



**LITHUANIAN
RESEARCH CENTRE
FOR AGRICULTURE
AND FORESTRY**

2020



ANNUAL REPORT

**LITHUANIAN RESEARCH CENTRE
FOR AGRICULTURE AND FORESTRY**



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DIRECTOR'S FOREWORD

We have started the year by marking the anniversary of the Lithuanian Research Centre for Agriculture and Forestry. Soon after, the onset of the COVID-19 pandemic and the quarantine imposed in the country made us change our routine activities. Events were interrupted, we had to quickly learn the subtleties of remote communication. I am glad and proud that LAMMC employees did not get lost, bravely accepted the challenges, and even managed to improve the institution's performance. In particular, this is true in terms of published research papers.

In 2020, the number of articles published increased by as much as 50% and reached 122 publications in the journals indexed in the *Clarivate Analytics Web of Science* database. Not only the number of published papers has increased, but also their quality – more than half of the research papers have been published in the Q1 and Q2 journals.

The rapidly improving publication results give us hope that we will more confidently join international research groups with proposals for research projects. And indeed, this year we have succeeded in joining a major international programme "Towards climate-smart sustainable management of agricultural soils" (EJP SOIL). Participation in this programme, together with partners from 23 countries, will hopefully be a springboard for LAMMC researchers to become more visible in the European research realm.

Equally important is the involvement in the activities of international organizations: EPSO, EUCARPIA, NJF, SNS, etc., in solving global scientific problems, such as finding solutions to the implementation of objectives of the European Green Deal.

At the national level, we are continuing cooperation with the FTMC (Center for Physical Sciences and Technology) and LEI (Association of Research and Technology Organizations "RTO Lithuania") by developing interdisciplinary research and with Vytautas Magnus University by carrying out joint PhD programmes.

In 2020, 5 plant varieties developed by LAMMC were registered. These are winter wheat 'Silva' and 'Taurija', oats 'Frekula DS', winter garlic 'Dangiai' (protected variety) and annual pepper 'Gabija'. It is gratifying to note that Lithuanian agricultural business entities will be able to choose crop varieties adapted to the country's growing conditions.

I would like to extend congratulations to Prof. Dr. habil. Vidmantas Stanys, Dr. Tadeušas Šikšnianas, Dr. Dalia Gelvonauskienė and Dr. Audrius Sasnauskas on becoming the winners of the Lithuanian Science Prizes for the series of experimental development works "Genetic and Biotechnological Research for the Development of Garden Plant Varieties". Congratulations to Dr. Viktorija Vaštakaitė-Kairienė on becoming a new member of the Young Academy of the Lithuanian Academy of Sciences. I wish her every success in representing young scientists.

The year 2021 is in front of us. It is difficult to say what it will be like, but the concentration and determination of the public at large and particularly, the scientific community to overcome the COVID-19 pandemic offer us hope that rational solutions to climate change mitigation will be found as well.



Director
Dr. Gintaras Brazauskas

A stylized, handwritten signature in dark ink, consisting of a large, flowing 'G' followed by a series of loops and a final horizontal stroke.

MAJOR FACTS

In 2020, the Lithuanian Research Centre for Agriculture and Forestry (hereinafter LAMMC): employed a total staff of

513, including **181** research workers, and had **63** doctoral students.



On August 26, the Ministry of Education, Science and Sports of the Republic of Lithuania approved Dr. Gintaras Brazauskas as LAMMC director for a five-year term.



5 agricultural crop varieties were included in the Lithuanian National List of Plant Varieties and **4** varieties were included in the EU Common Catalogue of Varieties of Agricultural Plant Species.



EJP SOIL
European Joint Programme

LAMMC, together with 23 countries, started to implement the **“Horizon 2020”** project “Towards Climate-Smart Sustainable Management of Agricultural Soils” (EJP SOIL) totalling **80 million** in value.



RTO
LITHUANIA

In 2020, LAMMC together with the other members of the association “RTO Lithuania” implemented **2** inter-institutional projects on the topic of the Green Deal.

6

Implemented
long-term
institutional research
PROGRAMMES.



8

LAMMC doctoral students
defended
DISSERTATIONS.

Carried out
34 international,
64 national research projects funded by the Research Council of Lithuania, Ministry of Agriculture, Ministry of Environment, fulfilled over **200** contract orders for national and foreign economic entities.

A scientific article “Ozone affects plant, insect, and soil microbial communities: A threat to terrestrial ecosystems and biodiversity”, prepared by Dr. Valda Araminienė together with co-authors, was published in the scientific journal **“Science Advances”**, holding an impact factor (IF) as high as 13.116 (2019).

LAMMC researchers published
122 scientific publications
in the journals indexed in the *Clarivate Analytics Web of Science* (hereinafter *CA WoS*).

ARRANGED

2 meetings of international projects, **1** seminar,
6 national conferences, more than **70** workshops,
discussions, field days, meetings of experience
sharing groups.



1. LAMMC VISION, MISSION AND VALUES

1

2

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:

- development of high-level research,
- enhancement of internationalization,
- development of doctoral studies,
- co-operation between science and business,
- community mobilization,
- expansion of public services.



3. COLLABORATION



While carrying out research and experimental development (R&D) activities, the Lithuanian Research Centre for Agriculture and Forestry co-operates with national and foreign scientific and business institutions. One of the examples of the successful collaboration is establishment of the Research and Technology Organisation “RTO Lithuania” in 2019 jointly with the Lithuanian Energy Institute, the Center for Physical Sciences and Technology, and the public institution “Science and Technology Park of the Institute of Physics”. On June 19, 2020, at the meeting of the Management Board, the Director of LAMMC, Dr. Gintaras Brazauskas was elected the new chairperson of the Management Board of the “RTO Lithuania”.

In 2020, new co-operation relations were established with the National Mordovian State University and the public institution “Žemaitijos Innovation Centre”.

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

European Plant Science Organization (EPSO)

European Forest Institute (EFI)

Global Research Alliance on Agricultural Greenhouse Gases

European Vegetable Research Institutes Network (EUVRIN)

International Society for Horticultural Science (ISHS)

European Fruit Research Institutes Network (EUFRIN)

International Union of Food, Science and Technology (IUFOST)

International Union of Forest Research Organizations (IUFRO)

European Association for Research on Plant Breeding (EUCARPIA)

4. HUMAN RESOURCES

4.1. RESEARCH BOARD

On September 24, the newly elected Research Board of LAMMC started its work.

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.



►
Research Board

Members of the Research Board



►
Chairperson of the
Research Board
**Prof. Dr. habil.
Zenonas Dabkevičius**

Dr. Giedrė Samuolienė

Deputy Director for Science, Head of Laboratory of Plant Physiology, Chief Researcher, Institute of Horticulture, Lithuanian Research Centre for Agriculture and Forestry, Deputy Chairperson of Research Board

Dr. Povilas Žemaitis

Senior Researcher of Department of Ecology, Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry, Deputy Chairperson of Research Board

Dr. Audronė Mankevičienė

Chief Researcher of Department of Plant Pathology and Protection, Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Secretary of Research Board

Dr. Marius Aleinikovas

Director of Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry

Dr. Vidmantas Bendokas

Deputy Director for Administration, Senior Researcher of Orchard Plant Genetics and Biotechnology, Institute of Horticulture, Lithuanian Research Centre for Agriculture and Forestry

Dr. Gintaras Brazauskas

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

Dr. Zita Duchovskienė

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

Dr. Saulius Jasius

Senior advisor of Sustainable Agricultural Production Policy Group, Ministry of Agriculture of the Republic of Lithuania

Dr. Žydrė Kadžiulienė

Director of Institute of Agriculture, Chief Researcher of Department of Plant Nutrition and Agroecology, Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry

Dr. Nerijus Kupstaitis

Head of Forest Policy Group, Ministry of Environment of the Republic of Lithuania

Dr. Alfars Pliūra

Chief Researcher of Department of Forest Genetics and Tree Breeding, Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry

Rolandas Pridotkas

Director of UAB "Rūta"

Dr. Alma Valiuškaite

Head of Laboratory of Plant Protection, Senior Researcher Institute of Horticulture, Lithuanian Research Centre for Agriculture and Forestry

Prof. Dr. habil. Rimantas Velička

Professor of Institute of Agroecosystems and Soil Sciences, Agriculture Academy, Vytautas Magnus University

4.2. WORKS COUNCIL

The Works Council of LAMMC is a collegial body representing employees. It defends the professional, labour, economic and social rights of the employees of LAMMC and its branches and represents their interests. It is elected for a 3-year term of service.

On December 3, the newly elected Works Council, consisting of 9 members, began its work.

Members of Works Council



Senior economist of Institute of Agriculture, Chairperson of Works Council **Ramunė Kvedarienė**.

Laura Ledeniova

Personnel specialist of Institute of Horticulture, deputy-chairperson of the Works Council

Agnė Jankauskienė

Head of Communication and Project Administration Group of Institute of Agriculture, secretary of the Works Council

Dr. Renaldas Žydelis

Occupational safety engineer, research worker of Institute of Agriculture

Dr. Žilvinas Kryževičius

Research worker of Vėžaičiai Branch

Assoc. Prof. Dr. Jonas Volungevičius

Senior research worker of Institute of Agriculture

Dr. Rita Asakavičiūtė

Senior research worker of Vokė Branch

Viktorija Gecaitė

Junior research worker of Joniškėlis Experimental Station

Kęstutis Žemantauskas

Agricultural advisor of the Agrochemical Research Laboratory

4.3. PERSONNEL

As of December 1, 2020, LAMMC employed a total staff of 513 of which researchers accounted for 36%, specialists and other employees – 32%, laboratory assistants, technicians – 23%, administration – 9%.

Head researchers – 20%, senior researchers – 32%, researchers – 24%, junior researchers – 24% (Figure 1).

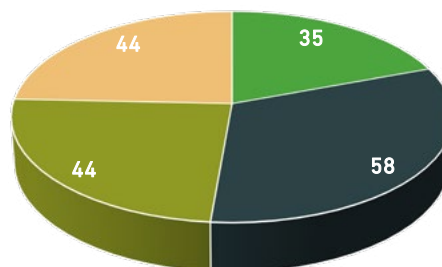


Figure 1.
Distribution of
researchers
according to
position

- Chief researchers
- Senior researchers
- Researchers
- Junior researchers

In 2020, LAMMC had a total of 63 doctoral students in the fields of agronomy, forestry, ecology and environment, and biochemistry sciences (Figure 2).

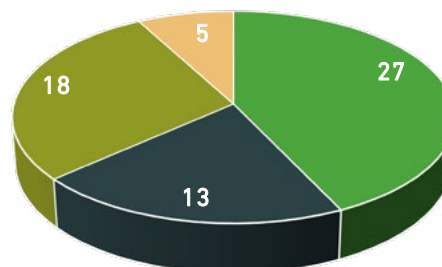


Figure 2.
Distribution
of doctoral
students
in LAMMC
branch
divisions

- Institute of Agriculture
- Institute of Horticulture
- Institute of Forestry
- Regional branches

5. DOCTORAL STUDIES

5

Based on the order of Minister of Education, Science and Sports, in 2019 LAMMC was granted the right for doctoral studies in 4 science fields:

➤ **Agronomy**

(jointly with Vytautas Magnus University);

➤ **Forestry**

(jointly with Vytautas Magnus University);

➤ **Ecology and environmental science**

(jointly with Vytautas Magnus University);

➤ **Biochemistry**

(jointly with Vytautas Magnus University and Lithuanian University of Health Sciences).



**LIETUVOS
AGRARINIŲ IR MIŠKŲ
MOKSLŲ CENTRAS**



**VYTAUTO
DIDŽIOJO
UNIVERSITETAS**
MCMXXII

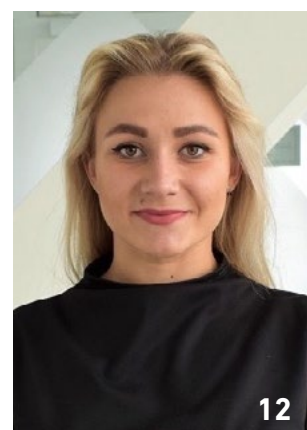


**LIETUVOS SVEIKATOS
MOKSLŲ UNIVERSITETAS**

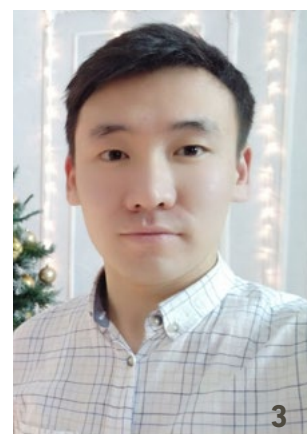




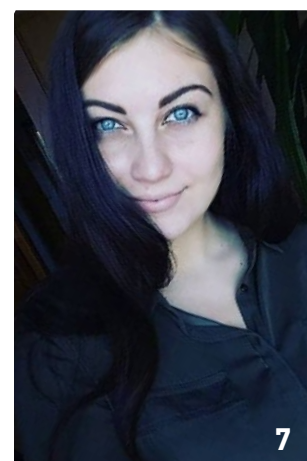
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12



3



7

The four-year PhD programmes 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. DOCTORAL STUDENTS ENROLLED IN 2020 AND THEIR RESEARCH TOPICS

Agricultural Sciences, Agronomy (A 001)

1. **Aida Skersienė.** Capacity of long-rooted and multicomponent grasslands to sequester carbon in the soil in the rhizosphere zone seeking to reduce atmospheric carbon dioxide. Supervisor Dr. Alvyra Šlepetienė.
2. **Agnė Buivydienė.** The influence of crop diversification on soil and plant in different crop management systems. Supervisor Dr. Irena Deveikytė.
3. **Arman Shamshitov.** Characterisation of soil microbiota decomposing the plant residues in cereal based cropping system. Supervisor Dr. Skaidrė Supronienė.
4. **Aušra Bakšinskaitė.** The effective use of organic and organic-mineral fertilizers for the improvement of crop and soil quality and reduction GHG emissions. Supervisor Dr. Vita Tilvikienė.
5. **Evelina Zavtrikovienė.** Phenotypic diversity and harmfulness to wheat of *Fusarium* species residing in non-gramineous plants. Supervisor Dr. Skaidrė Supronienė.
6. **Gabija Vaitkevičiūtė.** The impact of metabolite profiles on freezing tolerance in winter wheat under changing climate. Supervisor Dr. Rita Armonienė.
7. **Ieva Gudžinskaitė.** The photophysiological aspects of improving the quality of green vegetables during postharvest storage. Supervisor Dr. Viktorija Vaštakaitė-Kairienė.
8. **Loreta Meškauskienė.** Adoption of integrated weed management in sustainable tillage. Supervisor Dr. Gražina Kadžienė.
9. **Martynas Urbutis.** Physiological and metabolic responses induced by plant biostimulants. Supervisor Dr. Giedrė Samuolienė.

