cultivar. Thus, it seems like our initial assumption that introgression and recombination of exotic materials followed by natural/artificial selection is needed to create novel germplasm. Also, most of the accessions seem to be susceptible to rust attack. Freezing tests of accessions confirmed the results from freezing tests of the cultivars, as diploids were consistently more freezing tolerant than tetraploids. Flow-cytometric analyses of the ploidy level of the accessions showed that as much as about 16% of the accessions were tetraploids while they were

for the development of appropriate disease and / or mycotoxin prediction models.

It is expected to get permission to extend the project duration for half a year. During the additional period, it is planned to prepare an application for a scientific project and organise the final meeting, which intends to establish contacts with international partners outside the project partner group.

classified as diploids in the gene bank. This is a serious problem for efficient utilization of gene bank germplasms for breeding and research.



Field trials of perennial ryegrass genotypes in Dotnuva



Project participants visiting a field of perennial ryegrass in Iceland

6.3.7. Results of ongoing projects and programmes obtained in 2018

1. “EUFORGEN – The European Forest Genetic Resources Programme”.

Coordinator in the Institute of Forestry Dr. Virgilijus Baliuckas. Since 2010.



The Steering Committee agreed that the main objectives of EUFORGEN remain valid also for Phase VI, but specific areas of work will need to be elaborated during the next Steering Committee’s meeting. The main objectives: 1. Collate, maintain and disseminate reliable information on forest genetic resources in Europe; 2. Coordinate and monitor the conservation of forest genetic resources in Europe; 3. Develop guidelines and analyses on topics and issues relevant for the use of forest genetic resources in Europe.



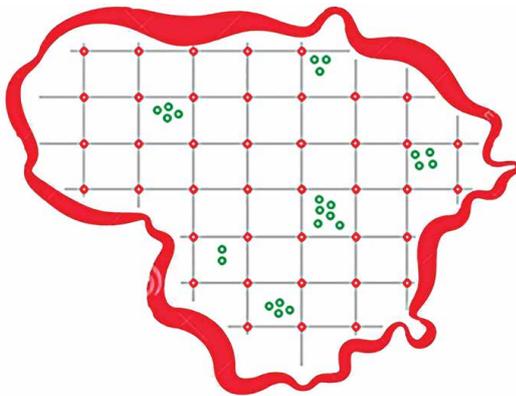
In situ genetic resources in Lithuania

2. SNS (the Nordic Forest Research Cooperation Committee) project “Northern European database of long-term forest experiments”.

Coordinator in the Institute of Forestry Dr. Marius Aleinikovas. Since 2008.

The aim with the database is to stimulate Nordic, Baltic and international cooperation within forest research, to increase the scientific quality of field research and to avoid expensive duplication of new experiments in the countries. Increased use of existing data and results are also expected to be a result of NOLTFOX. The project group consisted of researchers from all Nordic countries. SNS had for some years noticed that long-term field experiments in forest faced many of the same challenges in all Nordic countries. This was mainly a problem in raising sufficient financial support for maintaining high quality experiments and thereby to assure collection of data and achieve valuable scientific results also in the future. It was supposed that possible benefits for

the maintenance of existing and the establishment of new high quality experiments could be achieved by a closer Nordic co-operation within this field. One important prerequisite and the first step for increased scientific co-operation is to have a common database showing all experiments in the Nordic countries with a common classification standard. NOLTFOX is the result of the attempt to make such a database, easily accessible for everybody.



Simplified scheme of forest experimental plots established by LAMMC Institute of Forestry



Forest experimental plot

3. “Research on winter wheat winter hardiness and diseases”.

Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 1994.

The main objective was to evaluate the winter hardiness and disease resistance of winter wheat and triticale varieties, developed in the mild maritime climate conditions.

In 2018, we continued the long term project conducted together with Danish Sejet plant breeding station since 1994.

The main objective of these investigations was to study and evaluate under Lithuanian conditions the winter wheat and triticale breeding lines and varieties, developed in mild maritime climate conditions. In Denmark, winters are mild, and therefore it is not possible to evaluate the winter hardiness of the lines developed.

A total of 244 lines of winter wheat and triticale from Sejet breeding programs were investigated in 2018. Twenty five lines of winter triticale were investigated in replicated yield trials. The plant

breeders evaluated the testing results and decided to continue this project in 2019.



Assessment of winter wheat foliar diseases

4. “Research on facultative and winter wheat”.

Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 1993.

The main task was to investigate the facultative and winter wheat, developed at distant regions and select promising genotypes for local genetic collections and submit the data to the global investigations network.

The investigations program is organized and coordinated by the International Centre for Improvement of Wheat and Maize CIMMYT. It is a global investigations network and wheat varieties for these investigations are collected from the USA, West, Central and East Europe, Far East countries. Institute of Agriculture has been involved in these investigations since 1993.

A total of 165 lines and varieties developed in distant regions and received from CIMMYT wheat improvement program were investigated in 2018 at Institute of Agriculture. Winter hardiness, grain yield, 1000 grain weight, susceptibility to plant diseases and agronomic traits were assessed. The variety ‘Ada’ was used as a reference variety.

As a result of this program, some lines were developed, in whose pedigree there were included

varieties from the CIMMYT project. A promising line 7183-1, developed from this program, was tested in the replicated yield trials and State Variety Testing. F6 2; F5-3; F3 12 lines developed using germplasm from CIMMYT were investigated in other nurseries. A total of 39 varieties, selected for future crosses were investigated in the germplasm collection block.



Early and awned wheat from CIMMYT collection

5. “European plant genetic resources conservation programme”.

Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 1998.

The main task was to collect and investigate plant genetic resources for developing highly competitive varieties.

In 2018, we continued activity under “European plant genetic resources conservation program”. We collected and investigated the plant genetic resources of all plant species, which are included in the institute’s approved plant breeding programs. It will be useful genetic material for further breeding programs.

In the nurseries of winter wheat breeding there were grown and investigated 149 varieties and lines. One variety was transferred to the Gene Bank for long-term storage (conservation).

In the group of spring cereals we grew and investigated 411 varieties of spring barley from which 6 varieties were transferred for long-time conservation, and 497 varieties and breeding lines of spring wheat.

In oats gene resources collection we investigated 258 varieties, the most valuable traits were investigated. Three varieties were transferred to long term storage in the gene bank.

In the field pea collection, we investigated 136 varieties for resistance to lodging, grain yield and resistance to plant diseases.

In 2018, we investigated a large collection of perennial grasses. In the collection of forage grasses we collected and investigated: ryegrass and festulolium 359, meadow fescue 172, cocksfoot 104, Kentucky blue grass 72 varieties and breeding lines. In the nurseries of clovers, there were grown

and investigated 261, lucerne 211 varieties. Thirteen most valuable varieties and lines of perennial grasses were transferred to long term storage in the National Gene Bank.



Collection of grasses



Collection of lucerne

6. “Winter wheat breeding, variety testing and marketing in Estonia”.

Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 2000.

The main task is to develop winter wheat varieties suitable for growing in Estonian conditions.

In 2018, we continued the winter wheat breeding program, conducted together with Estonian Crop Research Institute. The program started in 2000. According to the targets of this program, the winter wheat lines developed in Lithuania are transferred to Estonian Crop Research Institute in Jogeva.

In 2018, 10 breeding lines were selected for investigation in Estonian Crop Research Centre. Fifteen lines developed at Institute of Agriculture were investigated in Estonian wheat breeding program. Twenty two winter wheat breeding lines, developed in Estonia, are investigated in winter wheat breeding nurseries of Institute of Agriculture.



Removal of snow for winter hardiness assessment

6.4. Plant breeding

LAMMC conducts breeding programs for the major field crops, vegetables and pomefruits, stonefruits and berries. In 2018, the following varieties were included in the EU Common Catalogue of Varieties of Agricultural Plant and Vegetable Species and in the Lithuanian National list of Plant Varieties: waxy wheat ‘Minija DS’, meadow foxtail ‘Valentas’, common timothy ‘Dovas DS’, carrot ‘Jola’; the following varieties were included into the National List of Plant Varieties: apple ‘Poema’, ‘Alemanda’, ornamental apple ‘Perlas’, ‘Vaja’, ‘Rylio’.

☉ Amylose-free wheat variety ‘Minija DS’

Breeders: Dr. Žilvinas Liatukas, Assoc. Prof. Dr. Vytautas Ruzgas, Kristyna Razbadauskienė, Dr. Gintaras Brazauskas and R. A. Garaibosch (University of Nebraska-Lincoln, USA).

‘Minija DS’ is the first amylose-free wheat variety in the Northern Europe region developed at LAMMC. Varieties of this type are referred to as waxy wheat. They have some mutations in the genome and synthesize not usual starch but starch containing 2–3 % amylose and 97–98 % amylopectin. The grain of the variety ‘Minija DS’ can be used for the production of special starch containing larger granules, whose pasting occurs at higher temperatures. Addition of a small amount of waxy wheat flour to dough during the bread-making process can extend the shelf-life of bread. The wheat variety ‘Minija DS’ was tested in the official state variety testing during 2014–2016. The mean grain yield was 9.58 t ha⁻¹, 1000 grain weight 48.3 g, protein content 12.0 %, sedimentation value 31, hectolitre weight 78.2 kg. The variety exhibits very good winter hardiness, is tall-growing and drought-resistant. The resistance to sprouting in ears is moderate, growth in the autumn and spring is fast, therefore the recommended sowing time is from 15

September. In the fertile soils, moderate nitrogen rates (90–120 kg ha⁻¹) are recommended.



Amylose-free wheat ‘Minija DS’

● **Meadow foxtail variety ‘Valentas’**

Breeder: Dr. Vaclovas Stukonis.

The meadow foxtail variety ‘Valentas’ has been developed at Institute of Agriculture, LAMMC. It is an early-maturing variety suitable for growing on wet or even waterlogged soils. ‘Valentas’ can produce medium-length rhizomes, because of which it spreads quickly and occupies empty gaps in a field. The variety produces the highest herbage yield in rainy years. It is recommended to cut it 3–4 times per season. The value for cultivation and use (VCU) testing of this variety was done at the Lithuanian Plant Variety Testing Stations in Pasvalys and Plungė in 2016–2017. It produced an average dry matter yield of 12.8 t ha⁻¹. The highest yield 16.47 t ha⁻¹ was produced in 2016. The period of vegetation up to the first harvest is 130 days. The variety exhibits excellent over winter survival (9 points out of 10). It is of medium height (78.3 cm) and fairly resistant to lodging (8.7 points). Usually it is harvested at the end of June. The protein content at the beginning of inflorescence emergence is 16.5 %, fibre content

23.5 %, digestibility of dry matter 67.4 % and water soluble carbohydrate content 15.0 %. Density of foliage at the beginning of the inflorescence emergence is up to 59.5 %.



Meadow foxtail (*Alopecurus pratensis* L.) variety ‘Valentas’

● **Common timothy variety ‘Dovas DS’**

Breeders: Dr. Nijolė Lemežienė, Dr. Eglė Norkevičienė.