10. Regina Rancane. Epidemiology of horticultural crops diseases and sustainable management in the changing climate conditions. Supervisor Dr. Alma Valiuškaitė.

11. Urtė Stulpinaitė. The influence of growing hemp on soil quality and effective utilization of their straw. Supervisor Dr. Vita Tilvikienė.

12. Viktorija Puzerytė. Modeling and optimization of fermentation technology for plants raw materials. Supervisor Dr. Dalia Urbonavičienė.

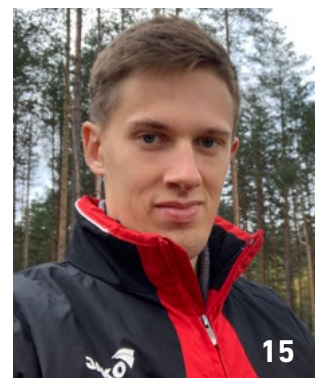
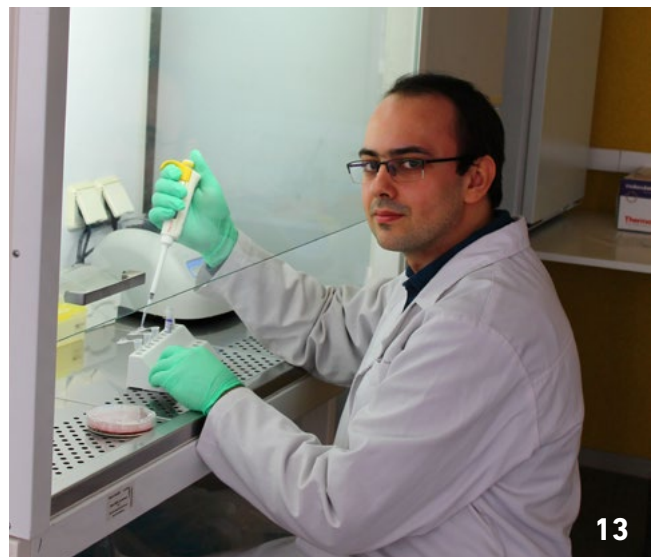


Agricultural Sciences, Forestry (A 004)

13. Aliaksandr Padutau. „Genetic and phenotypic structure of Scots pine families in second generation seed orchards. Supervisor Dr. Virgilijus Baliuckas.

14. Ieva Lučinskaitė. Increasing the overall resistance of Lithuania main forest tree species to pathogens by the innovative combination of genetic and physical methods. Supervisor Dr. Vaida Sirgedaitė-Šežienė.

15. Vytautas Česna. Effects of insect mass outbreaks on scots pine forest ecosystem functioning and soil health in the process of climate change. Supervisor Dr. Diana Marčiulyrienė.



5.2. DOCTORAL DISSERTATIONS DEFENDED IN 2020

Agricultural Sciences, Agronomy (A 001)

1. **Aurelijus Starkus.** Biological mechanisms of stable apple tree fruiting. Supervisor Prof. Dr. habil. Vidmantas Stanys, scientific advisor Dr. Dalia Gelvonauskienė.

2. **Donata Drapanauskaitė.** Effect of different chemical composition and structure of liming materials on acid soil neutralizing. Supervisor Dr. Romas Mažeika, scientific advisor Dr. Regina Repšienė.

3. **Ingrida Mažeikienė.** Genetic background of plant resistance to gall mite and fruit anthocyanin quality in *Ribes* spp. Scientific advisor Prof. Dr. habil. Vidmantas Stanys.

4. **Yuliia Kochiieru.** Mycotoxins in spring cereals and their effect on the quality of grain products. Supervisor Dr. Audronė Mankevičienė, scientific advisor Dr. Jurgita Cesevičienė.

5. **Kristina Bunevičienė.** Quality of biofuel ash-based fertilizer products and their effect on soil and plant. Supervisor Dr. Romas Mažeika.

6. **Mykola Kochiieru.** The effect of crop cover and soil water retention on physico-chemical and biophysical quality of soils of different origin. Supervisor Dr. Virginijus Feiza, scientific advisor Assoc. Prof. Dr. Jonas Volungevičius.

Agricultural Sciences, Forestry (A 004)

1. **Benas Šilinskas.** Norway spruce (*Picea abies* (L.) Karst.) and scots pine (*Pinus sylvestris* L.) wood properties dependence on growth conditions and stand management. Supervisor Dr. Iveta Varnagirytė-Kabašinskienė.

Biomedical Sciences, Ecology and Environmental Science (N 012)

1. **Gintarė Bajerkevičienė.** Juvenile-stage response and plasticity of different tree species and populations under the impact of simulated climate change and other environmental stressors. Supervisor Prof. Dr. Alfas Pliūra.



6. RESEARCH AND DEVELOPMENT

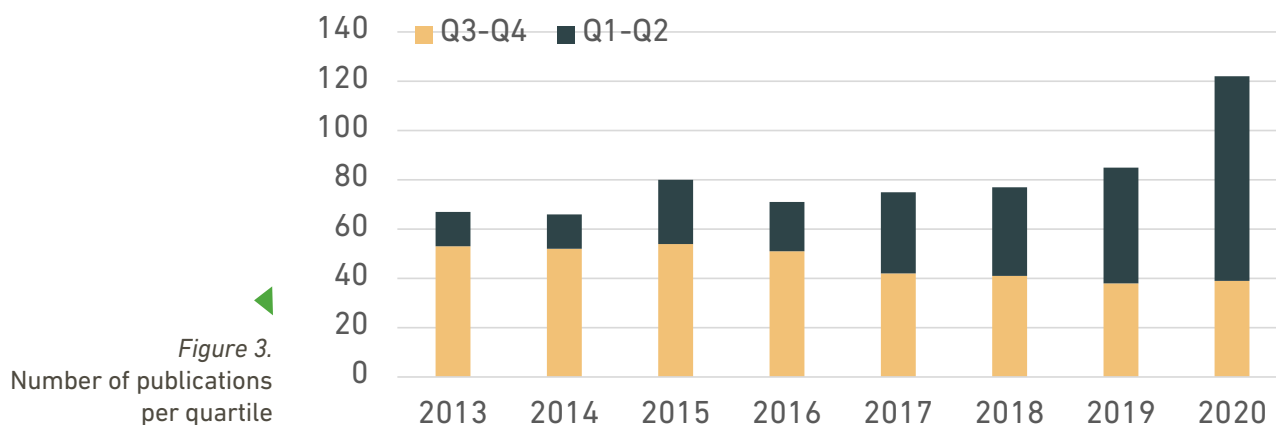
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6.1. SCIENTIFIC PUBLICATIONS PUBLISHED IN 2020

The year 2020 was the most productive in the entire history of LAMMC – there were published 122 scientific publications in the journals with an impact factor (IF) indexed in the *CA WoS* database. The highest IF of the scientific journal, which published research data obtained by LAMMC researchers and colleagues from research and study institutions of other countries, is **13.116** (2019).

In 2020, LAMMC researchers, in publishing their research results, paid a lot of attention not only to the number of publications, but also to the quality of journals, in which research is presented. For several years now, there has been an increase in publications in Q1 and Q2 quartile journals, reflecting not only the activeness of researchers but also the high level of research and the international recognition of their results (*Figure 3*).

In addition, in 2020, there were written and published two sections in the monographs published by the internationally recognized publishers, books, textbooks or their sections, 24 articles in peer-reviewed periodicals, more than 70 popular science articles.



6.2. LONG-TERM RESEARCH PROGRAMMES

LAMMC is involved in six long-term R&D programmes (2017–2021). The results for the year 2020 of the ongoing long-term research programmes are presented below.

Biopotential and quality of plants for multifunctional use

Leader Dr. Žydrė Kadžiulienė

The effects of climate change, environmental requirements, agronomic expectations, and consumer demands are increasingly driving the focus on innovative crop production technologies, beneficial agro-ecosystem services, and the search for new solutions for more efficient use of renewable resources. Research within the scope of the programme is underway and addressed in that direction.

In 2020, studies on the long-term cultivation of non-traditional for Lithuania energy perennial grasses and their fertilization with sewage sludge compost, on biological nitrogen accumulation and nitrogen leaching in sandy soils of different legumes were started.



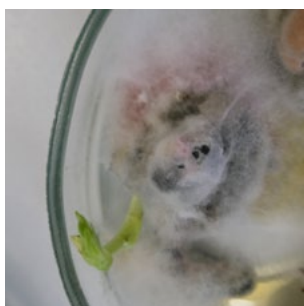
▶ Model studies on the causality of biological nitrogen accumulation and nitrogen leaching



▶ Pupal exuviae of the nun moth (*Lymantria monacha*)



▶ Entomological scoop used to collect insects from grass cover



▶ *Fusarium* spp. infested bean seeds

Research is being continued on enhancement of the multi-functionality of agroecosystems and addresses the aspects of productivity potential and stability of the crop rotation in the systems of varying intensity under changing climate conditions. Other ongoing 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 results of the programme are disseminated in various ways. Researchers involved in the programme have published 9 articles in the journals indexed in the CA WoS database, 12 presentations have been made at international and national conferences, practical aspects of research have been presented in workshops and popular science articles.

Sustainable forestry and global changes

Leader Dr. Marius Aleinikovas

The aim of the programme 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.

In 2020, identification of grey alder, black alder and their hybrids was performed using 14 nuclear DNA markers, and wood properties in different habitats were studied. Epigenetic effects initiated in vegetative propagation of hybrid poplar clone's reciprocal 2×2 factorial experiment in a phytotrone were further studied in Jonava field trial. After studying 13 black alder (*Alnus glutinosa*) and hybrid alder (*Alnus* \times *pubescens*) genotypes for their development and resistance against the bud-colonizing fungi during in vitro culture, it was found that from 18.6% to 83.3% vegetative bud explants in the cultures of different alder genotypes carried fungal infections.

The influence of exogenous stimulants used for plant morphogenesis of hybrids *Populus deltoides* \times *P. nigra*, *P. maximowiczii* \times *P. trichocarpa*, *P. deltoides* \times *P. trichocarpa*, and *P.* \times *canadensis* on the Dixon quality index was studied. We studied the growth of silver birch (*Betula pendula*) plantations planted in the different soil types and in the differently prepared soil.

The samples of needles and shoots of Scots pine (*Pinus sylvestris*) and soil under the canopy of trees were collected. This will allow us to determine the influence of the damage caused by the black arches or nun moths (*Lymantria monacha*) on the diversity of fungi colonizing the needles and shoots of Scots pine. Soil mycobiota studies will be performed to determine the effect of fallen excrement on soil microorganisms.

The damage caused by ungulates to forests was assessed. The sustainable management principles of their populations restoring balance between moose and roe deer population density were applied. The guidelines for the adaptive management of wild boar and beaver populations were prepared for use.

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.

Three studies of the long-term programme were completed in 2020, another six are being continued. The results are presented in 13 scientific journals, 11 of them indexed in CA WoS database.

Four new studies were started in 2020:

1. "Phenotypic diversity of *Fusarium* species common in different host plants and harmfulness to wheat".

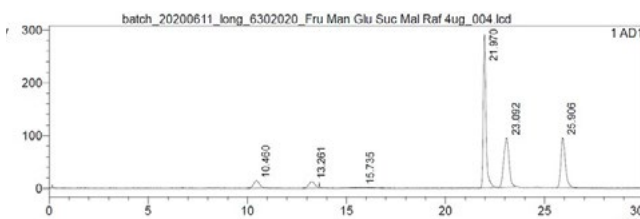
The aim of the study is to investigate the diversity of the population of *Fusarium* species common in different host plants according to phenotypic traits – pathogenicity



- Assessment of germination of bean weevil-affected and healthy bean grains



- Growth inhibition of *Botrytis cinerea* with different concentrations of cinnamon extract



- From raw material to product

to cereals, susceptibility to fungicides and potential for mycotoxin production.

2. "The prevalence and development of *Rhexocercosporidium carotae* (Ärsvoll) U. Braun in the field and the occurrence on stored carrot roots".

The aim of the study is to determine the factors determining the prevalence of black spot and the patterns of development in edible carrot crops and to assess the harmfulness of the disease during storage, compare the efficacy of different fungicides and determine their optimal application time.

3. "The impact of agronomic factors on the disease occurrence in winter and spring wheat in the context of climate change".

The aim of the study is to determine the diseases occurrence in winter and spring wheat under different sowing times and different seed rates and to evaluate the changes in the agronomic factors over time.

4. "Nutritional value of forage crops, mycotoxin risks and relationships with natural and anthropogenic factors".

The aim of the study is to determine the nutritional value of fodder maize and barley grains as well as contamination with mycotoxins, find out what kind of influence natural and anthropogenic factors exert on their quality and safety indicators.

Horticulture: agrobiological foundations and technologies

Leader Dr. Giedrė Samuolienė

The research in horticulture is carried out in various aspects – fundamental and applied in Lithuania. When 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, analyse 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 exports. Results achieved in 2020: 30 articles in the journals indexed in CA WoS database, 3 publications in peer-reviewed periodical publications, 1 chapter in a book, published by internationally acknowledged publishers, and popular science articles.

Productivity and sustainability of agricultural and forest soils

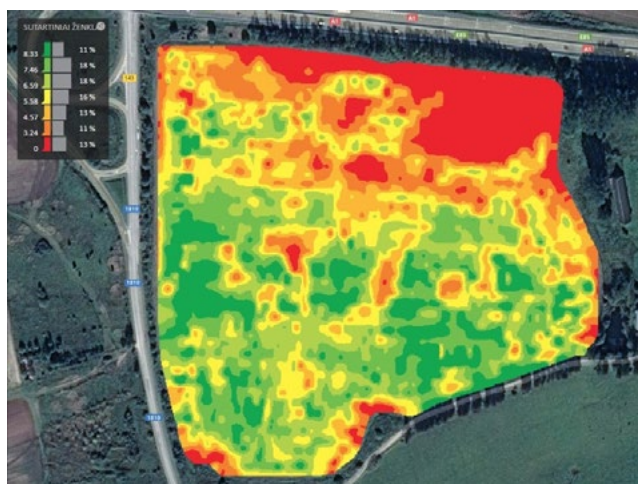
Leader Dr. Virginijus Feiza

EC documents set out common principles for Soil Thematic Strategy to protect soils across the EU. The document states that each EU member state must take care of the sustainable use of soils on its territory so that their quality and productivity do not deteriorate.

The aim 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



► Spatial distribution of yield data



► Barley crop in unlimed soil

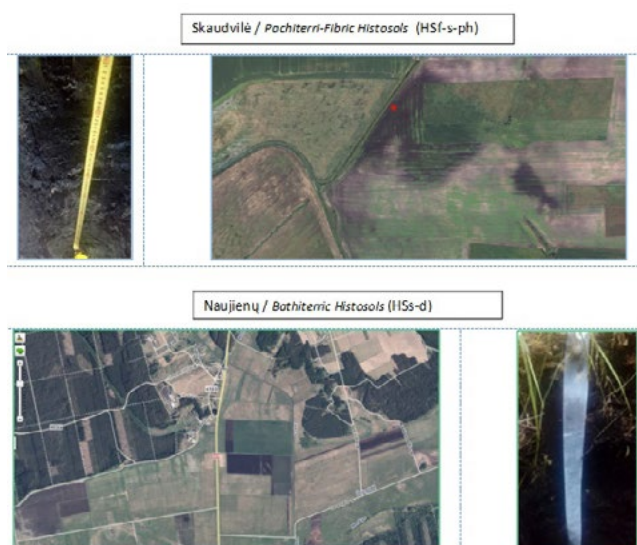
of degradation processes the soils of morainic and limnoglacial origin;

- 2) rational use of natural soil resources, organic and mineral materials of local origin;

- 3) to evaluate productivity potential of agricultural and forest soils.

Researchers from different disciplines (agriculture, biomedicine, physical sciences) are participating in the programme to gain a better understanding of the processes taking place in the soil.

In 2020, the participants of the programme published 20 papers in the journals having IF, 12 papers are under review, 19 popular articles were published in the national press, participated in national and international conferences with 9 oral presentations.



► Satellite image of the studied peatlands

Genetic determination of the traits of agricultural and forest plants, development of modern cultivars

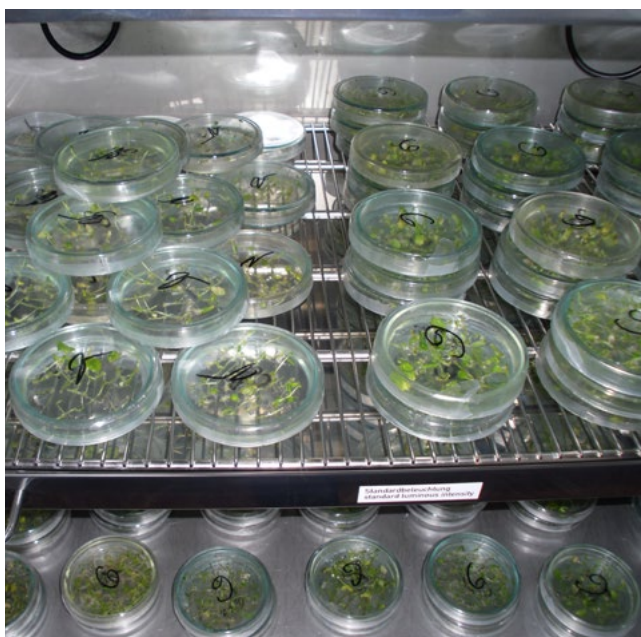
Leaders: Prof. Dr. habil. Vidmantas Stanys, Assoc. Prof. Dr. Vytautas Ruzgas

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 fluctuation 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 the current economic and environmental needs.

The objective is to develop molecular markers for abiotic and biotic stress resistance, plant productivity and quality parameters; to create high quality novel breeding material for the development of new commercially successful



► Studies of the selected trees under the forest breeding programme



► Biotechnological potato breeding work

plant varieties; to identify genotypes of forest plants beneficial for the development of the national economy.

In 2020, 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 traits, development and assessment of breeding populations were carried out.

In 2020, the results were published in: 17 articles in the journals indexed in CA WoS database; 1 article in other scientific journal; 384 new breeding lines were developed; 6 new varieties were submitted for registration, 9 varieties were included in the National Variety List. A total of 120 offspring of the white birch were investigated in 3 experimental nurseries. The results were presented in 3 scientific conferences, in 5 professional seminars, 8 articles were published in the professional press.



► Pea breeding experiments in the hybridization nursery

6.3. PROJECTS

In 2020, LAMMC implemented international and national R&D projects, funded by the Research Council of Lithuania, the Ministry of Agriculture (MA), the Ministry of the Environment (ME), the Ministry of Transport and Communications, the Agency for Science, Innovation and Technology (MITA) and over 200 orders commissioned by Lithuanian and foreign economic entities (*Table*).

The year 2020 is exceptional, because a closer co-operation with other members of the association "RTO Lithuania" was started, 2 R&D projects on the topic of the Green Deal were jointly implemented: "Investigation of aerosol black carbon emissions from biomass incineration units and deposition on tree foliage" (leader Dr. Valda Araminienė) and "Development of a database of specific parameters of plant pathogens for disease diagnosis by non-destructive methods" (leader Dr. Alma Valiuškaitė).

A full list of ongoing national and international research projects is provided in the annexes.

	International	Research Council of Lithuania	Ministry of Agriculture, Ministry of Environment, Ministry of Transport and Communications, MITA, etc.	Lithuanian economic entities	Foreign economic entities
Institute of Agriculture	15.5	11	13	17	44
Institute of Horticulture	3.5	9	4	16	10
Institute of Forestry	12.5	7	18	5	—
Regional branches	2.5	—	2	111	3
Total:	34	27	37	149	57

► *Table. Projects implemented by LAMMC in 2020*

6.3.1. National projects launched in 2020 and projects ongoing in 2020



In 2020, **30** national projects were launched:

- **12** projects of the Research Council of Lithuania (LMT),
- **6** of the Ministry of Agriculture,
- **12** of the Ministry of Environment and its subordinate state institutions.



In 2020, **11** national projects were ongoing:

- **8** of Research Council of Lithuania,
- **2** of Ministry of Agriculture,
- **1** of Ministry of Environment.



Provided below are the descriptions of the LMT projects ongoing in 2020, funded by the European Union funds, and carried out by High-Level Research Groups and under Research Project Grants of the High-Level Research Groups.

A full list of projects is provided in the annexes.



▶ Wood samples modified in the laboratory using heat treatment in chemical modified solutions, simulating the composition of chemical compounds found in the bog

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

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

Project leader Dr. Marius Aleinikovas. 2017–2021.

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 2020, the analysis of modified wood properties was done. During hydrothermal treatment, the highest amount of Fe ions was accumulated in the wood of coniferous species – *Pinus*, *Picea*, also in *Juglans*. The outer wood layer accumulated higher amount of Fe ions compared with intermediate and inner wood layers. However, analysis of total phenolic compounds in the solvents after hydrothermal treatment showed that the amount of tannins decreased during treatment. It is possible that during hydrothermal treatment part of tannins at low pH may interact with Fe ions through hydroxyl groups forming ferrous tannates, which are insoluble and form dark precipitates. On other hand, during hydrothermal treatment other intermediate compounds not accounted for in this study may appear and they may act synergistically with tannins and pH, forming ferrous-tannates, which may be absorbed into sapwood and protect the surface of wood.



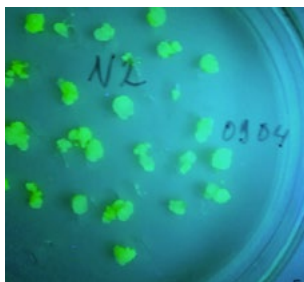
▶ Characterization of recombinant peptides by liquid chromatography and mass spectrometry methods

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 human extracellular matrix proteins (PMEM).

During period of the year 2020, new constructs of peptides mimicking functional domains of fibronectin and collagen mimicking peptide (CMP) were developed, and recombinant peptides were produced in bacterial and plant expression systems. A DNA construct including green fluorescent protein, polyhistidine purification tag, protease cleavage site and the target peptide encoding sequence was developed using GoldenBraid cloning technology. Tobacco and carrot plants were transformed using a constitutive expression DNA vector, and callus and cell suspension lines with PMEM expression were selected. In collaboration with the FTMC partner, a method for coating surface of bioinert substrate with the recombinant PMEM was developed. Thickness and homogeneity of the obtained EMIP coating was comparable to surfaces



Detection of extracellular matrix mimicking protein expression in tobacco callus tissues using green fluorescent protein



Basil grown under LED lighting supplemented with UV-A wavelengths

Leaf pigments and growth characteristics of lettuce subjected to different light qualities

Images from: Samuolienė G., Viršilė A., Miliauskienė J., Haimi P.J., Laužikė K., Jankauskienė J., Novičkovas A., Kupčinskienė A., Brazaitytė A. The Photosynthetic Performance of Red Leaf Lettuce under UV-A Irradiation. *Agronomy* 2020, 10(6), 761; <https://doi.org/10.3390/agronomy10060761>

prepared using a native fibronectin protein. Experiments on efficiency of adhesion of human fibroblast cells to the surfaces are being carried out. During implementation of the project, the activity dedicated to optimization of plant cultivation in vitro technology, a role of endophytic bacteria on in vitro plant growth vigour and stress were assessed. Metagenomic 16S rRNA analysis revealed that bacterial diversity of tobacco shoot maintained on a medium with antibiotic is reduced compared to the control. The study demonstrated that endophytic *Bacillus* sp. bacteria isolated from apple and tobacco plants enhanced biomass accumulation in tobacco shoots, and gene expression analysis revealed that the bacterial isolates up-regulate expression of genes involved in synthesis of plant growth stimulating phytohormones.

	Control		Timentin	
O₂^{•-} (NBT)				
	7.6 ± 0.7*		13.1 ± 0.1*	
H₂O₂ (DAB)				
	21.5 ± 5.6		30.1 ± 2.0	

Analysis of antibiotic Timentin effect on oxidative stress parameters of tobacco shoots in vitro using histochemical staining of reactive oxygen species

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

Project leader Dr. Akvilė Viršilė. 2017–2021.

The project aims 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 2020, the reproducibility of UV-A light effects on various plant species and varieties as well as repeatability of the UV-A impacts in the context of different basal lighting was investigated. There were selected target parameters for prototypes of the recipes for the cultivation of exceptional value of green vegetable and medicinal plant cultivation.

Treatments	CRI	ARI	PSRI	NDVI	DW, g	LA cm ²
RB	0.15b±0.03	0.12b±0.02	0.03a±0.01	0.77a±0.05	0.96ab±0.09	798.8ab±98.4
RBUV402	0.08b±0.04	0.05c±0.01	0.06a±0.04	0.65a±0.16	1.17a±0.23	899.5a±81.1
RBUV387	0.26a±0.02	0.17a±0.02	0.03a±0.00	0.85a±0.02	0.81b±0.11	626.0bc±93.4
BRUV367	0.10b±0.02	0.03c±0.01	0.01a±0.00	0.83a±0.00	0.63b±0.02	576.5c±59.3

RB	RBUV402	RBUV387	BRUV367

RB – Red 662 and Blue 452 nm (Control); BRUV402 – Control with UV-A 402 nm; BRUV387 – Control with UV-A 387 nm; BRUV367 – Control with UV-A 367 nm. CRI – carotenoids/chlorophyll ratio, ARI – anthocyanin amount, PSRI – dry or senescent carbon, NDVI – biomass content, DW – dry weight, LA – leaf area.



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-origin biomass in biogas plants produces not only the energy-efficient product – biogas, but also a by-product – biofertilizer, which is potentially useful for soils and crop production. At the same time, there is a need for fast but accurate quality diagnostic methods for such bio-fertilizers. However, few suitable methods have been developed and little research has been done, this leads to problems in the analysis of the composition of the bio-products. **The main idea of the project** is to develop a new method that allows for rapid but very accurate bio-fertilizer analyses. One of the possible methods is the planned spectrometry method, which will allow the assessment of the specific instantaneous chemical composition of the bio-product. Based on these indicators, it will be possible to predict the impact on plants and the environment.

The aim of the project is to evaluate and compare the quality of various agricultural raw materials available in the country on the basis of scientific knowledge; to reveal their potential for use, considering their suitability for industrial processing into biogas; to promote the use of residual biomass from biogas plants as bio-fertilizer in agriculture and to improve its quality diagnostics by developing an innovative and accurate NIR spectrometry method.

In 2020, field experiments were completed, planned publications based on the project results were published. A database of the chemical composition of digestates was compiled, and preliminary equations for analysis with the NIRS device were developed.



► Biomass content and chemical composition of differently fertilized plants were estimated



► Chemical composition of the various digestates was determined



► Wheat breeder V. Ruzgas (on the right) inspects experimental field of winter wheat variety 'Vaiva' together with farmer A. Laurinkietis



► Multiplication of winter wheat variety 'Sarta'



► Amylopectin-rich winter wheat variety 'Eldija'



► Agrotechnological research of chickpea and other legumes

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

Project leader Dr. Gintaras Brazauskas. 2017–2021.