The common timothy variety ‘Dovas DS’ has been developed at Institute of Agriculture, LAMMC. The value for cultivation and use (VCU) testing of the variety was done at the Lithuanian Plant Variety Testing Stations in Pasvalys and Plungė in 2016 – 2017. ‘DOVAS DS’ is a medium early to medium late cultivar: the beginning of inflorescence emergence of plants is in early June, maturity of seeds – in the middle of August. The plants are of medium height. According to the data from the Plant Variety Testing Stations, the height of plants at the beginning of inflorescence emergence (before the first harvest) reaches 83.6 cm. During the testing years, the plants of the cultivar ‘DOVAS DS’ produced 16.95 t ha⁻¹ dry matter and the highest dry matter yield peaked to 20.56 t ha⁻¹. The protein content at the beginning of the inflorescence emergence was 11.64 %, fibre content 29.78 %. The new meadow foxtail variety

‘DOVAS DS’ is resistant to lodging (8 points). It is suitable for making seed mixtures intended for sowing meadows and pastures, hay making as well as for field rotation with red clover.



Common timothy (*Phleum pratense* L.) variety ‘Dovas DS’

● **Carrot variety ‘Jola’**

Breeders: Dr. Rasa Karklelienė, Jolita Nėniūtė.

Carrot (*Daucus sativus* Röhl.) hybrid ‘Jola’ is mid – late hybrid of *Nantes* type. The duration of vegetation is 120–130 days. Carrots reach the fresh production maturity 55–60 days after sowing. The colour of carrot roots is orange, middle size, cylindrical with bumper end, about 19–22 cm length and 3.9–4.3 cm diameter. Phloem and Xylem are of orange colour. Xylem is not big, round angled or round. The accumulation of carotene reached 18.0–



Roots of the carrot variety ‘Jola’

20.0 mg 100g⁻¹, dry soluble material 10.0–10.5 % and total sugar amount 8.0–8.8 %. It is recommended to grow the variety in a sandy loam and light loam soil rich in humus and free from weeds. The optimal pH is 6.0–7.0. Carrots are suitable for growing on a plain and profiled soil surface. Carrots are resistant to diseases and suitable for autumn harvesting and storage during winter.



Leaves of the carrot variety 'Jola'

● **Summer apple variety 'Poema'**

Breeders: Dr. Bronislovas Gelvonauskis, Dr. Dalia Gelvonauskienė, Dr. Audrius Sasnauskas.

Summer apple (*Malus domestica* Borkh.) 'Poema'. Origin – 'Red Free' × 'Sylvia'. Fruits – large or very large (200 g), globose conical. Skin ground colour yellowish white, over-colour blushed red, with bright red stripes and pale small and medium lenticels. Picking time: end of August. Stores 3 months in cool storage. Flesh white, soft,

juicy. Taste: acid sweet, very good. Use: dessert. Tree: medium vigorous, suitable to grow on rootstock B.396, P60. Bearing fruits: early, productive, fruiting every year. Winter-hardiness – good in Lithuania. Disease tolerance: resistant to scab (*Vff/Rvi6*), apple blotch. Suitable for ecological orchards.



Apple variety 'Poema'

● **Summer apple variety 'Alemanda'**

Breeders: Dr. Bronislovas Gelvonauskis, Dr. Dalia Gelvonauskienė, Dr. Audrius Sasnauskas.

Summer apple (*Malus domestica* Borkh.) 'Alemanda'. Origin – 'Red Free' × 'Sylvia'. Fruits: large (155 g), globose conical, ground colour yellowish, covered by blush and red striped. Ripen in the middle of August. Stores about 1 months in cool storage. Flesh yellowish, soft, juicy. Taste: subacid,

very good. Use: dessert. Tree – medium vigorous, suitable to grow on rootstock B.396, P60. Bearing fruits: early, productive, fruiting every year. Winter-hardiness: good in Lithuania. Disease tolerance: resistant to scab (*Vff/Rvi6*) and apple blotch.



Summer apple variety 'Alemanda'

● **Ornamental apple variety ‘Perlas’**

Breeders: Dr. Bronislovas Gelvonauskis, Dr. Dalia Gelvonauskienė, Dr. Audrius Sasnauskas.

Ornamental apple (*Malus sieboldii* Rehd.) ‘Perlas’. Origin – seedling of *M. sieboldii* Rehd. – open pollination. Fruit trees are winter hardy, medium vigorous, resistant to fungal diseases. Late flowering, white flowers, fruits are small, globose, skin ground colour yellow, with light red blush.



Ornamental apple variety ‘Perlas’

● **Ornamental apple variety ‘Vaja’**

Breeders: Dr. Bronislovas Gelvonauskis, Dr. Dalia Gelvonauskienė, Dr. Audrius Sasnauskas.

Ornamental apple (*M. baccata* Borkh.) ‘Vaja’. Origin – seedling of *M. baccata* Borkh. – open pollination. Fruit trees are winter hardy, medium vigorous, resistant to fungal diseases. Early flowering, pink-violet flowers, leaves red-green, dark red small fruits.



Ornamental apple variety ‘Vaja’

● **Ornamental apple variety ‘Rylio’**

Breeders: Dr. Bronislovas Gelvonauskis, Dr. Dalia Gelvonauskienė, Dr. Audrius Sasnauskas.

Ornamental apple (*M. baccata* Borkh.) ‘Rylio’. Origin – seedling of cultivar ‘Arbat’. Open pollination. Fruit trees are winter hardy, vigorous, resistant to fungal diseases. Late flowering, bright red flowers, leaves dark green, red round fruits.



Ornamental apple variety ‘Rylio’

6.5. Food produce of exceptional quality

LAMMC is involved not only in the research activities but also in the experimental product development activities. The experimental basis of the Institute of Horticulture encompasses gardens, nursery gardens, orchards and greenhouses where fruits and vegetables are grown for the production of healthy and natural food products of exceptional quality. The quality control test results of the production meets quality standards established by European Union – the quality of the products is confirmed by issued certificates. Whereas, the national product quality certificate confirms that products meets specifications of the national agricultural and food quality system and gives a right to mark such products with a national product quality mark “KOKYBĖ”.

● **Snacks “Greenz”**

When developing an innovative, functional snack line “Greenz” from high biological value plant raw materials, technologists of the confectionery factory “Rūta” cooperated with scientists from LAMMC Institute of Horticulture and adapted products to the nutritional needs of different groups of people. It

is namely the cooperation between the science and practical production which added exceptional value to the products.

The “Greenz” snack line features carefully selected ingredients, all products are gluten and sugar free (no added sugar) and are suitable for vegetarians

and vegans. In the international agricultural and food industry exhibition “Agrobalt 2018”, fruit, nut and seed snacks “Greenz” developed by LAMMC and

sweets factory “Rūta” were awarded a medal for innovation and were presented with a golden medal at the exhibition “Choose a Lithuanian product 2018”.



Snacks “Greenz”



Snacks “Greenz” were presented with a golden medal at the exhibition “Choose a Lithuanian product 2018”



Snacks “Greenz” were awarded a medal for innovation at the exhibition “Agrobalt 2018”

🕒 Presentation at business-investment forum

In the business-investment forum “Sail of Shanghai” (Kaunas) held in September 2018, Dr. Dalia Urbonavičienė, a researcher from Institute of Horticulture, presented protein shakes developed in cooperation with UAB “Mėlynė” under the project of innovative cheques.



Business-investment forum “Sail of Shanghai”

🕒 Accomplishment

A student of the Gymnasium of Lithuanian University of Health Sciences (since 2018 a student of the University) Gabija Imbrasaitė at Biochemistry and Technology Laboratory, Institute of Horticulture conducted research “The Impact of Bioplastics with Blue Mould Fungus *Penicillium roqueforti* on the Ripening and Storability of Pears”, supervisor Prof. Dr. Pranas Viškelis, consultants Dr. Dalia Urbonavičienė and Dr. Jonas Viškelis. In 2018, this work was presented at the national stage of the EU Young Scientists’ Competition, where she won the first prize and was the only one from Lithuania who participated in the EU Young Scientists’ Competition in Dublin (Ireland), where she was awarded a special prize for “Fighting Global Food Waste”.



Gabija Imbrasaitė at the EU Young Scientists’ Competition in Dublin (Ireland), where she was awarded a special prize for “Fighting Global Food Waste”

7. RESEARCH INTERNSHIPS

Internship of Dr. Diana Marčiulygienė in Sweden

Short Term Scientific Mission (STSM) in the Southern Swedish Forest Research Centre (SSFRC) at the Swedish University of Agricultural Sciences (SLU) in the framework of COST STSMs. Period from 26 02 2018–20 03 2018 COST Action FP1401: A global network of nurseries as early warning system against alien tree pests (Global Warning).

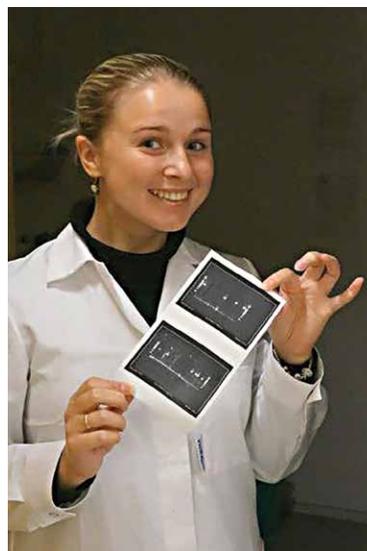
The overall aim of this project was to provide new scientific information, with high practical relevance, on the fungal species diversity of native and non-native trees planted in common gardens and arboreta and their implications for invasive species introductions.

The focus of the work was on assessing biotic threats of native and non-native tree species planted in large arboreta and common garden experiments in two different countries: Lithuania and Ukraine. These countries are two of the total seven countries (Canada, Sweden, Turkey, Finland, UK, Lithuania and Ukraine), that will be part of a global study.

During the STSM period, I proceeded on working with Lithuanian samples and Ukrainian samples by preparing them for Next Generation Sequencing (NGS) in order to define communities in pine needles and compare fungal species diversities and richness amongst native and non-native tree species belonging to the genus *Pinus*.

Short Term Scientific Mission (STSM) in the Southern Swedish Forest Research Centre (SSFRC) at the Swedish University of Agricultural Sciences (SLU) in the framework of COST STSMs. Period from 12 11 2018–02 12 2018 COST Action No. CA15212: to promote creativity, scientific literacy, and innovation throughout Europe (Citizen Science).

The aim of the project was creation of the information tools for citizen scientists (volunteers)



Dr. Diana Marčiulygienė at the Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences

by increasing science literacy and providing volunteers with skills needed to excel in science. For this, a number of activities have been planned:

1. Creation of a protocol for the public in order to collect data in a standardized way.
2. Creation of informative signage for volunteers and stakeholders to develop a better understanding of the *Phytophthora* diseases.
3. Continuous website update to ensure a high level of information and data.

As a result of this STSM we are expected to create information tools that will make it easier for the public to engage in Citizen science and ensure the motivation of participants and maximize their enjoyment and satisfaction in taking part.

Internship of the doctoral student Adomas Stoncelis in Poland

The study visit was held in the Polish Forestry Institute (Instytut Badawczy Leśnictwa, IBL) on March 12–23.

The main part of the study visit was dedicated to visiting Forest Research Institute, laboratories instruments and genetic trials of the main tree species of Poland. Also, the intern visited the *Institute of Dendrology PAS (Kórnik, Poland)* and made an oral presentation “The relationship of wood properties and wood growth conditions for the main forest tree species in Lithuania studied in genetic field trials”.



Doctoral student Adomas Stoncelis at Polish Forest Research Institute

Internship of Dr. Sandra Sakalauskienė at the United Kingdom

Phenotyping of Lithuanian varieties of winter wheat for cold tolerance.

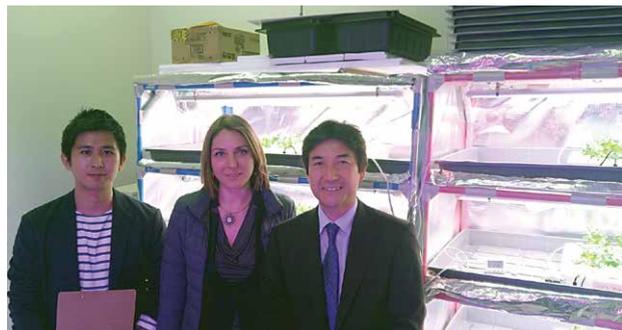
March 15 – May 13, a research worker Dr. Sandra Sakalauskiene from LAMMC, Institute of Horticulture, Laboratory of Plant Physiology had the internship at Lancaster University, United Kingdom. The goal of her internship was to elucidate the physiological mechanism to overcome chilling (cold temperatures) in winter wheat, an stress that constrains gain yield in northern countries. She smartly used the extent of wheat germplasm developed in Lithuania and the expertise in photosynthesis and water relations from researchers at Lancaster University to join together a valuable description of winter wheat response to chilling. Furthermore, this internship was a great opportunity to raise academic qualifications, learn new methods, discuss and share the scientific experience with other researchers.



Dr. Sandra Sakalauskienė at at Lancaster University Environment Centre

Internship of Dr. Giedrė Samuolienė in Japan

On April 6–13, head researcher of the Plant Physiology Laboratory of the Institute of Horticulture Dr. Giedrė Samuolienė did an internship at the Division of Environmental Science and Technology, Graduate School of Agriculture, Kyoto University (Japan). The internship was led by prof. Hiroshi Shimizu. The researcher familiarized herself with the research on plant productivity using solid-state lighting technology, flower pollination under closed conditions. Dr. G. Samuolienė visited a vertical farming “Plant factory” SPREAD, where she became familiar with the technology of growing lettuce under controlled conditions.



On the right prof. Hiroshi Shimizu, head of Division of Environmental Science and Technology, Dr. Giedrė Samuolienė and doctoral student of Hiroshi Shimizu

Internship of Dr. Vita Tilvikienė in Sweden

On May 17 – June 1, senior researcher of Institute of Agriculture, Dr. Vita Tilvikienė did a scientific internship at the Swedish University of Agricultural Sciences (SLU), Skara (Sweden). The aim of the internship was to master the methodology of working with the spectrometer AgriSpec, to analyze the methods of development and application of calibration curves, to develop calibration curves and to apply them for qualitative and quantitative assessment of soil and plant biomass and to establish relations with Swedish colleagues for further scientific cooperation.

During the internship, samples collected from LAMMC experiments and recorded spectra were analyzed. All the objectives of the internship were met: the methodology for analyzing the spectra obtained by the device AgriSpec was mastered; calibration curves for determining chemical

composition of plants and soil were developed; qualitative and quantitative parameters of the samples were estimated; scientific and other related activities carried out by the researchers at the Swedish University of Agricultural Sciences were familiarized with.



Swedish University of Agricultural Sciences (SLU)

Internship of the doctoral student Benas Šilinskas in the United Kingdom

Wood quality and wood quality determination methods.

The internship took place from 26 May, 2018 to 9 June, 2018 in Edinburgh Napier University, Wood Research Laboratory.

The purpose of this internship was to get more knowledge about wood quality and wood quality assessment methods.

During the internship, the knowledge about international wood standards was improved. A lot of attention was given to non-destructive wood measurement methods. Wood quality of non-native tree species was analyzed with Brokheus MTG and Arbotom 3D devices.

An intern participated in “Timber Research Update” workshop, which was held in Scotland Innovation Centre (SIC), Glasgow. During the seminar, scientists introduced research to

representatives from industry from the whole country. Significant attention was given to wood quality of non-native tree species. In this seminar participants had a possibility to visit the Laboratory of Scotland Innovation Centre.



Wood quality testing at Wood Research Laboratory of Edinburgh Napier University

Internship of Dr. Kristina Amalevičiūtė in Poland

On May 28 – June 11, 2018 a research worker of Institute of Agriculture, Chemical Research Laboratory and a post-doctoral student Dr. Kristina Amalevičiūtė-Volungė did an internship at at the Department of Environmental Engineering of the University of Warmia and Mazury (UWM) in Olsztyn.

The aim of the internship was to master the method of biogas extraction from energy plants, to study the qualitative composition of biogas, as well as to get acquainted with other analyses performed at the department and to establish international relations that would result in joint research projects and joint publications.

During the internship, the research on biogas formation from plants was studied: selection of substrates, application of methods for each different substrate, determination of analytical conditions, mastering of biogas analysis equipment, analysis

of obtained data, data analysis and evaluation. Cooperation links were established during the internship.



Dr. Kristina Amalevičiūtė-Volungė at the Department of Environmental Engineering the University of Warmia and Mazury (UWM)

Internship of Dr. Jurgita Cesevičienė in Poland

On May 28 – June 11, a senior research worker of Institute of Agriculture, Chemical Research Laboratory Dr. Jurgita Cesevičienė did an internship at at the Department of Environmental Engineering of the University of Warmia and Mazury (UWM) in Olsztyn.

During the internship, the interest was focused on analyses of quality parameters of biogas production raw materials and waste product (organic matter, total N and P, COD, ammoniacal nitrogen) as well as on mastering of analytical equipment and data analysis. A biogas plant was visited. International scientific contacts were established.



Dr. Jurgita Cesevičienė at the Department of Environmental Engineering the University of Warmia and Mazury (UWM)

Internship of the doctoral student Karolina Barčauskaitė in Czech Republic

A junior researcher and a doctoral student of Institute of Agriculture, Agrobiological Laboratory Karolina Barčauskaitė, attended an internship at the Research Centre for Toxic Compounds in the Environment (Czech Republic) during June 1–30.

RECETOX (Research Centre for Toxic Compounds in the Environment) is an independent department at Faculty of Science, Masaryk University, with its own research and development, educational programs and expert activities within the field of environmental contamination. The Centre focuses on persistent organic pollutants (POPs), polar organic compounds, toxic metals and their species and natural toxins – cyanotoxins.

The aim of the internship was to deepen the knowledge about persistent organic pollutants and their investigations, to get more practical skills using a chromatography system with a MS/MS detector, to gain experience which will be useful in the future method developing steps for determination of persistent organic pollutants in the soil, composts and plants.

During the internship, the concentration of PAHs was determined in soil, compost and spring barley grain samples. A lot of experience was gained in sample extraction, clean-up and chromatography analysis procedures for non-polar organic compounds. National Atmospheric Observatory in

Košetice was visited. This is a less contaminated area in Czech Republic, surrounded by forests where using passive and active air samplers, air monitoring has been carried out for more than 30 years. Using modern analytical techniques POPs, PM 2.5, PM 5, PM 10 are determined in the air.



Doctoral student Karolina Barčauskaitė at RECETOX centre, Brno, Czech Republic

Internship of the doctoral student Gintarė Bajerkevičienė in Finland

June 4–15, during the internship in Suonenjoki Unit of Luke, the doctoral student visited its facilities and laboratories, participated in ongoing research and visited research tree seedling nursery. Sampling of etephone treated spruce seedlings for biochemical and histological analysis was performed. The visitor took part in seedling height and root collar measurements, measurements of chlorophyll fluorescens, surface flavonoids and chlorophyll amount of UV-C treated young spruce seedlings. Sampling of needles for malonylaldehyde analysis was performed. The visitor participated in a trip to two spruce autumn planting sites in Siilinjärvi and Kuopio. Demonstration of mechanical planting site and investigation of reasons for poor seedling growth was performed. During a visit to a 10-year-old spruce planting area showing severe deformations region, reasons for poor growth in North-Karelia were investigated.



Suonenjoki Unit of Luke

Internship of Dr. Jonas Žiauka in Poland

Determination of the factors that regulate *in vitro* development of different *Populus* genotypes.

The internship took place from 1 July to 30 September, 2018 in the Forest Research Institute

of Poland (Instytut Badawczy Leśnictwa, IBL), Department of Silviculture and Genetics of Forest Trees. The visiting researcher was working on the following tasks:

1) estimation of the possibility to regulate shoot and root development in different *Populus* genotypes by providing specific environmental conditions during *in vitro* culture;

2) comparison of the effects caused by certain growth regulators on the *in vitro* cultures of different *Populus* genotypes;

3) estimation of the bacterial microflora's influence on *Populus* development during *in vitro* culture.

During the visit, the research work to determine the peculiarities of *in vitro* development was conducted on several hybrid *Populus* genotypes, originating from the following crossing combinations: *P. maximowiczii* × *P. trichocarpa*, *P. tremula* × *P. alba*, *P. tremula* × *P. tremuloides*.



Dr. Jonas Žiauka at Forest Research Institute of Poland

Internship of Dr. Darius Kviklys in China

Agricultural Produce Processing and Export, Shandong foreign trade college, China.

November 6–20, chief researcher and head of department Dr. Darius Kviklys from LAMMC Institute of Horticulture, Department of Horticulture Technologies did an internship in China.

Internship “Agricultural Produce Processing and Export” was organised by Shandong foreign trade college and sponsored by Ministry of Commerce of the People Republic of China.

During the internship several topics were presented and discussed:

- enterprise management of modern agricultural enterprises and marketing art of agricultural produce;
- introduction to fruit and vegetable processing technology;
- application of e-commerce in agricultural products export;

- introduction to grain and oil processing technology;
- storage and preservation of agricultural products;
- inspection and quarantine of Chinese agricultural products;
- establishment of food quality and safety traceability system.



Internship of Dr. Darius Kviklys in China

Internship of the doctoral student Armina Morkeliūnienė at Nature Research Centre in Vilnius

During November 26 – December 21, Armina Morkeliūnienė, a doctoral student of the Plant Protection Laboratory of Institute of Horticulture did internship at the Plant Pathology Laboratory of the Botanical Institute of the Nature Research Center in Vilnius.

The aim of the internship was to acquire new competencies and practical skills in plant pathogen identification, phytopathological and molecular research. During the internship, the doctoral student got acquainted with the research carried out by her colleagues and familiarized herself with the identification of pathogenic fungi of *Fraxinus pennsylvanica* and *Fraxinus excelsior*. Techniques for DNA isolation of pathogens were mastered and PCR analysis was performed. New practical knowledge of research methodology used in plant pathology science was acquired. The obtained research data will be used in the dissertation and in the publications.



Doctoral student Armina Morkeliūnienė at the Plant Pathology Laboratory of the Botanical Institute of the Nature Research Center in Vilnius

8. DISSEMINATION OF SCIENTIFIC KNOWLEDGE

In 2018, national and international events were organized: conferences, workshops. The 80th anniversary of Institute of Horticulture's activities was commemorated. The international conference "Scientific Topicalities and Innovations in Horticulture 2018" (SAIH2018) attracted considerable attention of a large international scientific community. Not only events were organized but also publications for science and the general public were prepared. In 2018, the citation index of the scientific journal "Zemdirbyste-Agriculture" increased in the *CA WoS* database, new informational publications were published. Cooperation agreements with Lithuanian and foreign research and study institutions were signed.