Lithuania is a net wheat grain exporter listed as one of the top-5 EU exporters with an annual export of 1.5 million tons of wheat grain. However, the export of the low-value material is highly dependent on price fluctuations of the global grain market, which hinders development of value-added processing industry. The capacity of the industry enables processing of larger amounts of wheat grain; however, specific purpose wheat genotypes are needed to meet the global demand for amylose-free (waxy) starch and vital gluten. These compounds show great potential in the production of biopolymer-based edible / biodegradable plastics, natural food ingredients for increased product shelf life, paper and paint. Waxy wheat genotypes producing amylose-low or amylose-free starch originate from heat- and water-stressed environments and usually are not adapted for cultivation at northern latitudes. The development of locally adapted waxy wheat varieties would expand the growing area of waxy wheat, meet the demand of processing industry and provide opportunities of diversification for wheat growers.

This project aims at developing winter wheat varieties for industrial biorefinery – functional amylopectin starch and vital gluten production – by using innovative phenomic, genomic and physico-chemical tools and methods. The first stage of the project focused on the development of novel selection methods in winter wheat for the selection of superior waxy wheat genotypes that are adapted to cultivation in Northern Europe. The developed methods enabled selection for amylose-low genotypes having good qualities of vital gluten as well as demonstrating good freezing tolerance and overwintering. The selected genotypes are further examined for the Distinctness, Uniformity and Stability (DUS) at the Community Plant Variety Office (CPVO) authorized cultivar testing centre. Simultaneously seed multiplication and testing at production level are carried out as initial steps prior to variety marketing.

New amylopectin-rich winter wheat varieties DS 6460-1 and DS 6460-3 as well as protein rich variety DS 7183-1 were investigated in official plant variety testing trials during 2020. Variety denominations 'Eldija', 'Sarta' and 'Vaiva' were given to DS 6460-1, DS 6460-3 and DS 7183-1, respectively. Varieties 'Eldija', 'Sarta' and 'Vaiva' were further tested and multiplied on farmer fields in three locations. These trials will be continued in 2021 to support variety release after official registration.

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

Project leader Dr. Žydrė Kadžiulienė. 2017–2021.

Legume crops will be very important in the future agriculture. An increased production of protein crops would benefit the environment by extending crop rotation, improving soil quality, and enhancing biodiversity.

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 objects of the research are new varieties of peas and special technologies for their cultivation, primary technologies for sowing chickpeas and table lentils in our climatic and soil conditions.

In 2020, 40 new lines of peas were evaluated under traditional farming conditions, and 28 varieties and lines were grown and evaluated in the organic field. The most promising lines were selected for further research.

Studies on chickpea and lentil growing technologies in conventional and organic farming systems were continued. Investigations of the most important technological cultivation elements of new pea varieties under ecological conditions were performed in the field experiments and in the organic farm. The yields of the studied field peas intercropped with oats varied depending on the location. The new lines of peas in the intercropping with oats significantly increased the overall yield of the mixture.



► Wounds on ash trunk



► Phytophthora-damaged ash tree

Grant for high-level researchers' group project

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

Project leader Dr. Audrius Menkis. 2017–2021.

The aim of the project 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.

In order to reach the objective and aims of the project, five research activities were carried out. In each activity, the study sites were selected, and representative field materials were collected. Molecular studies were performed to determine the diversity of microorganisms. The research also included the cultivation of microorganisms on nutrient media as well as insect and lichen accounting.

At this stage of the project, after the collection of all the necessary field material, data analysis is performed,

and scientific publications are prepared. The following results were planned to obtain: the diversity of microorganisms in Lithuanian pine and spruce ecosystems and its functioning in different environmental conditions, common diseases, their prevalence and impact on the health of stands will be determined. The biodiversity of microorganisms in Lithuanian ash, their impact on the health of ash and their possible use for the biocontrol of ash disease is also under analysis. Preliminary results were obtained from the surveys of epiphytic lichens and wood colonizing insects in larch stands and adjacent spruce stands. A total of eight insect groups colonizing larch and spruce wood were detected and identified. Exit holes of *Ips tipographus* and *Haematopus palliatus* were detected only on damaged spruces, unlike the damaged larch trunks. In different regions of Lithuania, a total of 11 epiphytic lichen species were found on larch and spruce trunks, all of which are common or very common in Lithuania. The suitability and potential of *Fraxinus mandshurica* and Siberian elm as more disease- and pest-resistant trees for the conservation of the destroyed local ash and elm stands and the functioning of their ecosystems are analysed.

6.3.2. National projects completed in 2020



In 2020, **23** national **projects** were implemented:

- **7** of the Research Council of Lithuania,
- **9** of the Ministry of Agriculture,
- **7** of the Ministry of Environment and its subordinate state institutions, the Ministry of Transport and Communications, the Science, Innovation and Technology Agency and the Association “RTO Lithuania”.



Below are presented descriptions of all projects implemented in 2020.

Research funded by the Research Council of Lithuania

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.



➤ Project implementation moments

The aim of the project is by using a holistic approach to gather fundamental and applied knowledge on local and newly occurring, and massively tree devastating pathogenic microorganisms and factors determining their biogeography and spread.

In order to address the objective and aims of the project, four research activities were carried out. In each activity, the study sites were selected, representative field materials were collected, DNA was isolated, amplified using specific tagged primers, and prepared samples were subjected to high throughput sequencing to identify microbial communities including pathogens causing plant diseases. Within each of the I–IV activities we received up to 330,000 DNA sequences that were analysed, clustered together, and identified by using bioinformatics. The results showed that a high diversity of microorganisms was detected in each of the I–IV activities.

Analysing the diversity of microorganisms in different sampling sites, the main conclusions were drawn: 1) by examining fungal communities in Lithuanian pine forests, similar diversity and composition of fungal communities in managed and unmanaged Scots pine stands were found, analysing pine needles and rhizosphere soil. Nevertheless, some fungal taxa were strongly (significantly) associated exclusively with managed or only unmanaged pine forests, which provides valuable information about their ecology and adaptation mechanisms; 2) during the study of irrigation water from forest nurseries, a high abundance of fungal species was found, but the fungal communities were characterized as site-specific. Relatively small amount of plant pathogens was identified, but under the suitable conditions, they can develop rapidly, spread through the irrigation system, and threaten the growth of high-quality tree seedlings; 3) by studying the roots of different seedling species and soil in their rhizosphere in forest nurseries, a large variety of fungal species was

also found. Despite some differences in the structure of the fungal community of coniferous and deciduous tree species, the structure of the fungal community between different tree species was generally similar in the root and soil samples. Saprotrophic and mycorrhizal fungi predominated in the seedling roots, while fungal pathogens and oomycetes were less abundant.

The research results have been published in two scientific journals with a citation index, and two more scientific articles have been prepared for publication.

2. “GrowGene – Genome-wide functional analysis of perennial ryegrass for improved growth under water limiting conditions”.

Project leader Dr. Kristina Jaškūnė. 2017–2020.

The aim of the project is to analyse perennial ryegrass genetic polymorphism on a genome-wide scale in order to identify the genes, underlying biomass formation under water limiting conditions and to validate their function using emerging genomic and phenomic technologies.

Substantial variation for leaf growth under water deficit was detected within the perennial ryegrass panel. The most sensitive genotypes limited the growth already under moist conditions ($\Sigma < 1.50 \log_{10} (\text{hPa})$), while some of the genotypes-maintained leaf growth under lethal conditions ($\Sigma > 4.00 \log_{10} (\text{hPa})$). The comparison between ecotype and cultivar groups in the association panel revealed no significant differences ($P > 0.05$) for all assessed traits, but significant differences were found when comparing the subgroups. Three significant marker trait associations were found with growth reduction under water deficit, with all of them passing Bonferroni correction. Two of these markers are in close proximity to predicted genes with sequence homology to *Phytochrome B (PhyB)* and *MYB41*. Both genes have well established functions within plant kingdom; they are known to modulate abiotic stress response in many plant species. In order to validate the function of *tMYB41* and *PhyB* genes, gene expression analysis was

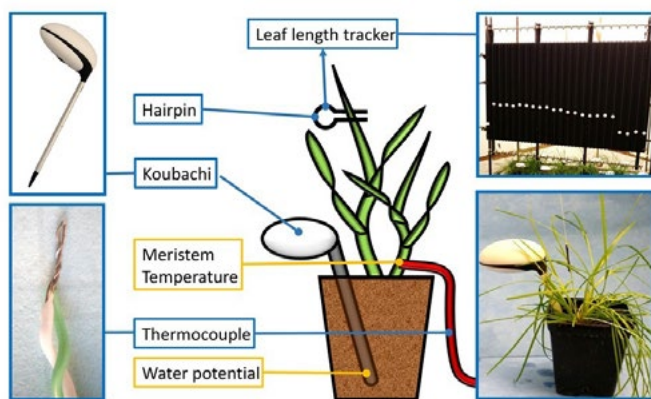
performed with drought sensitive and tolerant perennial ryegrass genotypes.

3. “Dynamic light spectrum and intensity modelling and photoresponse in different vegetable morphogenesis stages”.

Project leader Dr. Giedrė Samuolienė. 2017–2020.

The objective of the project was to create solid-state lighting models, based on the trends in variation of natural lighting, for vegetables of different life strategies in order to improve their nutritional quality and productivity. The tracking of natural lighting parameters and analysis of principal components showed that total lighting intensity (F1 99.85%) and light spectrum (F2 0.12%) are the main basal functions. The morphophysiological properties of species as well as the variation of sunlight spectrum and intensity was taken into account when optimizing lighting schemes for plants during different stages of morphogenesis (sprout, vegetative growth and generative development). Blue and red, blue or red concentrated until 8 h photoperiod caused stress conditions for PSII in dark-adapted state. The dynamic arrangement of blue light component during the day resulted more intensive transpiration and secondary metabolism. Moreover, radish formed the biggest root, and red leaf lettuce formed the biggest leaf area under dynamic blue light. Meanwhile, dynamic arrangement of red light during the day resulted more intensive photosynthesis and primary metabolism. The ABTS free-radical scavenging capacity showed significant differences in green leaf lettuces between the red component concentrated for 8 h and between dynamic arrangement of blue component. No significant differences were detected in antioxidant response in red leaf lettuce.

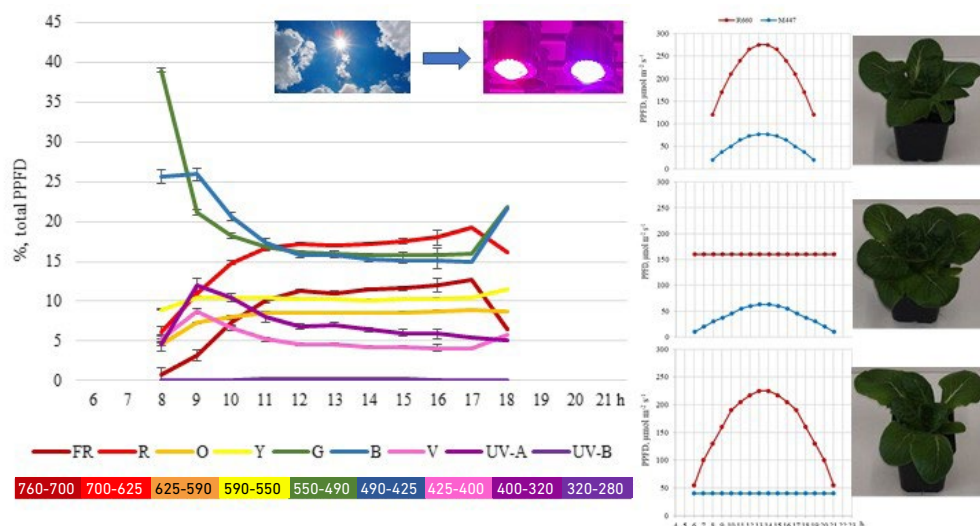
Positive photoresponse was achieved when red leaf lettuce seedlings grew under increased blue intensity and during biomass formation irradiated with supplemental green component. The most favourable spectrum conditions for seedlings are the combination of blue and red or supplemental green. Supplemental UV-A negatively affected the photoresponse of red leaf lettuce, whereas antioxidant indices decreased with decreasing total PPFD, decreasing the dosage of blue light, or without UV-A. However, increased PPFD did not result in significant response of the antioxidant system. The most favourable conditions for tomato sprouts or biomass formation are supplemental UV or green. The response of the dark-adapted state of PSII shows that UV-A irradiation during tomato seedling stage caused photostress, while the values of PSII were significantly higher. Supplemental green light led to more intensive photochemical and non-photochemical fluorescence quenching processes. The biggest effect on tomato development was achieved with supplemental UV-A.



► Phenotyping platform for chronological profiling of the leaf elongation rate



► Solid state LED lighting can affect plant yield and quality



► Modelling of light spectrum according to natural conditions and the effect on lettuce morphology

4. “Improvement of apple fruit quality by application of innovative horticultural technologies”.

Project leader Dr. Darius Kviklys. 2017–2020.

The aim of the project is to investigate the impact of new intensive growing technologies on apple tree generative development, external and internal fruit quality, stressing attention on processes of synthesis of bioactive compounds.

All treatments and conditions that partially increase plant stress, e.g., root pruning, trunk incision, dense planting, or establishment of orchards in far North – enhance accumulation of phenolic compounds, but at the same time have negative effect on fruit biochemical content. All treatments and conditions that improve light penetration into the crown, e.g., summer pruning, broader planting distances, fruit growing place on the top of the tree – enhance synthesis of anthocyanins and improve fruit biochemical content.

In the study of the competitive stress of fruit trees, it was found that with decreasing planting distances, the growth, flowering and the yield from the fruit tree as well as the colouring of the fruits decrease. Root pruning significantly reduces the growth of trees, and substantially improves fruit colour. Trunk incision reduces the growth of trees, tends to increase the yield and productivity. Proheksadion Ca significantly reduces growth, increases flowering abundance.