8.1. Scientific conferences, seminars

8.1.1. International conferences, seminars

June 4–6. The second **international conference "Scientific Topicalities and Innovations in Horticulture 2018" (SAIH2018)** took place in Kaunas. Organizers: Institute of Horticulture and Department of Agriculture and Forestry, Lithuanian Academy of Sciences. The conference participants discussed topical issues and innovations in horticulture, and shared the research results. The main topics of the conference: ecological and technological aspects; production quality and storage; genetics, physiology, breeding; applied gardening. The second international conference, SAIH2018, has attracted many participants from other countries. Presentations were made by the representatives of Lithuania, Estonia, Latvia, Poland, Mexico, Belarus,

Romania and other countries. A total of over 100 participants attended the conference.



September 6. An **international conference-discussion** was organized by the Institute of Forestry and Aleksandras Stulginskis University "**Lithuania has forest resources and a strong forest sector – how can the local timber construction sector contribute to the creation of a strong bioeconomy?**" The conference was organized in the framework of the European Union's 7th Research Framework Program ERA-NET Joint International Research Project "Comparative Analysis of Value Chain Sustainability Scenarios". The conference was attended by the representatives of Ministry of Environment of the Republic of Lithuania, scientific institutions, universities, various associations and wood processing companies. In the first part of the conference, ongoing project and goals were presented. Later, case studies of the project in Austria and Lithuania were discussed: comparing the use of renewable wood resources and non-renewable materials in the construction sector, the sustainability impact of replacing non-renewable materials with wood materials and the potential mitigation of climate change. Problems, opportunities and wood

resources in Lithuania in the construction sector were also presented. The second part of the conference dealt with the existing problems, legal regulations that hinder the wider use of wood in the construction sector. Using the Ketso method, possible solutions were identified. Great attention was paid to possible technologies of future use of wood, the application of which would contribute to faster development of bioeconomy in Lithuania. Later, the factory of one of the project partners "Jūrės medis" was visited.



February 9. An international seminar “**Innovations in Strawberry Growing Technologies**” was held at the Institute of Horticulture. The seminar was organized by: Institute of Horticulture, Kaack Pflanzenvermehrung GmbH u. Co. KG and A. Ragaišis farm. The topics discussed during the event: cultivation of strawberries in a greenhouse and film-mulched beds, technological peculiarities and solutions; new fertilizers for strawberries; repelling birds and animals in strawberry fields; watering/irrigation systems in strawberry fields, and other issues.



8.1.2. National conferences, seminars

January 24–26. **Scientific Conference “Agrarian and Forestry Sciences: Latest Research Results and Innovative Solutions”**. On the first day of the event, the results of the three long-term programs “Productivity and sustainability of agricultural and forest soils”, “Harmful organisms in agro-forest ecosystems” and “Plant biopotential and quality for multifunctional use” were presented. The second day of the conference dealt with the importance of control and conservation of forest populations (wild boar, beaver, wood-grouse), trends in the spread of pests and diseases in changing climate conditions, the impact of pollutant/contaminants entering the soil with precipitation on forest ecosystems and others. The third day of the conference was devoted to the presentation of results of the long-term research program “Research on the genetic nature of features of agricultural and forest plants, targeted change

of genotypes for creation of modern varieties”. In addition, topical garden and garden plant research topics were discussed: plant photophysiology, genetics, variety productivity, fertilizer impact on crops, crop yield and soil, etc.



February 27. **Conference-seminar “Acid Soil Liming – Inevitable Necessity”** held at Vėžaičiai Branch. Topics discussed: acidic soils in Lithuania – current situation and prospects; peculiarities of soil acidification in Eastern Lithuania: consequences and solutions to problems; the effect of liming on biological soil activity; the importance of liming on aluminum forms in soil; the influence of liming and its combinations with other agronomic practices on soil structure and organic carbon content, etc.



March 20. **Conference “Between the Earth and the Sky”** held at Institute of Agriculture. The event was dedicated to the Earth’s Day. Saulius Rumbutis, Head of the Ornithology Department of Kaunas T. Ivanauskas Zoological Museum, presented the objectives of the project “Birds – Lithuanian Ambassadors”: to mark the 100th anniversary of the restoration of the Lithuanian state in a non-traditional way, to promote the name of Lithuania in the world with the help of birds, to contribute to the research on protected Lithuanian winged bird species’ migrations, draw people’s attention to bird protection. In addition, the results were summarized:



149 juveniles of protected bird species were marked with Lithuanian “passport” with the address of Kaunas Zoological Museum, over 160 old nesting sites of protected bird species were checked and new nesting sites were found. Migration routes of

different species of birds fitted with GPS transmitters were also discussed. Arūnas Pranaitis, director of Žuvintas Biosphere Reserve, spoke about the values of Žuvintas nature and their protection.

April 17. **Conference “Sustainable soil – the basis of today’s farming”** held at Vėžaičiai Branch. The conference introduced the concept of sustainable soil, identified key physical, chemical indicators for sustainable soil use and key agro-technical tools for improving soil fertility and sustainable use. It has been emphasized that the decline of organic matter in soils, the availability of nutrients needed for plants and the compaction of soils in the future may lead to a decrease in the productivity of *Cambisols*.



April 24. **Conference “Problems and Prospects for Contemporary Forest Planting in Agricultural Land in the Context of Climate Change”** held at Institute of Forestry. The event was dedicated to Lithuanian Honoured Forester, Honorary Member of the Forestry Union, Dr. Vincentas Verbyla (1918–2017). Topics discussed: forests and forestry in the second half of the 20th century; peculiarities of afforestation of wasteland, etc.



May 18. **Conference “Plant Physiology Research in the Breakthrough Fields of Crop Production”** held at Institute of Horticulture. Organizers: Department of Agriculture and Forestry of Lithuanian Academy of Sciences and Institute of Horticulture. Topics discussed: the role of active oxygen compounds in plant metabolism; process management and adaptation in photosynthesis; the ability of photo-stress to control the antioxidant potential of plants; concept of mycotoxins. The conference was supported by the Ministry of Agriculture of the Republic of Lithuania.



June 14. **Scientific Conference “Innovations in Crop Science and Technological Developments”** held at Institute of Agriculture. The aim of the conference was to review the development of crop science over a century, discuss its development and research results in the context of various regions of the country, present the latest plant varieties developed at the Institute of Agriculture, visit field experiments, discuss plant productivity and nutrition, soil health, plant protection and other issues. After presentations, the participants of the conference visited the experimental fields of Institute of Agriculture. The event was supported by the Ministry of Agriculture of the Republic of Lithuania.



June 26. **Conference “The Future of Agriculture – Sustainable Farming”** held at Institute of Agriculture. At the beginning of the event, the Minister of Agriculture of the Republic of Lithuania Giedrius Surplys had a discussion with farmers. The participants were interested in issues of drought assessment, benefits and other relevant issues. The discussion was focused on sustainable farming, which is associated with smart land use. The importance of preserving soil properties to achieve a balanced, acidification, alkali or erosion-free soil was discussed. It was emphasized that if soil fertility does not decrease, the cultivation of the soil is optimal. Balance between economic and ecological goals was advocated. The importance of research on nutrients in soil was highlighted. Plant protection place in sustainable farming was

presented. Proposals and solutions for the sustainable agriculture strategy were also presented by business representatives. The event was supported by the Ministry of Agriculture of the Republic of Lithuania and the Lithuanian Grain Producers Association.



July 4. **Scientific-practical conference “Possibilities and Measures for Improving Soil and Plant Productivity”** held at Joniškėlis Experimental Station. The conference was focused on the selection and fertilization of pre-crops in an intensive crop production farm, the importance of melliferous herbaceous plant strips in the fields under intensive agriculture, the maintenance of soil productivity and adequate soil properties by tillage, etc. The event was supported by the Ministry of Agriculture of the Republic of Lithuania.



November 26. **Conference “History, Present and Future in the Context of Science, Business and Society Partnership”** held at Institute of Agriculture. The event was attended by Marius Vasiliauskas, Director General of Institute’s partner UAB “Scandagra”, and Benediktas Vanagas, a national awareness-raising racer. The achievements of agronomy science in a century, the direction of scientific innovations for future farms, etc., were presented. After the conference, a festive 100th flag of the Project “100 Vytis Flags” organized by JSC Scandagra was hoisted at Institute of Agriculture.



January 9. **Seminar “Soil Productivity and its Improvement Possibilities”** held at Joniškėlis Experimental Station. Negative changes in soil properties due to excessive precipitation have become a problem for future crop productivity. Natural factors cannot be changed, but the seminar participants tried to find ways to mitigate the harmful consequences for agriculture. The seminar was initiated by Zigmantas Aleksandravičius, head of the Kupiškis Division of the Lithuanian Farmers’ Union. LFU Kupiškis Division unites active farmers interested in scientific and technological innovations. A lot of farmers from Kupiškis region attended the event. Researchers presented reports on the key measures to maintain and improve soil

productivity, and to find solutions to the problems of extreme years.



March 15. Seminar “Sustainable Agriculture using bio-preparations and mobilizing soil potential, Topicalities of Fertilization 2018” held at Institute of Horticulture. The importance of organic matter and biological factors for soil quality indicators was discussed in the event, the research work of IH Horticultural Technology Sector, a new generation of liquid organic fertilizer – Ferbanat L, etc., were presented.



June 12. Seminar “Heritage Gardens” held in Rumšiškės, Lithuanian Open Air Folk Life Museum, Firefighters’ Shelter. Organizers: Lithuanian Rural Tourism Association, Institute of Horticulture. More than 60 participants from Lithuanian Rural Tourism Association, Kaunas Regional Museum, Institute of Horticulture and other institutions attended the seminar. Participants were introduced to the formation of the tourism product “Heritage Gardens”. Project operators made oral presentations about the heritage of orchard, garden and ornamental plants in Lithuania. During the seminar, there was a discussion about the origin of plants in Lithuania, their biological properties, significance and purpose, peculiarities of varieties. After the meeting, an excursion and educational program was organized

at the Lithuanian Open Air Folk Life Museum. The seminar was conducted as part of the Interreg project “Heritage Garden”.



June 20. Seminar “Peculiarities of Weed Control in Organic Farm” held at Joniškėlis Experimental Station. Topics discussed during the event: choice of crop rotation, catch crops, and organic fertilizer to reduce weed incidence; the importance of soil tillage and possibilities of controlling the spread of weeds; the importance of pre-sowing cultivation and sowing for crop formation, etc.



July 3. Seminar-field day “Fusarium Head blight – Damage to Yield and Quality” held at Institute of Agriculture. About 70 participants attended the field day. In recent years, farmers’ questions and discussions have often begun and ended on Fusarium head blight-damaged crops, the efficacy and suitability of control products. Meanwhile, scientists encounter increasingly aggressive Fusarium pathogens that adapt to environmental conditions. The disease affects not only the yield, but also the quality. Quality parameters of cereal grain contaminated with toxins deteriorate, which causes additional problems for processors and exporters. Researchers presented the results of scientific studies, field experiments and expert experience. The extent of damage done by Fusarium head blight to cereal production farms was discussed. Participants familiarized themselves with the disease control strategy and learned how

to recognize it. New threats were assessed. The organized measure is related to the priority topics of knowledge transfer and information activities: Quality and Safety of Raw Materials and Food. The event was supported by the Ministry of Agriculture of the Republic of Lithuania.