By modelling the fruit spacing in the tree crown, it was found that fruits at the top of the tree have a harder skin, better colour, more sugar, phenolic compounds, anthocyanins and less organic acids compared to the fruit at the bottom of the crown. These fruits accumulated up to 14 percent higher triterpene compounds. The geographical location of fruit tree growing affected all parameters of apple fruit quality, but their changes were also due to the genotype. The more North cultivated apples, the more they accumulate phenolic compounds – in Estonia apples accumulated 2.5 times more phenolic compounds.



► Research was performed to ensure fruit quality



Kuriame
Lietuvos ateitį

2014–2020 metų
Europos Sąjungos
fondų investicijų
veiksmų programa

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

Sub-activity “Development of students’ abilities in scientific (art) research during semesters”

1. “Optimization of expression of recombinant peptides in tobacco plants and purification”.

Student Lukas Budginas,
supervisor Prof. Dr. habil. Vidmantas Stanys.
October 18, 2019 – April 30, 2020.

The aim of the project was to assess extracellular matrix mimicking peptide expression in tobacco tissues *in vitro* and to optimise purification procedure of the target peptide. During implementation of the project, a fibronectin III type 9–10 fragment construct with inserted directional cysteine amino acid residues (FN9–10) and attached GFP fluorescence and polyhistine purification probes was developed. Transformed tobacco plants were prepared. The experiments showed that medium for optimal tobacco cell suspension growth included 0.1 mg l^{-1} kinetin + 1 mg l^{-1} NAA or 0.25 mg l^{-1} BAP + 2 mg l^{-1} NAA and the highest cell viability was observed in the medium supplemented with 0.25 mg l^{-1} BAP + 2 mg l^{-1} NAA. The initial cell suspension density was lower than 0.045 g in 100 ml of medium. The maximum cell suspension growth was observed at 29°C ; however, the optimal temperature for target protein expression was 25°C . To assess the expression of the recombinant peptides with attached GFP probe, a quantitative measurement of GFP fluorescence in cell suspension was used and data were normalized based on cell metabolic activity. Such approach provided effective evaluation of the target peptide expression independent of variation of the dead and viable cell proportion. Protein purification experiments revealed that recombinant FN9–10 construction had specific interaction with the Ni ion affinity matrix, and the method was suitable for purification of the target protein.

▶ Technologies were applied to increase fruit quality

2. “Use of substrate recycled in biogas production for plant fertilization – impact on soil, GHG emissions and plant quality”.

Student Aušra Bakšinskaitė,
supervisor Dr. Vita Tilvikienė.
October 18, 2019 – April 30, 2020.

The aim of the study was to determine the influence of different substrates obtained during the biogas production process and used for plant fertilization on soil quality, plant development intensity and greenhouse gas emissions from the soil under controlled climate conditions.

The study found that the emission of one of the most aggressive greenhouse gases, methane, from non-fertilized and mineral fertilizer-fertilized and bio-substrate-fertilized crops varied very slightly in all treatments (1.796–2.651 ppm). Higher carbon dioxide emissions from the soil were observed 7 days after fertilization; of all the treatments, the crop fertilized with pig manure biosubstrate (1174.4 ppm) stood out the most. Plant productivity did not differ significantly between the treatments fertilized with mineral nitrogen fertilizers and those fertilized with biosubstrates. This is promising in order to replace as many mineral fertilizers as possible with organic ones, but more detailed studies under field conditions are needed.

3. “The influence of biochar fertilization on spring wheat formation under different watering conditions”.

Student Urtė Stulpinaitė, supervisor Dr. Dalia Feizienė.
October 18, 2019 – April 30, 2020.

The aim of the study was to evaluate the influence of biochar on soil moisture and chemical properties, plant chemical composition and productivity when growing plants under different humidity conditions.

The highest plant productivity (2.68 t ha⁻¹) was determined in the treatment of excess moisture with biochar, while the lowest crop productivity (0.96 t ha⁻¹) was recorded in the treatment of drought without biochar. Chlorophyll index measurements showed that the highest chlorophyll content was determined 62 days after sowing in the biochar-free treatment, where the humidity conditions were optimal, while the lowest chlorophyll content was established 27 days after sowing in the treatment with biochar, which was 5% in the presence of drought. Analysis of plant trace elements revealed that all plants had the highest concentrations of potassium. In the treatment without biochar, at the optimal moisture content, the highest calcium content (6.00%) was determined, while the lowest calcium content (3.75%) was recorded in the treatment with biochar and

drought. Analysis of heavy metals revealed that one of the main metals accumulated is zinc; it was mainly found in the treatments with biochar.

Applied research funded by the Ministry of Agriculture

Research and applied activities projects in agriculture, food and fisheries

1. “Production of alternative biomass sources (including alternative protein production sources and technologies) in primary agriculture: technological solutions, their use for bioeconomy development purposes – energy, feed, food”.

Project leader Dr. Vita Tilvikienė. 2020.

The aim of the project is to evaluate the possibilities of using bio-resources grown or produced in Lithuania for the production of new, non-traditional products.

Agricultural plant biomass is one of the most important renewable resources in Lithuania. It is well known that most agricultural crop production is used or exported for food and feed. Nevertheless, the changing needs and the way of life of people forces us to look for more diverse uses of agricultural plants or even new ones – less known and used by us. The European Commission's Green Strategy and its part “From Farm to Fork” are presented with new challenges. It is important to mention that in Lithuania a lot of attention has always been paid to food production and the sustainability of this whole food production value chain. This created opportunities for the scientists not only to develop new products that are important for human nutrition and health, but also to look at the use of



► Field experiments of agricultural crops

biomass from a slightly different angle – by developing specific products.

During the project, a detailed study of non-traditional use of biomass was carried out, which provides information on the production of functional food, sustainability of growing food and non-food crops, agricultural waste processing opportunities, bioenergy aspects and their place in the circular bioeconomy. The detailed report is available on the website of the Ministry of Agriculture.

2. “Impact of growing system on the quality and safety of fruit and vegetable production”.

Project leader Dr. Darius Kviklys. 2019–2020.

In Lithuania, fruits and vegetables are cultivated in accordance with different technologies: intensive, organic and NKP (National Agricultural and Food Quality System), the main differences of which are related to the intensity of use of plant protection products and mineral nutrition. **The aim of the project** was to develop recommendations on the safety and quality of fruit and vegetable production by reducing the use of plant protection products.

Growing in compliance with the requirements of the NKP improves the internal quality of apples, currants, potatoes, cabbage, carrots, and red beets: more soluble dry and dry matter is accumulated. In addition, the content of starch increases in potatoes, carotene in carrots, and vitamin C in cabbage. Apples also have a firmer flesh and have the potential for better storage. The growing system does not affect the internal quality of strawberries. Under intensive growing technologies, apples, currants, cabbage, and potatoes increased weight and diameter, but the size of strawberries, red beets and onions is not affected by the growing system.

When assessing disease and pest damage in both growing systems, significantly higher damage was found only in cabbage and carrots grown in accordance with the requirements of NKP. The production of apples, currants, strawberries, potatoes, cabbage, carrots, red beets and onions grown in Lithuanian commercial farms is completely safe, and no traces of pesticide residues are found in the products when production is grown in accordance with the requirements of NKP.

After the investigations of growing technology according to the requirements of the NKP of the main fruits and vegetables in Lithuania, the biggest challenges are in the production of cabbage and carrots, whose yield losses due to limited fertilization and insufficient use of pesticides can reach a critical level. NKP requirements also make it more difficult to ensure adequate protection of strawberries against disease damage.



► The biggest challenge for growers is pest control. Damage done by the onion fly



► Pheromone traps are recommended for pest control

3. “Long-term monitoring of soil agrochemical properties”.

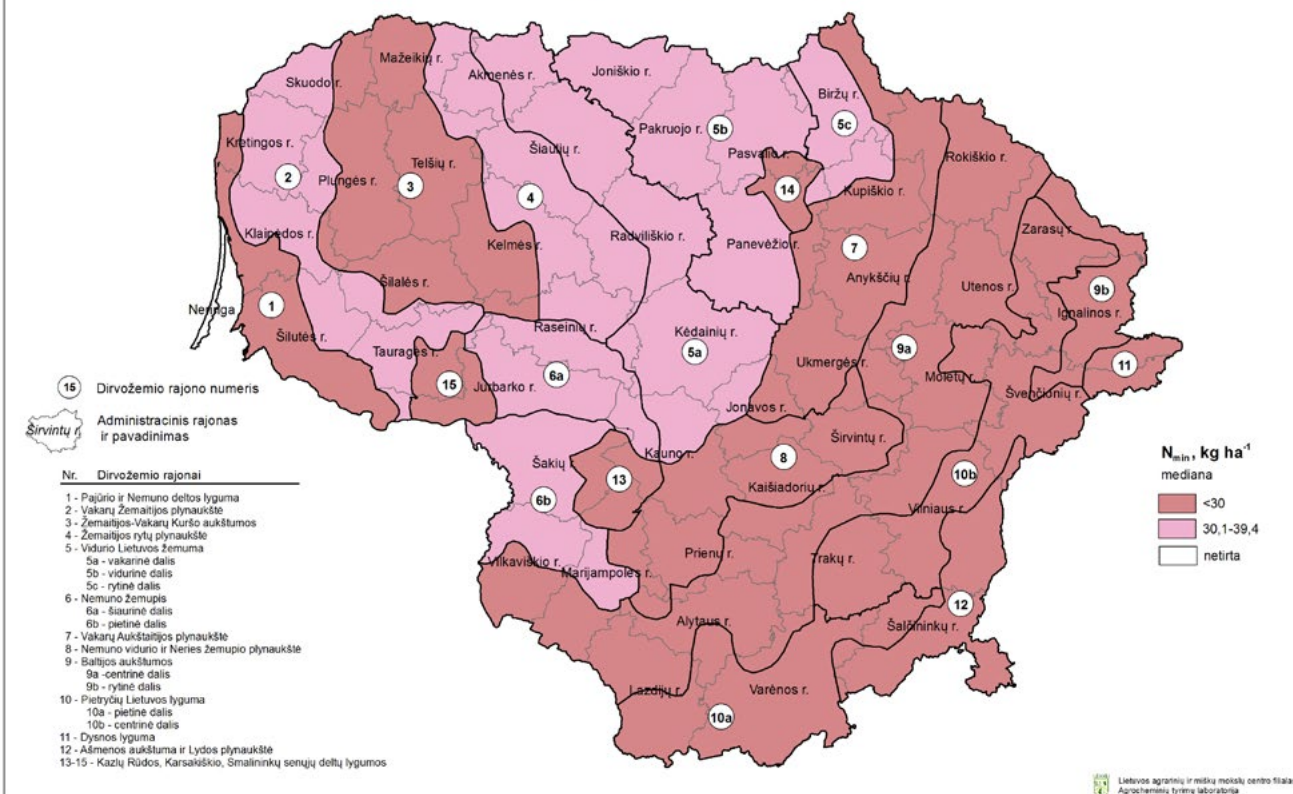
Project leader Prof. Dr. habil. Gediminas Staugaitis. 2016–2020.

Studies of soil agrochemical properties, including pH, humus, plant nutrients and their variation are very important at the national level. It is an integral part of the land information system (LIS) and land productivity assessment. The information systematised on the basis of these studies is used by agricultural entities, advisory services, educational and scientific institutions, planning organizations, municipalities, etc. The research material is important in assessing soil degradation, CO₂ emissions, calculating the fertiliser balance, selecting optimal ratios for nitrogen, phosphorus and potassium fertilisers and solving other ecological issues on national and regional levels.

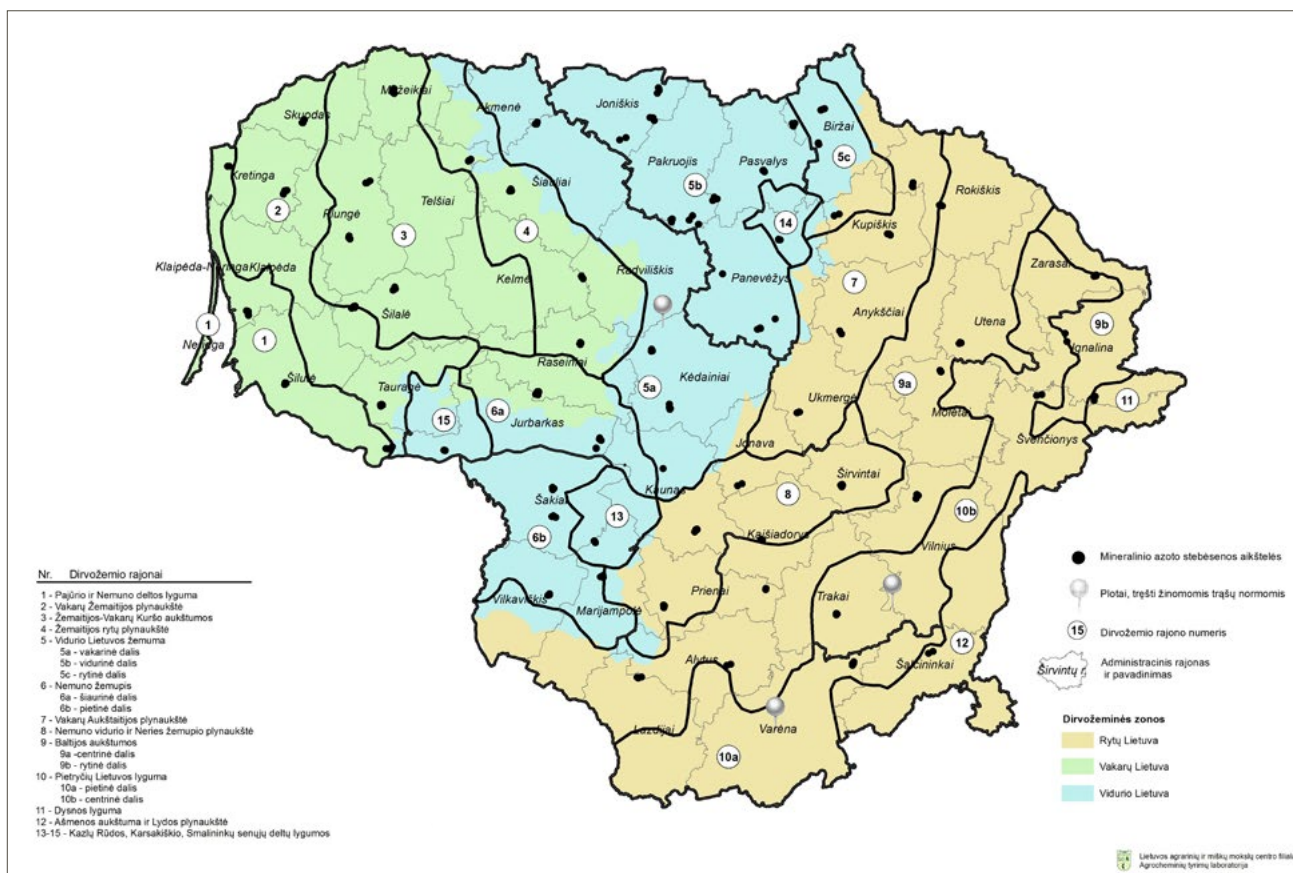
In the spring and autumn, the staff of the LAMMC Agrochemical Research Laboratory carried out monitoring of changes in mineral nitrogen (N_{min})

MINERALINIS AZOTAS (N_{min}) LIETUVOS DIRVOŽEMIO RAJONUOSE

2020 m. pavasaris, 0-60 cm sluoksnyje, $kg\ ha^{-1}$



Results of survey of soil agrochemical properties



Mineral nitrogen sampling sites

and mineral sulphur (S_{\min}) in the soil at various sites located in various parts of the country. For the research of agrochemical soil properties (pH, mobile P_2O_5 and K_2O), soil samples from 40,000 ha were collected in the fields: in Jurbarkas, Elektrėnai, Vilnius, Klaipėda and Radviliškis district municipalities. For the analysis of humus (organic carbon), mobile calcium, mobile magnesium, mobile aluminium, mobile trace elements (B, Zn, Mn, Cu, Fe, Mo, Co), heavy metals (Cd, Cr, Ni, Pb, As), soil samples were collected during the summer season from typical soils selected on agricultural lands in Biržai, Kelmė, Kupiškis, Prienai and Ukmergė districts.

The research results were also evaluated, summarized and uploaded into the Geographic Information System (GIS) database, maps of soil acidity and fields with similar soil properties (plant available P_2O_5 and K_2O) were drawn, their variation trends analysed, and the final report and an informational article for farmers on spring fertilisation with nitrogen prepared.

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

1. “Implementation and spread of innovative technologies in growing of clonal stands of *Populus* hybrids in the areas that are not suitable for agriculture”.

Project leader Dr. Virgilijus Baliuckas. 2019–2020.

The aim of the project is to strengthen human resources and disseminate progressive technologies and innovations in abandoned areas and in the areas that are not suitable for agriculture through the establishment and cultivation of particularly sustainable forests of populations and hybrids of *Populus*, thus enabling not only the development of forestry, but also ensuring the protective and other functions of forests.

Project outputs: 1) 3 groups of sharing farming experience were formed, in which the processes of demonstration trials and topical issues of the activity were discussed; 2) the results of the project were practically demonstrated in 6 demonstration trials, which are located in different districts of Lithuania (Kaunas, Utena, Klaipėda, Marijampolė and Šiauliai); 3) participants of seminars (150 participants), field days (150 participants) and conference (100 participants) were familiarized with the possibility of using abandoned areas and areas that are not suitable for agriculture for cultivation with particularly fast-



► Hybrid aspen test plants

growing clones and hybrids of the genus *Populus* and their growth peculiarities; 4) prepared and published recommendations and other relevant information (information articles, leaflets).

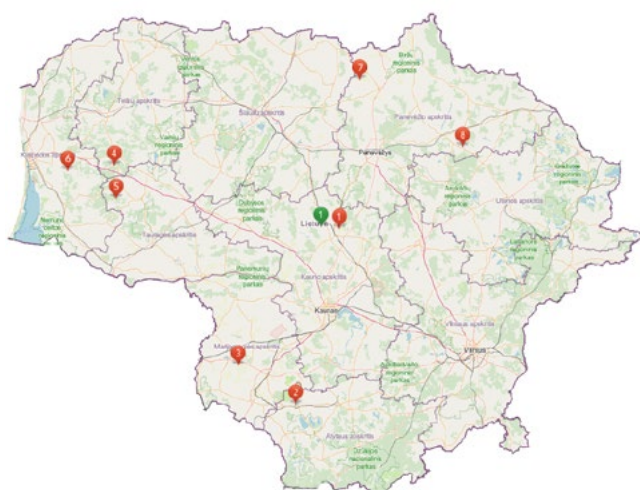
The collected scientific experience and the performed research allowed us to improve the breeding, maintenance and cultivation technologies of clones and hybrids of the genus *Populus*. To disseminate this knowledge, seminars and field days were organized in demonstration trials. This allowed the sharing of breeding and cultivation technologies for clones and hybrids of the genus *Populus* among owners of unsuitable agricultural land, managers and other final beneficiaries.



► Hybrid aspen test stands



► Demonstration trial of catch crops



Institution of science and studies

Applicant LAMMC Institute of Agriculture, Instituto av. 1, Akademija, Kėdainiai distr.

Partners, natural and legal persons involved in agricultural activities

- No. 1 Vilma Živatkauskienė, Gineitų st. 29, Gineitai vil., Kėdainiai distr.
- No. 2 Svajūnas Nevecka, Žuvintai vil., Alytus distr.
- No. 3 Darius Matijošaitis, Gudelių st., Šeimenos local admin., Vilkaviškis distr.
- No. 4 Stanislovas Antanas Jurkus, Bijūnų st. 13, Vatušiai vil., Rietavas local admin.
- No. 5 Osvaldas Jančauskas, Upynės st. 24, Pajūralis vil., Šilalė distr.
- No. 6 Giedrius Lapinskas, Žalioji st. 8, Girininkai vil., Klaipėda distr.
- No. 7 Laura Masilionytė, Šaipių st. 4, Vaškai, Pasvalys distr.
- No. 8 Zigmantas Aleksandravičius, Puožas vil. 7, Kupiškis distr.

► Map of demonstration trials



► Meeting of the experience sharing group in the trial field of Institute of Agriculture

2. “Crop rotation diversification and agrotechnology optimization for the restoration of biodiversity and agro-ecosystem functions”.

Project leader Dr. Lina Šarūnaitė. 2017–2020.

The aim of the project is to increase biodiversity in crop rotations by promoting the application of new agrotechnologies on farmers' farms. Demonstration trials were conducted in Alytus, Kaunas, Klaipėda, Marijampolė, Panevėžys, Tauragė and Telšiai municipalities to familiarize farmers with factors affecting biodiversity change, encourage the use of crop production technologies that support and enhance the diversity of soil and phytocenosis species.

All the 8 trials were aimed at proving and validating the benefits of increasing crop diversity in the crop rotation for farmers. During field days, the roots of plants were uncovered and the depth of penetration, branching, the location of the main root mass in the topsoil and subsoil were demonstrated. Plant nutrition conditions were determined by the physical properties of the soil (structure, density, porosity). Therefore, during the field days demonstrations of measurement of soil hardness (penetration resistance), water permeability was conducted. Organoleptic evaluation of soil structure was carried out as well as assessment of the formation of plough pan.

During the project, 13 field days and 12 seminars were organized and attended by 508 participants (farmers and consultants). Events were held in Kupiškis, Vilkaviškis, Kaunas, Klaipėda, Panevėžys, Pasvalys, Kėdainiai, Lazdijai and Šilalė municipalities. The final conference of the project was organised with the participation of 111 farmers and specialists. A booklet of recommendations for farmers and agricultural professionals was released.

3. “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.

The aim of the project is to base scientific knowledge and promote the improvement of the quality of dairy cattle production in the aspects of identification of nutritional value and risk management of different canned forages.

Through demonstration trials, dairy farmers and silage producers were familiarized with innovations in the production of canned feed. Demonstration trials were established and carried out in all Lithuanian municipalities in Kėdainiai, Telšiai, Šilalė, Tauragė, Klaipėda, Kupiškis, Radviliškis, Rokiškis, Alytus, Marijampolė and Ukmergė districts.

During the field days, seminars and group meetings, the researchers gave information on the



► Meeting of the experience sharing group in the trial field of Institute of Agriculture



► Participants of the field day, arranged in Radviliškis distr., discuss with project implementers



► Project implementer dr. Gražina Kadžienė tells participants of the field day, arranged in Šakiai distr., about the subtleties of use of growth regulators



► Plantations of 8-year old silver birch were established in the soil ploughed at a depth of 40 cm

quality of the raw material used for silage production, preservation of nutritional value, identification of risk factors and their negative impact on cattle productivity and on increasing dairy cattle productivity, product quality and environmental improvement and economic benefits. During the project, 13 field days, 12 seminars and 44 experience sharing group meetings were organized.

The published booklet of recommendations contains recommendations of scientists – project implementers – prepared on the basis of the results of tests and analyses performed. The recommendations are addressed to the beneficiaries: farmers, their partners, livestock producers and other natural and legal persons engaged in agricultural activities as well as teachers of agricultural schools and colleges, consultants, all those seeking innovative and efficient farming. The project recommendations are available on the LAMMC website www.lammc.lt.

EIP activity group projects

1. “Targeted introduction of integrated pest control under intensive farming conditions”.

Project leader Dr. Antanas Ronis. 2018–2020.

The overall aims of the project were: 1) to introduce a targeted system for the integrated control of harmful organisms; 2) to carry out analysis of the application and use of plant protection methods and measures by combining the country's most advanced resources – science, consulting and production; 3) to integrate scientific knowledge, application and dissemination of innovations and production experience in order to increase competitive and sustainable crop production.

During the project, it was estimated that farmers spent on average 111.2 EUR in 2019 and 112.32 EUR in 2020 using conventional technologies for the protection of winter oilseed rape crops. Using the integrated pest management technology, it was estimated that pesticide costs were reduced by 17.90 EUR in 2019 and 16.82 EUR in 2020.

Using conventional technologies for the protection of winter wheat crops, an average of 71.37 EUR was spent in 2019 and 94.27 EUR in 2020. Using the integrated pest management technology, it was estimated that pesticide costs were reduced by 16.88 EUR in 2019 and 23.46 EUR in 2020.

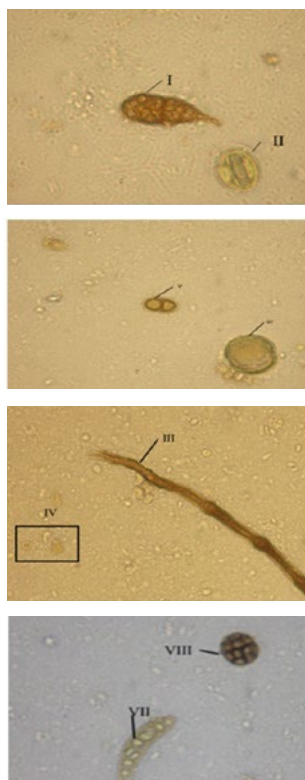
During the project, both the farmers (project partners) and the agricultural consultants have learned more about the benefits of integrated pest management. In addition, almost 300 farmers and representatives of pesticide companies took part in the organized field days. Eight recommendations have been prepared, which list the main pests of winter wheat and winter oilseed rape and indicate at which time it would be most beneficial to control them with the least possible damage to the surrounding environment.

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.

The influence of exogenous stimulants used for plant morphogenesis of hybrids *Populus deltoides* × *P. nigra*, *P. maximowiczii* × *P. trichocarpa*, *P. deltoides* × *P. trichocarpa*, and *P. × canadensis* on the Dixon quality index was studied. It was found that this indicator was influenced by both the concentration of stimulants in the substrate ($r = 0.77$) and the hybrid itself ($r = 0.56$), but the interaction of these factors did not have a significant effect ($r = -0.12$). Even small concentrations

of 0.5 mg l⁻¹ in the substrate ensure a Dixon index greater than 0.5. The growth of silver birch (*Betula pendula*) plantations planted in the different soil types and with the different soil preparation methods were studied. It was found that the plantation performed best in the normal humidity mesotrophic soils, which had been ploughed at 40 cm depth (on the average 20% better than in the soil prepared using other methods).



► Identification of microorganisms in honeydew honey

Support for the Lithuanian Beekeeping Sector

1. “Identification of protein diversity in honeydew honey”.

Project leader Dr. Violeta Čeksterytė. 2020.

The aim of the study is to identify the proteins contained in honeydew honey, depending on the composition of the nectar producing plants and contribution of aphids.

The variety of microbiota was identified in the preparations of honey samples prepared for microscopy. The following fungal spores were identified in the honeydew honey: *Alternaria brassicae* and *Cladosporium*. This microbiota was accumulated in honey samples in different sizes of colonies or single elements and was found in all honeydew honey samples. The higher content of royal jelly protein MRJP4_APIME identified in honey with honeydew elements may be associated with the higher protein content in the latter honey compared to the nectar honey. Honeydew honey is characterized by a higher amount of protein produced by the aphid organism, which is designated as J9JZG8_ACYPI, compared to the rapeseed nectar honey.

Honeydew produced by pea aphids (*Pisum acyrtosiphon*) is an alternative source of nectar. At the same time, honeydew and nectar collected and delivered to the hives by bees diversify the honey composition.