August 16. **Seminar of the National Science Program “Sustainability of Agro-, Forest and Water Ecosystems” “MIŠKOEKOKAITA Ecochange of forest is a response and plasticity of different tree species and emerging forest communities under the influence of climate change and other stress factors”** held at Institute of Forestry’s Phytotron. The seminar was attended by scientists and specialists of the State Forest Service, Nature Research Center, Kaunas Forest and Environmental Engineering College and Forest Institute. Phytotron equipment and four phytotron projects were introduced to the participants of the seminar. The goals, research trends and research results of the project MIŠKOEKOKAITA and research conducted in a phytotron with seven main types of forest trees exposed to a complex of various stressors (frost, drought, heat, UV radiation, ozone and CO₂) were presented. The results of research on forest regeneration in the forest ecosystems affected

by different disturbances were also presented. The results of the research on changes in the genetic (DNA) diversity of the regenerating affected forest ecosystems were introduced. The results of research on the effects of cold plasma and electromagnetic fields on the growth of tree seeds and seedlings were presented.



September 19. **Seminar “Innovations in Horticulture”** held at Institute of Horticulture. Topics discussed during the seminar: horticultural business in Lithuania: problems and prospects; opinion of growers: sources of knowledge and ways of improving skills; Government programs for horticulture; optimizing apple growth and yielding; ten years of Regalis research; plant diseases and pests: this year’s mistakes and topicalities for the future. After the event, the seminar participants visited the field trials of the Institute of Horticulture.



September 18. **Seminar of LAMMC agronomy research doctoral students** held at Institute of Agriculture. About 30 doctoral students of LAMMC made presentations in English at the event.

After the presentations, the seminar participants and guests were able to vote for the best presentations via online voting. The authors of the best presentations were Renaldas Žydelis, Mohammad Almogdad and Povilas Švėgžda.



October 25. **Seminar “The Importance of Carbon in the Perspective of Climate Change”** held at Institute of Agriculture. The aim of the seminar was to review the importance and opportunities of carbon sequestration in agriculture, to discuss the peculiarities of soil organic carbon accumulation and the links to greenhouse gas emissions in the context of climate change. Presentations were made on the topics: climate change mitigation in agriculture; greenhouse gases and their main sources in agriculture; organic carbon accumulation



in Lithuanian soils; the impact of agriculture on soil quality, carbon sequestration and greenhouse gas emissions; labile and humified carbon in the soil; crop rotation, catch crops and carbon storage in the soil.

Organic carbon accumulation not only enriches the soil, increases its sustainability, but also improves the quality of the whole ecosystem and contributes significantly to climate change mitigation. Carbon sequestration in the soil is a long-term fixation of atmospheric CO₂ in soil compounds. This reduces the carbon dioxide emissions into the atmosphere,

November 22. **Seminar “Sustainable cultivation of legumes in conventional and organic cropping systems”** held at Institute of Agriculture. More than 100 participants attended the seminar on the topic of legume cultivation. The presentations dealt with pea and bean varieties, their breeding in Lithuania; non-traditional plants: possibilities of growing soy, lentils, chickpeas in Lithuania; peculiarities of weed control; the use of legumes as pre-crops, catch crops and in mixtures; experience in and development of the cultivation of these plants on a conventional farm. The seminar was funded by the LegValue project.

December 11. **Seminar “Use of Natural Biological Preparations and Plant Protection Products in Modern Agricultural Growing Technologies”** held at Institute of Horticulture. More than 80 participants attended the seminar. The importance of biological plant cultivation products in combating environmental pollution and reducing the amount of mineral fertilizers and chemical pesticides in vegetable growing technologies was highlighted. Participants were familiarized with Lithuanian KPP 2014-2020 program’s measures, increasing production volume, emerging issues and anticipated solutions. Biological stimulators and liquid

thus reducing the likelihood of reducing the greenhouse effect and hence the warming of the climate. The event was organized in the framework of the 2015–2020 Program for Research and Experimental Development of Agriculture, Food, Fisheries and Rural Development. Projects: 1. “Evaluation of Carbon Sequestration Potential in Agriculture”, according to the project execution contract. MT-17-9; 2. “Inventory of greenhouse gas emissions in the country’s crop production sector”, under the agreement of joint activities 04 05 2017 No. 0017/2017.



fertilizer Ferbanat were presented. The seminar was organized by the Institute of Horticulture, Lithuanian Association of Vegetable Growers, “Aljara” UAB.



8.2. Science popularization activities

May 15. **Field day** devoted to demonstration of scientific achievements “Lithuanian varieties of the most promising grass species for successful economic development” held at the Institute of Agriculture. Farmers, agricultural advisors and specialists attended the workshop. Presentations were made about grassland husbandry in relation to animal husbandry. Various grassland swards, which may differ in their botanical composition, purpose and duration of development, were discussed. After indoor presentations, participants visited the experimental fields where presentations were made by Institute of Agriculture’s researchers about the species and varieties of grasses, various grass

mixtures for feed and forage production. Other topical issues of grassland husbandry were discussed.



May 15. **Press conference on the “HERITAGE GARDENS” project held at the Institute of Horticulture.** The press conference was organized in relation to 2014-2020 Interreg V-A Latvian-Lithuanian Cross-Border Cooperation Program Project LLI-181 “Revival of Old Orchard, Garden and Ornamental Plants: Tour of Heritage Gardens”. Twenty journalists representing the national radio and television (LRT), the central and regional press, the Seimas of the Republic of Lithuania and Internet portals, attended the conference. The activities of the Institute of Horticulture as well as the idea, progress and discoveries of the “Heritage Gardens” project were presented. Information about the project promotion activities and measures aimed to

inform as many potential visitors as possible about the orchard, garden and ornamental plant heritage objects, identified during the project, was provided.

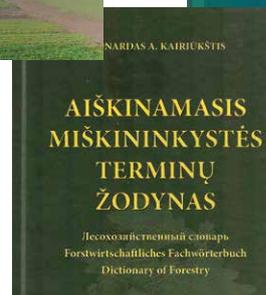
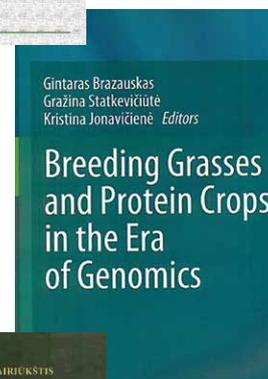
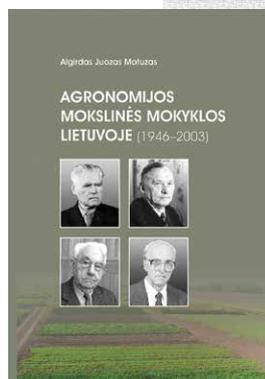
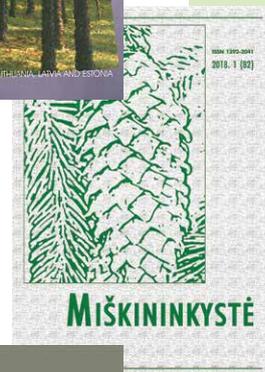
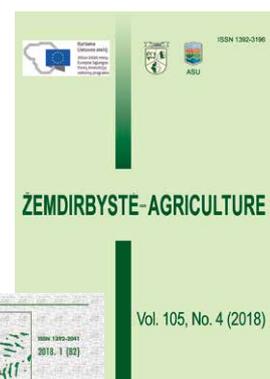
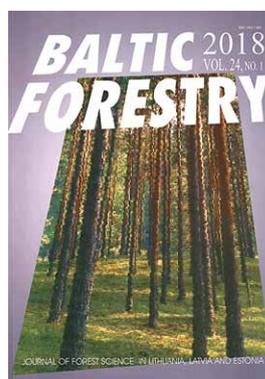


8.3. Publishing

LAMMC is a co-publisher of the scientific journals “Baltic Forestry” (IF 2017 / 2018 – 0.548), “Zemdirbyste-Agriculture” (IF 2017 / 2018 – 0.746), “Sodininkystė ir daržininkystė”, “Miškininkystė”, “Agronomy Research”. Other publications published in 2018:

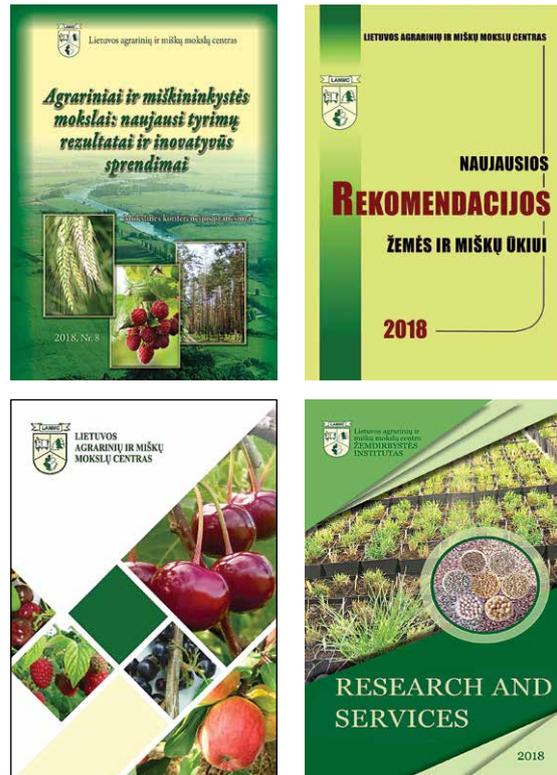
- “Explanatory Dictionary of Forestry Terms: (Lithuanian-Russian-German-English with Latin names of botany, zoology and forest typology terms)” published by the academician Leonardas A. Kairiūkštis. The dictionary includes over 5000 Lithuanian terms and several times more equivalents and synonyms used in the aforementioned languages. In addition to the special forestry terminology, the dictionary also contains some other terms of forestry that are encountered by professional foresters, forest owners and naturalists. The dictionary is designed for foresters: forestry professionals, forest owners and managers, as well as for schoolchildren, forestry students, teachers, and the general public, interested in forestry and modern nature conservation, ecology and sustainable development. This is the first dictionary of forestry terms in Lithuanian, Russian, German, and English with Latin names of botanical, zoological and forest typology terms that has been published in Lithuania and is devoted to the one hundredth anniversary of the Lithuanian forestry.

- A book “Breeding Grasses and Protein Crops in the Era of Genomics” edited by Dr. Gintaras Brazauskas, Dr. Gražina Statkevičiūtė, Dr. Kristina Jonavičienė was published by the internationally renowned SPRINGER publishing house. This book



includes papers presented at the 2017 Joint meeting of Fodder Crops and Amenity Grasses Section and Protein Crops Working Group of EUCARPIA-Oil and Protein Crops Section held on September 11–14, 2017, in Vilnius, Lithuania.

- A book of abstracts of reports made at the scientific conference “Agricultural and Forestry Sciences: Latest Research Results and Innovative Solutions”;
- A booklet “The Latest Recommendations for Agriculture and Forestry 2018”;
- A monograph by Prof. Dr. habil. A. J. Motuzas “Agronomy Research Schools in Lithuania (1946–2003)”;
- Informational pamphlet “Research and Services”.



8.4. Cooperation with institutions of science and studies

In October, leading scientists representing more than 85 European plant and life science research centres (including LAMMC) and institutes adopted a document urgently requiring European policymakers to protect innovation in plant and agricultural sciences. Scientists are concerned about the recent ruling by the European Court of Justice on modern methods of genome editing which would effectively ban innovative plant breeding. For this reason, European farmers may be deprived of the opportunity to grow the next generation of plants needed to respond to current ecological and societal challenges.