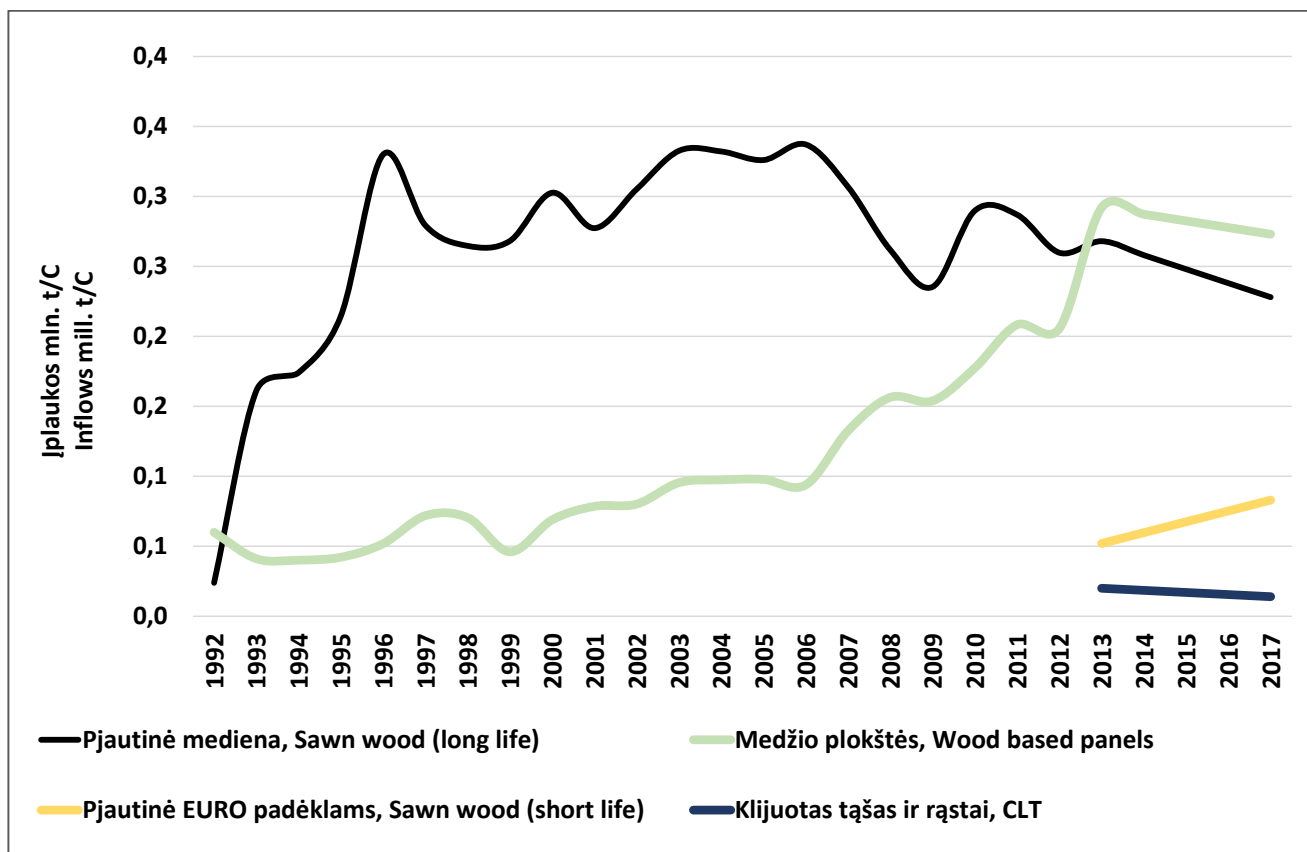
Applied research funded by the Ministry of Agriculture and its subordinate institutions

1. “Material flow analysis of industrial timber for carbon accumulation and quantitative change in harvested wood products”.

Project leader Dr. Marius Aleinikovas. 2019–2020.

Carbon storage in harvested wood products (HWP) is an internationally recognised measure to mitigate climate change. However, due to the lack of reliable and transparent data on production and trade of HWP, carbon accounting in HWP is complicated. The Intergovernmental Panel on Climate Change provides guidelines for reporting countries on how to estimate carbon stocks and their changes in HWP with the use of default or country-specific data as well as accounting methods so that countries can choose an accounting method depending on data availability.

The main objective of the research is to analyse the flow of industrial wood in Lithuania and to determine the carbon stocks and their quantitative changes in wood products. The carbon storage in HWP by applying different methods was estimated and compared the results. The estimates for Lithuania showed that carbon stock in HWP differs significantly when different methods are applied. The annual carbon inflow and the annual change in carbon stocks are significantly higher (92%) when the analysis of wood flow was used to the accounting of these indicators compared with statistics data on the production of wood products. This difference was due to the classification of domestically produced raw timber and generated wood waste into country-specific categories of industrial wood products. The increase in the change in carbon stocks was also due to the adjustment of country-specific half-lives.



► Annual carbon inflows in harvested wood products in different categories (1992–2017)

2. “Survey of the environmental risk assessment of GMOs”.

Project leader Dr. Algimantas Paulauskas (VDU), coordinator Dr. Rita Armonienė (LAMMC). 2019–2020.

The aim of the project is to ensure that the activities involving GMOs are carried out safely, GMOs do not spread into the environment and do not damage ecosystems. LAMMC is the project partner responsible for sampling of rapeseed during the growing seasons of 2019 and 2020.

In 2020, two field trips were organized to collect pooled samples. Plant samples of rapeseed and related species were collected along the railway tracks and roads,

nearby processing companies of rapeseed in various regions of Lithuania. During the first field trip, 13 samples were collected, and during the second field trip – 14 samples. A total of 27 pooled samples (547 plants) were collected, of which 15 samples of oilseed rapeseed (*B. napus*), 9 samples of field mustard (*S. arvensis*) and 3 samples of oil radish (*R. raphanistrum*). Nine samples were collected nearby rapeseed processing companies, 6 samples at railway tracks, and a maximum of 12 samples were collected on roadsides. The collected samples were submitted to the National Food and Veterinary Risk Assessment Institute (NMVRVI) for genetic modification testing.



► Volunteer oilseed rape plants emerged on roadsides



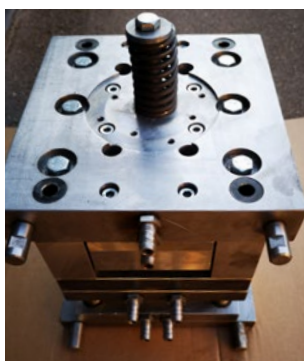
► Volunteer oilseed rape plants emerged at railway tracks



Collection of wood samples of black alder for DNA analysis



Seed stand of black alder in Šiluva



A prototype of implant press



Instrument for sap collection

3. “Adjustment of black alder, small-leaved lime and Norway maple provenance regions using DNA markers”.

Project leader Dr. Virgilijus Baliuckas. 2018–2020.

Objectives of the research: 1) to specify the provenance regions of black alder, small-leaved lime and Norway maple based on DNA markers; 2) to prepare a list of genotypes for the 2nd generation black alder seed orchards from plus trees and field trials; 3) to determine the possibilities (principles) for the transfer of forest reproductive material of black alder, small-leaved lime and Norway maple in the country and import from the neighbouring countries of the European Union.

A total of 15 black alder, 18 small-leaved lime and 19 Norway maple stands were selected for the study. From 20 to 22 trees in each stand were selected and wood samples were taken for DNA analysis. Eight polymorphic nuclear microsatellite loci were used for black alder and maple DNA analysis, for lime – 10. Within population genetic diversity properties of each tree species were determined. Significance of genetic differentiation between populations and regions in Lithuania was estimated. Analysis of population genetic structure based on DNA loci data, and related alleles frequency and admixture algorithms was performed. An alternative method for determining the genetic structure according to the regularities of the geographical distribution of the allele frequency was also used to identify the regions of origin.

The optimal number of regions of origin for black alder, small-leaved lime and Norway maple based on DNA markers was established. New regions of origin have been established: black alder – 2, small-leaved lime – 3, Norway maple – 3. A list of genotypes for the second-generation seed orchards has been compiled based on the newly identified black alder provenance regions. The possibilities of transfer of forest reproductive material of the studied tree species in the country and from the neighbouring countries of the European Union are discussed.

Technological development project funded by the Agency for Science, Innovation and Technology (MITA)

1. “Creation of prototypes of technology of birch juice industrial extraction and innovative biologically valuable products”.

Project leader Prof. Dr. Pranas Viškelis. 2019–2020.

The aim of the project is to develop birch sap industrial extraction technology and prototypes of innovative biologically valuable products.

The objectives of the project: 1) to create a prototype of birch sap industrial extraction technology, ensuring its high quality and safety and 2) develop prototypes of innovative biologically valuable products.

The main project outputs. Developed prototype of birch sap industrial extraction technology ensures high sap quality and safety. The developed implant press form creates conditions for the development of implant production and extraction of high-quality and safe birch sap on an industrial scale. The intellectual property of the implant is validated by the European Design Registration, EUIPO (EU Intellectual Property Office), No. 007535067-0001. The height of the birch, where the sap is extracted, had no significant effect on the amount of juice extracted per day, although the amount of sap extracted at a height of 0.5 m is higher than that extracted at a height of 10 m. It has been established that the amount of sap extracted from one tree per season depends on the age of the tree and reaches as much as 250 kg. Sap extraction height in the tree did not have a statistically significant effect on the chemical composition of birch sap quality and safety. Testing of 78 samples showed no pathogenic micro-organisms in either birch sap or prototypes of birch sap



products. There is a downward trend in the total amount of microorganisms, yeasts, and moulds with increasing sap extraction height, but it is not statistically significant. The content of moulds and yeasts is very low. Cooling the sap in the freezer also shortens the juice cooling time from 170 hours in the refrigerator for up to 64 hours, or about 2.5 times. Fresh or frozen birch sap is a very low-calorie drink, and fermented birch juice has practically zero calories (0.8 kcal).

The developed prototypes of innovative birch sap products create conditions for the development of higher sap extraction yields and the production of biologically valuable niche products.

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

Support for the project 2014–2020 EU Fund Investment Programme Priority 2 “Promotion of Information Society” Measure “Development of Advanced Electronic Services”



1. “Modernization and Development of Informational, Advisory and Training Electronic Services for Integrated Plant Protection”.

Leaders Ilma Rimkevičienė (Lithuanian Agricultural Advisory Service), Dr. Alma Valiuškaitė (LAMMC). 2017–2020.

The aim of the project is to increase the range of IKMIS electronic service users and the availability of electronic services, data accuracy, quality, relevance and convenience of information provision by expanding the scope of services, integrating additional functions and merging expert advice provided by different institutions.

The IKMIS is system of integrated plant protection information, consulting and training and provides 4 free electronic services:

- 1) provision of information on the distribution of harmful organisms in crops all through Lithuania;
- 2) use of electronic catalogues of diseases, pests and weeds as well as plant protection products registered in the country for farmers;
- 3) provision of interactive consultations regarding the issues of integrated plant protection;

4) organization of remote training for farmers, agricultural specialists and advisers with certificate issue.

The application of integrated plant protection on farms is very important as a lot of global problems can be addressed:

1) reducing risks and impacts of pesticide use on human health and the environment;

2) encouraging the development and introduction of integrated pest management and alternative approaches or techniques in order to reduce dependence on the use of pesticides, environmental conservation by its lesser pollution with chemical plant protection products;

3) the production of safer and higher quality food products without reducing yields.

Farmers with new knowledge can manage their farm resources available in more efficient and rational ways thus reducing farm costs. The information available in the IKMIS system is a key to a successful and environmentally friendly future farm.

“RTO Lithuania” projects



These inter-institutional projects are funded by their own funds from all three “RTO Lithuania” member-institutes: Lithuanian Research Centre for Agriculture and Forestry, Center for Physical Sciences and Technology, and Lithuanian Energy Institute.

1. “Investigation of aerosol black carbon emissions from biomass incineration units and deposition on tree foliage”.

Project coordinators: Dr. Valda Araminienė (LAMMC), Dr. Steigvilė Byčenkienė (FTMC), Dr. Eugenija Farida Dzenajavičienė (LEI). 18 May – 31 December, 2020.

The aim of the project is to evaluate the contribution of aerosol black carbon emissions from the combustion of biofuels to the thermal balance of the atmosphere and to investigate the effect of dry/wet deposition on the foliage surface of deciduous and coniferous trees on tree condition and growth.

The amount of black carbon accumulated on the foliage of trees might change surface albedo and can cause forest degradation.

Currently, the largest carbon emissions from the combustion of biofuels come from households with various types of heating equipment installed. These plants burn different types of fuel, which is often not adapted to the plant, so the fuel cannot be burned efficiently. The idea

of the project is to identify new threats related to climate change and their impact on trees by applying qualitative research of causal relationships focused on the coherence of tree processes with the promotion of biomass use and impacts on forests in the Baltic region.



▶ Black carbon collected from filters after biofuel combustion

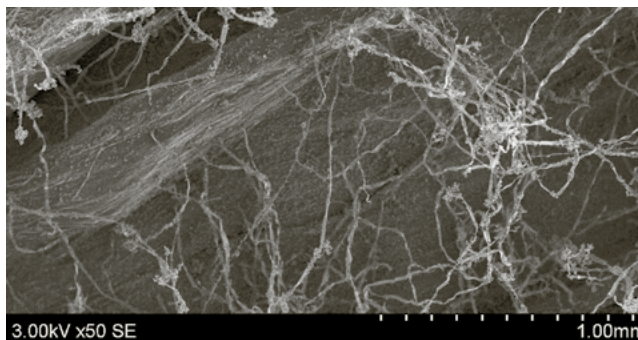


▶ Silver birch and spruce seedlings grown in a phytotrone for the study of black carbon

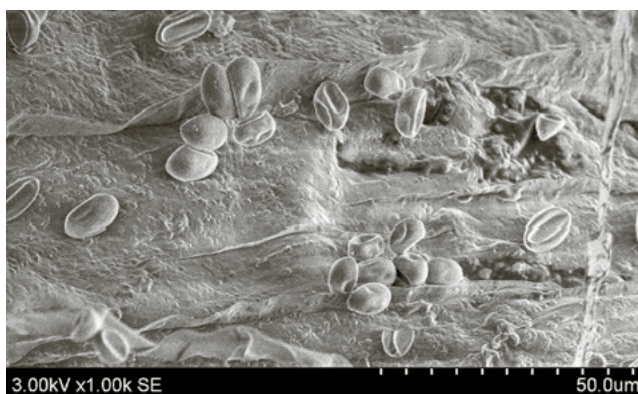
2. “Development of a database of specific parameters of plant pathogens for disease diagnosis by nondestructive methods”.