Link: <http://www.vib.be/en/news/Documents/Position%20paper%20on%20the%20ECJ%20ruling%20on%20CRISPR%2012%20Nov%202018.pdf>

Every year, pupils from different schools of the country and students from higher education institutions visit LAMMC in order to get acquainted with the research activities carried out there and with the PhD programs offered by the Centre. In 2018, new contacts with science/research and study institutions were established (see Figure 5).

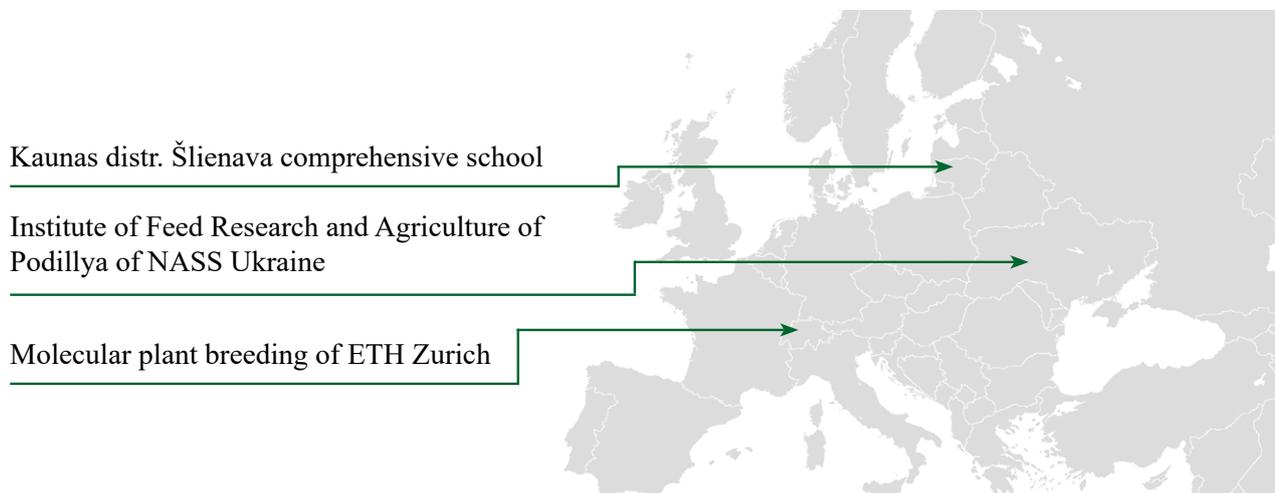


Figure 5. Cooperation agreements signed in 2018

- A cooperation agreement signed between LAMMC and Molecular Plant Breeding of ETH Zurich. The agreement provides for cooperation in plant genomics research.
- A cooperation agreement signed between the Institute of Agriculture and the NASS Institute of Feed Research and Agriculture of Ukraine (Podillya of NASS Ukraine). The cooperation will focus on conduct of joint research, production of joint publications, study visits/internships of doctoral students, exchange programs for researchers and doctoral students, participation in seminars, conferences and academic meetings.
- A cooperation agreement signed between the Institute of Forestry and Šlienava comprehensive school, Kaunas distr. The main goals of the cooperation are: to provide guidance in values so that the pupils perceive the fundamental concepts of science that help to know the world; to disseminate scientific knowledge and familiarize pupils with the scientific world.

9. EVALUATION OF RESEARCH ACTIVITIES

Bonuses, certificates of merit for students, doctoral students and young scientists

On February 20, awards were assigned by the Lithuanian Academy of Sciences (LAS) to the winners of research competitions for young scientists, doctoral students and students of higher education institutions, as well as LMA's certificates of merit.

In the Department of Agriculture and Forestry, the award for young scientists and doctoral students was assigned to Dr. Andrius Aleliūnas for the research work "Identification of functional markers of freezing tolerance in perennial ryegrass (*Lolium perenne L.*)". A certificate of merit was assigned to Dr. Inga Tamošiūnė, a younger researcher of the Institute of Horticulture for her research work "Endophytic bacteria population structure of domestic apple and interaction with apple cells and shoots *in vitro*."



In the top row, the second from the left
Dr. Andrius Aleliūnas

Lithuanian Academy of Sciences' scholarships for young scientists

The Presidium of the Lithuanian Academy of Sciences awarded LAS scholarships (2018–2019) to young scientists of LAMMC Institute of Agriculture, Genetics and Physiology Laboratory Dr. Rita Armonienė (for research work "Identification and analysis of new alleles of genes activated during winter wheat cold acclimation") and to a senior researcher of Forest Protection and Hunting Department of LAMMC Institute of Forestry Dr. Diana Marčiulygienė (for research work "Identification of chemical fingerprints of common ash against the deadly invasive forest pathogen *Hymenoscyphus fraxineus*").

The scholarships for young scientists assigned by the Lithuanian Academy of Sciences are aimed at promoting scientific creative activities, supporting the research work of the most talented ones and promoting creative competition between young scientists.



In the second row, the second from the left
Dr. Diana Marčiulygienė, in the third row,
the second from the left Dr. Rita Armonienė



Dr. Diana Marčiulygienė is being awarded the LAS scholarship 2018–2019



Dr. Rita Armonienė is being awarded the LAS scholarship 2018–2019

Members of the Young Academy of the Lithuanian Academy of Sciences

On December 18, the meeting of the Presidium of the Lithuanian Academy of Sciences took place at which the resolution on the approval of the members of the Young Academy of the Lithuanian Academy of Sciences was adopted. For a four-year term, two LAMMC scientists were elected at the Department of Agriculture and Forestry: Dr. Diana Marčiulygienė (LAMMC Institute of Forestry) and Dr. Jurga Miliauskienė (LAMMC Institute of Horticulture). Members of the Lithuanian Academy of Sciences' Young Academy are elected by means of a competition. The eligible candidates are those who have achieved significant scientific results and are active in professional activities, obtained a doctoral degree not more than 10 years ago and are not more than 40 years of age before the election day.



Dr. Diana Marčiulygienė and President of the Lithuanian Academy of Sciences academician Jūras Banys



Dr. Jurga Miliauskienė and President of the Lithuanian Academy of Sciences academician Jūras Banys



Dr. Diana Marčiulygienė ir Dr. Jurga Miliauskienė

Other awards

The National Food Cluster, whose member is LAMMC Institute of Horticulture, has received the “Bronze Label” certificate. This award is used worldwide and is recognized as an evidence of a reliable and effective cluster.

The association “The National Food Economy Cluster” is a cooperation network of Lithuanian food sector’s business enterprises and research institutions that seeks to: identify market niches, on the basis of which the Lithuanian food industry could replace the low value added chains to high added value chains; concentrate human, financial, organizational, infrastructural and technological resources by occupying the intended market niches for Lithuanian companies; to organize a continuous process of acquisition of skills, knowledge and information of the network participants, enabling them to become active and competitive market participants.



10. FUNDING

LAMMC budget is composed of state budget appropriations, funds from national and international projects, funds from contract work for Lithuanian and foreign economic entities and other income (sales of agricultural produce, rent of premises, etc.) (Figure 6). In 2018, LAMMC revenue amounted to 11.6 million Eur.

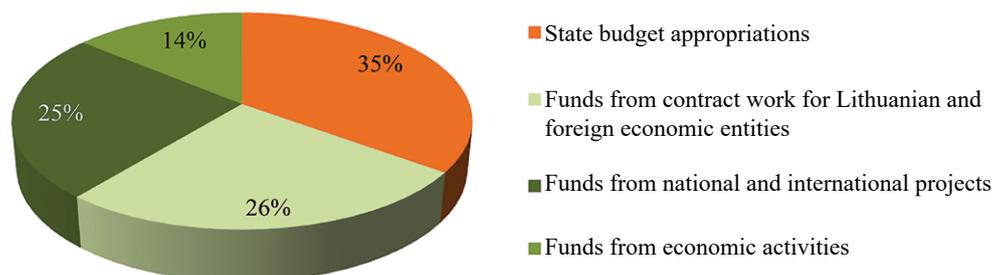


Figure 6. Funding sources

Major expenditure: salaries/ wages and social insurance (73 %), goods (12 %), services (5 %), business trips (2 %). Other expenditure: public utility services and communications, maintenance of transport means/ vehicles, doctoral scholarships, royalties, etc.

11. APPENDICES

11.1. All projects

11.1.1. National

Research funded by the Lithuanian Research Council

Projects of the national research programme “Sustainability of agro-, forest and water ecosystems”

1. “The influence of long-term contrasting intensity resources management on the soils of different genesis and on other components of agroecosystems” (AGROTVARA). Partners: LAMMC, ASU, VU. Project leader Dr. Virginijus Feiza. 2015–2018.
2. “Establishment and diversity of a newly emerging cereal pathogen in the agroecosystem due to changing climate and farming practices”. Partners: LAMMC, NRC. Project leader Dr. Gražina Kadžienė. 2015–2018.
3. “Response and plasticity of different tree species & juvenile-stage forest communities under impact of climate change and other environmental stressors”(MIŠKOEKOKAITA). Partners: LAMMC, NRC. Project leader Prof. Dr. Alfars Pliūra. 2015–2018.
4. “Study of impact of clear cuttings on biodiversity dynamics in forest ecosystems”. Partners: LAMMC, VMU. Project leaders: Dr. Remigijus Daubaras (VMU), Dr. Vidas Stakėnas. 2015–2018.
5. “Integrated impact of climate and environmental changes on the productivity, biodiversity and sustainability of agro-ecosystems” (KLIMAGRO). Partners: LAMMC (Dr. Sandra Sakalauskienė, Dr. Jurga Miliauskienė), VMU. Project leader Prof. Dr. habil. Romualdas Juknys (VMU). 2015–2018.

Projects of researchers’ teams

1. “Biogeography and spread of local and invasive tree pathogens: focus on climate, tree species and intensity of forest management”. Project leader Dr. Audrius Menkis. 2017–2020.
2. “GrowGene – Genome-wide functional analysis of perennial ryegrass for improved growth under water limiting conditions”. Project leader Dr. Kristina Jonavičienė. 2017–2020.
3. “Dynamic light spectrum and intensity modelling and photoresponse in different vegetable morphogenesis stages”. Project leader Dr. Giedrė Samuolienė. 2017–2020.
4. “Improvement of apple fruit quality by application of innovative horticultural technologies”. Project leader Dr. Darius Kviklys. 2017–2020.
5. “Involvement of oxidative stress in molecular mechanism of seed response to cold plasma treatment”. Project leader Dr. Danas Baniulis. 2017–2019.
6. “Control of nitrate reduction in green vegetables: metabolic effects of light and other environmental factors”. Project leader Dr. Akvilė Viršilė. 2015–2018.
7. “Development of molecular markers for genomic selection of adaptation in perennial ryegrass” (ADAPTGENAS). Project leader Dr. Gintaras Brazauskas. 2015–2018.
8. “Role of lipids in low-temperature adaptation of apple”. Project leader Dr. Perttu Haimi. 2015–2018.
9. “Supercritical fluid extraction of lycopene and the application of its extracts in development of innovative products”. Project leader Prof. Dr. Pranas Viškelis. 2015–2018.

High level R&D projects (SMART)

1. “Development of wood modifying eco-friendly technology for higher value products”. Project leader Dr. Marius Aleinikovas. 2017–2021.
2. “Closed plant cultivation system for production of raw materials for peptide nanoengineering applications”. Project leader Dr. Danas Baniulis. 2017–2021.

3. “UV-A lighting strategies for controlled environment horticulture: upgrade to sustainable, high-value production”. Project leader Dr. Akvilė Viršilė. 2017–2021.
4. “Quality diagnostics of biogas production by-product (digestate) for innovative use as a biofertilizer”. Project leader Dr. Alvyra Šlepetienė. 2017–2021.
5. “Development of winter wheat varieties for amylose-free starch and vital gluten processing”. Project leader Dr. Gintaras Brazauskas. 2017–2021.
6. “Enhancement of the multifunctional properties of legumes in feed and food value chains” (SmartLegume). Project leader Dr. Žydrė Kadžiulienė. 2017–2021.

Grant for high-level researchers’ group project

“Insights into future forests: challenges of climate change and diseases, and possible measures for saving biodiversity and ecosystem functioning”. Project leader Dr. Audrius Menkis. 2017–2021.

Post-doctoral internships in Lithuania

1. “The resistance of different Scots pine (*Pinus sylvestris* L.) genotypes against root rot (heterobasidion annosum (Fr.) Bref.)”. Post-doc Dr. Adas Marčiulynas. Research supervisor Dr. Virgilijus Baliuckas. 2017–2019.
2. “The metabolic response of summer rape (*Brassica napus* L.) to negative effects of climate change”. Post-doc Dr. Austra Dikšaitytė. Research supervisor Dr. Akvilė Viršilė. 2017–2019.
3. “The impact of light quantity and quality parameters on changes of the *fragaria* × *ananassa* pathogens bioecological properties”. Post-doc Dr. Neringa Rasiukevičiūtė. Research supervisor Dr. Aušra Brazaitytė. 2017–2019.
4. “Assessment of different perennial herbaceous plant species as potential feedstocks for conversion into bioenergy products”. Post-doc Dr. Kristina Amalevičiūtė-Volungė. Research supervisor Dr. Bronislava Butkutė. 2017–2019.

Other projects of the Research Council of Lithuania

Sub-activity “Development of students’ competences through participation in scientific summer practice”

1. “Development of students’ competences through participation in scientific summer practice at LAMMC”. No. 09.3.3-LMT-K-712-09-0206. Leader Dr. Vita Tilvikienė. 2018 July 1 – 2018 August 31.
2. “Value of flower-rich margins for wild pollinators’ habitat formation in the fields under intensive agriculture”. No. 09.3.3-LMT-K-712-09-0262. Leader Dr. Lina Šarūnaitė. 2018 July 1 – 2018 August 31.

Sub-activity “Research done by students during the non-study time”

1. “Morphological and photosynthetic response, distribution of nitrogen in lettuce under assimilative light”. No. 09.3.3-LMT-K-712-03-0009. Leader Dr. Giedrė Samuolienė. 2017 October 2 d. – 2018 April 30.
2. “Metabolic interrelations between nitrates and ascorbic acid: the control of nutritional value indices in green vegetables in controlled environment agriculture”. No. 09.3.3-LMT-K-712-03-0024. Leader Dr. Akvilė Viršilė. 2017 October 2 – 2018 April 30.
3. “Enhancement of student competence in research on the effective use of biomass for bioenergy”. Leader Dr. Vita Tilvikienė. 2018 October 1 – 2019 April 30.
4. “The response of orchard and garden plants’ photosynthesis and antioxidant system to *Botrytis spp.* pathogenesis under light exposure”. Leader Dr. Viktorija Vaštakaitė-Kairienė. October 1, 2018 – 2019 April 30.
5. “Bio-response-based vegetable greens growing in indoor systems”. Leader Dr. Giedrė Samuolienė. 2018 October 1 – 2019 April 30.

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

The agriculture, food and fisheries research and development projects

1. “Evaluation of the most harmful seed borne diseases of cereals and fodder legume crops, and the establishment of their thresholds in certified cereal and fodder plant seed”. Project leader Dr. Roma Semaškienė. 2017–2019.
2. “Development of the Code for Good Agricultural Practice, whose application would mitigate negative effects of agriculture on soil, water, air and climate. Project leader Dr. Virginijus Feiza. 2018–2019.

3. "Evaluation of the most harmful seed-borne diseases of cereals and fodder crops and determination of their thresholds in certified seed of cereals and fodder crops". Leader dr. Roma Semaškienė. 2017–2019.
4. "Assessment of the potential of carbon sequestration in agriculture". Project leader Dr. Žydrė Kadžiulienė. 2017–2019.
5. "Evaluation of cereal varieties susceptibility for integrated pest management (IPM)". Project leader Dr. Jūratė Ramanauskienė. 2017–2019.
6. "The use of digestate for the fertilization of agricultural crops". Project leader Dr. Vita Tilvikienė. 2017–2019.
7. "The inventory of greenhouse gas emissions in crop production". Project leaders Dr. Jūratė Aleinikovienė (ASU), Dr. Vita Tilvikienė. 2017–2019.
8. "Analysis of epidemiological and laboratory research of ASF (African swine fever), prognosis of disease transmission, risk analysis and disease management strategy in wildlife and pig farming localities in the Republic of Lithuania". Project leader Dr. Olgirda Belova. 2017–2019.
9. "The nurture facilities of Stelmuze's progeny clones *in vitro* culture". Project leader Dr. Sigutė Kuusienė. 2017–2018.
10. "The dynamics of grain contamination with mould fungi as influenced by climate, grain storage facilities and conditions". Leader Dr. Audronė Mankevičienė. 2017–2018.
11. "Optimization of horticultural plants' mineral nutrition using of biostimulants of natural origin". Project leader Dr. Ona Bundinienė. 2017–2018.
12. "Scientific research of risk factors of plant origin products produced in Lithuania and preparation of methodological recommendations". Project leader Prof. Dr. Pranas Viškelis. 2017–2018.
13. "Long-term monitoring of soil agrochemical properties". Project leader Prof. Dr. habil. Gediminas Staugaitis. 2016–2020.
14. "Pest risk analysis for 12. *Xylella fastidiosa* (Wwlls et al.)". Project leader Dr. Artūras Gedminas. 2016–2018.
15. "The state of agricultural crop stands and yield predictions in Lithuania". Project leader Dr. Virginijus Feiza. 2016–2018.
16. "Research into pollen species composition and its content in honey in relation to bee foraging distance". Project leader Dr. Kristina Jonavičienė. 2016–2018.
17. "Health evaluation of new varieties of orchard plants and development of the highest category of planting material". Project leader Ingrida Mažeikienė. 2016–2018.

Support for the beekeeping sector in Lithuania

1. "Investigation of the *Apis mellifera carnica* bee lines, consolidation and conservation of the gene pool". Project leader Dr. Violeta Čeksterytė. 2018.
2. "Application possibility and effectiveness of the ecological veterinary medical products Api Life VAR and Api-Bioxal for the control of *Varroa* mites". Project leader Dr. Violeta Čeksterytė. 2018.

Support for projects of the measure "Knowledge transfer and information activities" (Program for the Lithuanian rural development 2014–2020)

1. "Quality and risk assessment of conserved forages aimed at ensuring high feeding-value forage and well-being for dairy cattle". Project leader Dr. Audronė Mankevičienė. 2017–2020.
2. "Crop rotation diversification and agro-technology optimization for the restoration of biodiversity and agro-ecosystem functions". Project leader Dr. Lina Šarūnaitė. 2017–2020.

Support for international research and technology development projects

"IT-solutions for user friendly IPM-tools in management of leaf spot diseases in cereals". Project leader Dr. Antanas Ronis. 2017–2020.

EIP activity group project (Program for the Lithuanian rural development 2014–2020)

1. "Targeted introduction of integrated pest control under intensive farming conditions". Project leader Dr. Antanas Ronis. 2018–2020.
2. "Improvement and dissemination of innovative technologies for larch, spruce, birch and alder tree species plantation forestry breeding and maintenance". Project leader Dr. Gediminas Čapkauskas. 2018–2020.
3. "Innovation gateway" centre for knowledge gathering and transfer, development and demonstration of agricultural technologies". Project leaders Rimtautas Petraitis (LAAS), Dr. Roma Semaškienė. 2017–2019.

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

1. “Sustainable forests for the future society”
Project leader Dr. Marius Aleinikovas. 2017–2019.
2. “Selection of Scots pine genotypes resistant to root rot”. Project leader Dr. Virgilijus Baliuckas. 2017–2019.
3. “Dependence of wood properties of Norway spruce and silver birch on growing conditions and genotype”. Project leader Dr. Virgilijus Baliuckas. 2016–2018.

Support of the Ministry of Transport and Communications of the Republic of Lithuania

Support for the project 2014-2020 EU Fund Investment Program Priority 2 “Promotion of Information Society” 02.3.1-CPVA-V-529 Measure “Development of Advanced Electronic Services”

“Modernization and Development of Informational, Advisory and Training Electronic Services for Integrated Plant Protection” No. 02.3.1-CPVA-V-529-01-0003. Leaders Ilma Rimkevičienė (Lithuanian Agricultural Advisory Service), Dr. Alma Valiuškaitė. 2017–2020.

11.1.2. International

“Horizon 2020” projects

1. “Fostering sustainable legume-based farming systems and agri-feed and food chains in the EU” (LEGVALUE). Coordinator in the Institute of Agriculture Dr. Žydrė Kadžiulienė. 2017–2021.
2. “Thematic network to design the penetration path of non-food agricultural crops into European agriculture” (PANACEA). Coordinator in the Institute of Agriculture Dr. Vita Tilvikienė. 2017–2020.
3. “European Fruit Network” (EUFRUIT). Coordinator in the Institute of Horticulture Dr. Audrius Sasnauskas. 2016–2019.

Projects of “Interreg” program

1. “Revival of old traditional fruit, vegetable and ornament plants and their products: Heritage Gardens Tour”. Coordinator in the Institute of Horticulture Dr. Darius Kviklys. 2017–2019.
2. R004 “Advancement of nontechnological innovation performance and innovation capacity in fruit growing and processing sector in selected Baltic Sea Region countries” (InnoFruit). Coordinator in the Institute of Horticulture Dr. Darius Kviklys. 2016–2019.
3. “Water Management in Baltic Forests (WAMBAF)”. Coordinators in the Institute of Forestry: Dr. Marius Aleinikovas and Dr. Olgirda Belova. 2016–2019.

Projects of the 7th Framework Program

1. FP7 ERA-NET SUMFOREST “Benchmarking sustainability performance of value chains using ToSIA, the tool for sustainability impact assessment” (BenchValue). Coordinators in the Institute of Forestry Dr. Marius Aleinikovas. 2017–2019.
2. FP7-ERANET-2013-RTD “IT-solutions for user friendly IPM-tools in management of leaf spot diseases in cereals” (SpotIT). Coordinator in the Institute of Agriculture Dr. Antanas Ronis. 2017–2019.

Projects of other EU programs supporting research

1. Swedish Institute Baltic Sea Cooperation project “Baltic Sea Region network for sustainable wheat production” (BALTICWHEAT). Coordinator in the Institute of Agriculture Dr. Rita Armonienė. 2017–2018 m.
2. Swedish Institute Baltic Sea Cooperation project “Cooperation in the Baltics on the development of strategies to foresee outbreaks of fusarium damage”. Coordinator in the Institute of Agriculture Dr. Skaidrė Supronienė. 2017–2018.

3. Long Term Forest Research CoFoRD Programme 14C/846: WP3 – FORM Forest Management “Research required to investigate genetic resistance to ash dieback disease *hymenoscyphus pseudoalbidus* (anamorph *chalara fraxinea*) and the development of disease resistant ash planting stock”. Coordinator in the Institute of Forestry Prof. Dr. Alfars Pliūra. 2016–2020 m.
4. “Perennial ryegrass breeding research in Nordic and Baltic countries”. Coordinator in the Institute of Agriculture Dr. Gintaras Brazauskas. 2014–2018.
5. SNS (Nordic Forest Research Co-operation Committee) project CAR-ES III “Centre of advanced research on environmental services from Nordic forest ecosystems”. Coordinator in the Institute of Forestry Dr. Iveta Varnagirytė Kabašinskienė. 2016–2020.
6. The 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 (ImprovLoliumCol)” Coordinators in the Institute of Agriculture Dr. Eglė Norkevičienė, Dr. Vilma Kemešytė. 2018–2021.
7. LIFE project “NutriBiomass4LIFE - Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy”. Coordinator in Agrochemical Research Laboratory dr. Lina Žickienė. 2018–2022.
8. Nordfruit: “Pre-breeding for future challenges in Nordic fruits and berries” partly supported by the Nordic Council of Ministers. Coordinator in the Institute of Horticulture Dr. Audrius Sasnauskas. 2018–2020.

COST actions

1. **FP1406** “Pine pitch canker – strategies for management of *Gibberella circinata* in greenhouses and forests”. Coordinator of Action in the Vokė Branch Dr. Audrius Kačergius. 2015–2019.
2. **FA1306** “The quest for tolerant varieties – phenotyping at plant and cellular level”. Coordinator of Action in the Institute of Horticulture Dr. Rytis Rugienius. 2014–2018.

11.2. The main scientific publications

Articles in the journals indexed in *Clarivate Analytics Web of Science* database (impact factors for 2017)

1. Connolly J., Sebastia M.-T., Kirwan L., Finn J. A., Llubra R., Suter M., Collins R. P., Porqueddu C., Helgadóttir A., Baadshaug O. H., Bélanger G., Black A., Brophy C., Čop J., Dalmannsdóttir S., Delgado I., Elgersma A., Fothergill M., Frankow-Lindberg B. E., Ghesquiere A., Golinski P., Grieu P., Gustavsson A. M., Höglind M., Huguenin-Elie O., Jørgensen M., **Kadziulienė Z.**, Lunnan T., Nykanen-Kurki P., Ribas A., Taube F., Thumm U., De Vlieghe A., Lüscher A. 2018. Weed suppression greatly increased by plant diversity in intensively managed grasslands: a continental-scale experiment. *Journal of Applied Ecology*, 55 (2): 852–862. **IF – 5,742**
2. Černiauskienė Ž., Raila A. J., Zvicevičius E., **Kadziulienė Ž.**, **Tilvikienė V.** 2018. Analysis of *Artemisia dubia* Wall. growth, preparation for biofuel and thermal conversion properties. *Renewable Energy*, 118: 468–476. **IF – 4,900**
3. Zvicevičius E., Raila A., Čiplienė A., Černiauskienė Ž., **Kadziulienė Ž.**, **Tilvikienė V.** 2018. Effects of moisture and pressure on densification process of raw material from *Artemisia dubia* Wall. *Renewable Energy*, 119: 185–182. **IF – 4,900**
4. Sicard P., Agathokleous E., **Araminiene V.**, Carrari E., Hoshika Y., De Marco A., Paoletti E. 2018. Should we see urban trees as effective solutions to reduce increasing ozone levels in cities? *Environmental Pollution*, 243, Part A: 163–176. **IF – 4,358**
5. Villari C., Dowkiw A., Enderle R., Ghasemkhani M., Kirisits T., Kjær E. D., **Marčiulygienė D.**, McKinney L. V., Metzler B., Muñoz F., Nielsen L. R., **Pliūra A.**, Stener L-G., **Suchockas V.**, Rodriguez-Saona L., Bonello P., Cleary M. 2018. Advanced spectroscopy-based phenotyping offers a potential solution to the ash dieback epidemic. *Scientific Report*, 8: 17448. **IF – 4,122**
6. **Žydelis R.**, Weihermüller L., Herbst M., Klosterhalfen A., **Lazauskas S.** 2018. A model study on the effect of water and cold stress on maize development under nemoral climate. *Agricultural and Forest Meteorology*, 263: 169–179. **IF – 4,039**
7. **Tamošiūnė I.**, **Stanienė G.**, **Haimi P.**, **Stanys V.**, **Rugienius R.**, **Baniulis D.** 2018. Endophytic *Bacillus* and *Pseudomonas* spp. Modulate Apple

- Shoot Growth, Cellular Redox Balance, and Protein Expression under *in vitro* Conditions. *Frontiers in Plant Science*, 28 June 2018. **IF – 3,678**
8. Adamson K., Mullett M. S., Solheim H., Barnes I., Müller M. M., Hantula J., Vuorinen M., **Kačergius A.**, Markovskaja S., Musolin D. L., Davydenko K., Keča N., Ligi K., Priedite R. D., Millberg H., Drenkhan R. 2018. Looking for relationships between the populations of *Dothistroma septosporum* in northern Europe and Asia. *Fungal Genetics and Biology*, 110: 15–25. **IF – 3,476**
 9. Nichiforel L., Keary K., Deuffic F., Weiss G., Thorsen B. J., Winkel G., Avdibegović M., Dobšínská Z., Feliciano D., Gatto P., Mifsud E. G., Hoogstra-Klein M., Hrib M., Hujala T., Jager L., Jarský V., Jodłowski K., Lawrence A., **Lukmine D.**, Malovrh Š. P., Nedeljković J., Nonić D., Ostoić S.K., Pukall K., Rondeux J., Samara T., Sarvašová Z., Scriban R. E., **Šilingienė R.**, Sinko M., Stojanovska M., Stojanovski V., Stoyanov N., Teder M., Vennesland B., Vilkriste L., Wilhelmsson E., Wilkes-Allemann J., Bouriaud L. 2018. How private are Europe's private forests? A comparative property rights analysis. *Land Use Policy*, 76: 535–552. **IF – 3,194**
 10. **Feiziene D.**, **Feiza V.**, Karklins A., **Versulienė A.**, **Janusauskaite D.**, **Antanaitis A.** 2018. After-effects of long-term tillage and residue management on topsoil state in Boreal conditions. *European Journal of Agronomy*, 94: 12–24. **IF – 3,192**
 11. Nussbaumer A., Waldner P., Apuhtin V., Aytar F., Benham S., Bussotti, F., Eichhorn J., Eickenscheidt N., Fabianek P., Falkenried L., Leca S., Lindgren M., Manzano Serrano M.J., Neagu S., Nevalainen S., Pajtik J., Potočić N., Rautio P., Sioen G., **Stakėnas V.**, Tasdemir C., Thomsen I.M., Timmermann V., Ukonmaanaho L., Verstraeten A., Wulff S., Gessler A. 2018. Impact of weather cues and resource dynamics on mast occurrence in the main forest tree species in Europe. *Forest Ecology and Management*, 429: 336–350. **IF – 3,169**
 12. Jukonyte R., Zadeike D., Bartkiene E., Lele V., Cernauskas D., **Suproniene S.**, Juodeikiene G. 2018. A potential of brown rice polish as a substrate for the lactic acid and bioactive compounds production by the lactic acid bacteria newly isolated from cereal-based fermented products. *LWT - Food Science and Technology*, 37: 323–331. **IF – 3,129**
 13. Drózdź P., **Šėžienė V.**, Wójcik J., Pyrzyńska K. 2018. Evaluation of bioactive compounds, minerals and antioxidant activity of lingonberry (*Vaccinium vitis-idaea*) fruits. *Molecules*, 23 (1): 53. **IF – 3,098**
 14. González-Burgos E., **Liudanskas M.**, **Viškėlis J.**, Žvikas V., Janulis V., Gómez-Serranillos M.P. 2018. Antioxidant activity, neuroprotective properties and bioactive constituents analysis of varying polarity extracts from Eucalyptus globulus leaves. *Journal of Food and Drug Analysis*, 26 (4) 1293–1302. **IF – 2,852**
 15. Bartkiene E., Bartkevics V., Elīnalkkere L., Pugajeva I., Zavistanaviciute P., Lele V., Ruzauskas M., Bernatoniene J., Jakstas V., Klupsaite D., Zadeike D., **Viškėlis P.**, Juodeikiene G. 2018. The effects of ultrasonication, fermentation with *Lactobacillus*, and dehydration on the chemical composition and microbial contamination of bovine colostrum. *Journal of Dairy Science*, 101 (8): 6787–6798. **IF – 2,749**
 16. **Butkutė B.**, Dagilytė A., Benetis R., Padarauskas A., **Cesevičienė J.**, Olšauskaitė V., **Lemežienė N.** 2018. Mineral and phytochemical profiles and antioxidant activity of herbal material from two temperate *Astragalus* species. *BioMed Research International*, Article ID 6318630, 11 pages. **IF – 2,583**
 17. Chawade A., **Armonienė R.**, Berg G., **Brazauskas G.**, Frostgård G., Geleta M., **Gorash A.**, Henriksson T., Himanen K., Ingver A., Johansson E., Jørgensen L.N., Koppel M., Koopel R., Makela P., Otriz R., Podyma W., Roitsch T., **Ronis A.**, Svensson J.T., Wallenback P., Weih M. 2018. A transnational and holistic breeding approach is needed for sustainable wheat production in the Baltic Sea region. *Physiologia Plantarum*, 67 (4): 442–451. **IF – 2,580**
 18. Helgadóttir Á., Aavola R., IsoLahti M., Marum P., Persson C., **Aleliūnas A.**, **Brazauskas G.**, Krisjānsdóttir T. A., Asp T., Rognli O. A. 2018. Adaptability and phenotypic stability of *Lolium perenne* cultivars of diverse origin grown at the margin of the species distribution. *Journal of Agronomy and Crop Science*. 204 (5): 493–504. **IF – 2,571**
 19. Savickiene N., Jekabsone A., Raudone L., Abdelgeliel A.S., Cochis A., Rimondini L., Makarova E., Grinberga S., Pugovics O., Dambrova M., Pacauskiene I.M., Basevičienė N., **Viškėlis P.** 2018. Efficacy of Proanthocyanidins from *Pelargonium sidoides* Root Extract in Reducing *P. gingivalis* Viability While Preserving Oral Commensal *S. salivarius*. *Materials*, 2018, 11(9), 1499 **IF – 2,467**
 20. Drózdź P., **Šėžienė V.**, Pyrzyńska K. 2018. Mineral composition of wild and cultivated blueberries. *Biological Trace Element Research*, 181 (1): 173–177. **IF – 2,361**

21. **Volungevicius J., Amaleviciute-Volunge K., Versulienė A., Feiziene D., Feiza V., Šlepetienė A., Liaudanskiene I., Vaisvalavicius R.** 2018. The effects of agrogenic transformation on soil profile morphology, organic carbon and physico-chemical properties in Retisols of Western Lithuania. *Archives of Agronomy and Soil Sciences*, 64 (13): 1910–1923. **IF – 2,254**
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