Project coordinators: Dr. Alma Valiuškaitė (LAMMC), Dr. Virginijus Bukauskas (FTMC), Dr. Darius Milčius (LEI). 18 May – 31 December, 2020.

The aim of the project is to develop a database of specific parameters of plant pathogens for diagnosis of diseases by non-destructive methods. Changes in plant physiological parameters in infected plants and their relationships have been identified to help to create a database for early disease diagnosis.



▶ Fungal hyphae on a damaged leaf x50 / LEI photo



▶ Pathogen spores on an infected leaf x1.000 / LEI photo

6.3.3. International projects launched in 2020

In 2020, LAMMC launched **6** international **projects**. Provided below are the descriptions of all international projects launched.

Project of the “Horizon 2020” programme



1. “Towards climate-smart and sustainable soil management” (EJP SOIL).

Coordinator in the Institute of Agriculture Dr. Žydrė Kadžiulienė, deputy coordinator Dr. Virginijus Feiza. 2020–2024.

Fertile and productive soils are the prerequisite for a stable supply of food, fibre, animal feed, timber, and other biomasses. Soils are part of the solution to realising the SDGs.

The “Horizon 2020” project EJP SOIL unites a unique group of 26 leading European research institutes and universities in 24 countries.

The main objective of EJP SOIL is to create an enabling environment to enhance the contribution of agricultural soils to the key societal challenges, such as climate change adaptation and mitigation, sustainable agricultural production, provision of ecosystem services and prevention of soil degradation and restoration of land. Through

sustainable soil management, it is possible to preserve and even enhance the provision of ecosystem services by soil and biodiversity. Soil management can also be climate smart, contributing to mitigation of climate change by carbon storage and to adaptation of agroecosystems to changing climate. The implementation of climate smart sustainable soil management differs from region to region, between agricultural practices and obviously between different soil types.

EJP SOIL activities in interaction with stakeholders will pursue the long-term goal of promoting farmers as stewards of land and soil resources and support policy development and deployment, in particular the CAP and Climate policies.

For more information about EJP SOIL, please visit www.ejpsoil.org and www.lammc.lt.

Project of the “Eureka” programme

1. “Developing of novel symbiotic functional drink with different plant-based fractions using *Medusomyces gisevii* culture”.

Coordinator in the Institute of Horticulture Prof. Dr. Pranas Viškelis. 2020–2023.

The aim of the project is to develop a functional fermented probiotic drink using a symbiotic culture of *Medusomyces gisevii* and plant-based fractions as the enzymatic base.

Fractions of various plant raw materials with potential functional properties, such as antioxidant, immune-boosting, antiviral, anti-inflammatory, etc., will be incorporated into this innovative drink. Following the research envisaged in the project, the propagation technology of the mother culture of *M. gisevii* and the prototype technology of the fermented high-value-added



► Countries of project partners



► Project implementers



► Fermentation

functional drink will be developed and pilot versions of the product prototype will be carried out by a food company. The development of a natural fermented beverage with potentially functional properties will open the way for research and experimental development and will allow the company to grow by developing new innovative products.

Baltic Research Programme Project

1. “Sustainable use of soil resources in the changing climate” (SUCC).

Project coordinators: Dr. Kęstutis Armolaitis (Institute of Forestry), Dr. Jelena Ankuda (Vokė Branch). 2020–2023.

European tundra and boreal forest ecosystems will experience one of the strongest impacts of climate change on the Earth. The humans can control much of the greenhouse gas emissions related to land use shifts, agricultural and forestry practices by determining and implementing ‘climate-friendly’ ways of management and sustainable use of soil resources in agriculture and forestry from the global change perspective.

Project objectives:

1. To develop novel molecular methods for rapid abundance assessment of various microbial groups and their potential of organic degradation and carbon release.
2. To determine shifts in carbon allocation in plants and carbon sequestration in soil along the latitudinal gradient in response to climate change.
3. To evaluate the economic costs and benefits of changing climate on various aspects of forestry and soil carbon balance.
4. To determine ecological sustainability of afforestation of former agricultural land.
5. To develop sustainable forestry and other land use practices to mitigate the negative effects of climate change, on the one hand, and secure forest productivity, on the other hand.



► Dr. Kęstutis Armolaitis measures the distance between soil sampling points

COST actions



1. CA19116 “Trace metal metabolism in plants” (PLANTMETALS).

Coordinators in the Institute of Agriculture Dr. Karolina Barčauskaitė, Dr. Renaldas Žydelis. 2020–2024.

The PLANTMETALS COST Action will tackle fundamental and applied issues related to TM deficiency or excess levels in plant physiology and crop production. The first online meeting was held on October 8–9.

2. CA19125 “EPI genetic mechanisms of crop adaptation to climate change” (EPI-CATCH).

Coordinator in the Institute of Agriculture Dr. Kristina Jaškūnė. 2020–2024.

EPI-CATCH COST Action **aims** at defining and publicly delivering standardized methods, workflows, and methods in crop epigenomics needed to develop agriculture of tomorrow adapted to climate change.

Objectives:

1. To define standards, pipelines, workflows and best practices for wet lab, *in silico* data analysis and “omics data integration” in plant epigenetics / epigenomics.
2. To transfer part of knowledge and methodologies in epigenetic / epigenomic research in all other living organisms.
3. To promote future research in plant epigenetics / epigenomics through the establishment of an internationally recognized consortium that will develop innovative proposals for future funding calls in related fields.
4. To promote the future development of molecular tools (epi-molecular markers, better-adapted cultivars, wet and dry methodologies) for stakeholders (growers, agroindustry, biotechnological companies).
5. To facilitate the transfer of technology and the creation of start-up companies through the formation of skilled European talents involved in plant epigenetics / epigenomics.

Project of other EU programmes supporting research

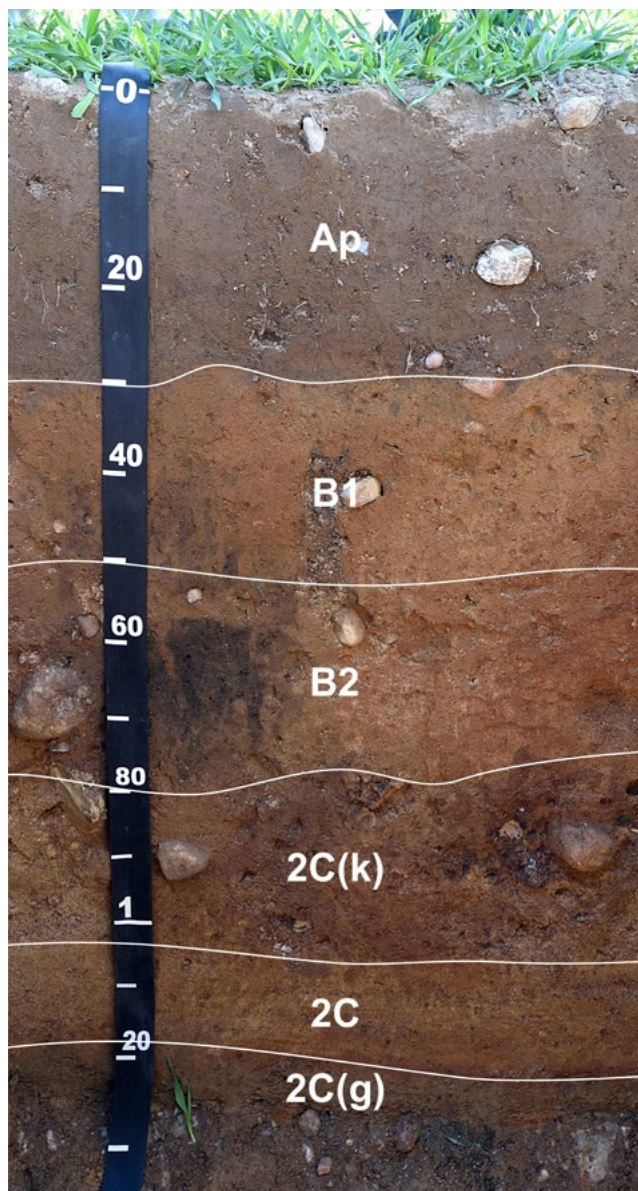
1. Programme FACCE SURPLUS project “Biofortified and climate-resilient food and fodder production on marginal soils” (BioFoodOnMars).

Project leader Dr. Virmantas Povilaitis. 2020–2023. Support for international research and technology development projects funded by LR Ministry of Agriculture.

The aim of the project is to increase potential of crop yields and create added value of crop production in marginal soils in different agroclimatic zones of Europe by using various biological fertilizers (various composts,



► Spring barley experiment on a low productivity soil



► Profile of a low productivity soil

etc.), plant quality and productivity enhancing additives – selenium and silicon. The project aims to develop modern management tools that will allow for the sustainable intensification of agriculture and will be beneficial for agribusiness, farmers and other interested users.

The project is implemented together with the following foreign project partners: Estonian University of Life Sciences (project coordinator), Warsaw University of Life Sciences (Poland), Institut Nationale de la Recherche Agronomique (INRA), (France), UHasselt, Belgium (Flanders), Helmholtz Zentrum München GmbH, COMI, (Germany).

In Lithuania, field trials are conducted at the LAMMC Institute of Agriculture (perennial grasslands) and the Vokė Branch (spring barley). In the first year, the agrochemical and physical properties of the soil were evaluated, and the potential of yield of spring barley and perennial grasslands was estimated under different fertilization technologies applied. Using a drone, 4 different vegetative indices of plants were calculated during spring barley vegetation and compared with grain yield. The correlation-regression

analysis showed that the strongest relationship between grain yield and vegetative indexes was obtained during stage of intensive growth of stem. The collected research results allowed to develop an optimal fertilization strategy for the next year of the project when organic fertilization products will be prepared for application.



6.3.4. International projects ongoing in 2020

In 2020, the Lithuanian Research Centre for Agriculture and Forestry continued to implement 18 projects of various international programmes. This section provides descriptions of the ongoing international projects under the “Horizon 2020” and LIFE programmes. A full list of the projects is provided in the annexes.

Projects of the “Horizon 2020” programme

1. “Stepping-up IPM decision support for crop protection” (IPM Decisions).

Coordinator in the Institute of Agriculture Dr. Roma Semaškienė. 2019–2024.

In Europe, there is a diverse range of decision support systems (DSS) for integrated control of weeds, pests and diseases available on the market. There are excellent examples of crop protection DSS, which are well tested and implemented, but the proportion of farmers and advisors using DSS is low. Information about 73 DSSs have been collected: 40 diseases, 26 insects, 6 weeds, 2 slugs and 1 haulm killing. The catalogue was the basis for identifying priority DSSs for initial inclusion in the IPM Decisions platform. This platform will provide farmers, advisors and researchers with the tool to assess the reliability and suitability of different decision support systems, so they can select those that are most suited to their needs.

From December 2019 to February 2020, IPM Decisions partners ran workshops with IPM DSS owners/developers, farmers and advisors across 12 EU countries including Lithuania. The interest, needs and wishes for the IPM Decisions platform expressed by different stakeholder groups and their feedback are used to improve the IPM Decisions Platform. The functionality, visual attractivity and simplicity of DSS were much discussed in the workshop organized in Lithuania on the 29th of January 2020. The issue of DSS maintenance in the future was addressed as well. Representatives of different partner groups were provided with specialized questionnaires, which were completed and sent to France for data processing. Preliminary data of the survey were presented at project participants’ meetings in July and November. An updated IPM Decisions platform was presented at the November meeting.



► Presentation of the IPM Decisions platform to stakeholders, January 29, 2020





More information
www.best4soil.eu



A network of 20 countries

2. “Best4Soil”.

Coordinator in the Institute of Agriculture Dr. Antanas Ronis. 2019–2021.

The main objective of the thematic network is to maintain, improve or re-establish soil health in Europe. Open-access databases with information on the range of pathogens and nematodes that affect vegetable, arable and cover crops are created to help practitioners to build appropriate crop rotations and innovative control strategies.

Currently, information data, databases, videos are being developed, and networking activities are being organised. With Best4Soil, a community of practice network across Europe is being built by inter-connecting growers, advisers, educators and researchers. This network promotes knowledge ready for practice on 4 best practices (compost, green manure, anaerobic disinfestation, (bio)solarisation) for the control of soil borne diseases. Therefore, a website is built, and meetings and events are organized, where knowledge on soil health with our communities of practice is exchanged.



3. “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. 2017–2021.

The PANACEA **project aims** to create a thematic network to promote effective knowledge exchange between research, industry, and the farming community to map the integration of non-food crops into European agriculture.

In 2020, training was organized for farmers to familiarize participants with the opportunities and challenges of growing fibre hemp. Fibre hemp is a well-known agricultural crop, which has long been uncultivated and poorly used. In recent years, as human needs have increased, especially due to the specific properties of the active compounds of hemp grown for fibre, there has been renewed interest in growing these plants not only in Lithuania but also throughout Europe. It was indicated that there is a need for new research to evaluate technologies for growing hemp for fibre and its most efficient use.



Seminar “The importance of fibre hemp and other crops for an efficient organic farm”

4. “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 aim of LEGVALUE is to pave the path for the development of sustainable and competitive legume-based farming systems and agri-feed and food chains in the EU. In recent years, project researchers have been elaborating legume crop development assessments, examining legume cultivation practices and ecosystem services. Initial analysis of the data collected from farmers in different countries reveal that farmers generally value and pay attention to services provided by legumes, such as yield, quality, income and are less aware of or understand energy and environmental services.

Like partners from other countries, we organized a workshop “Legume plants in future crop systems”. The aim of the seminar was to discuss the current dominant crop production systems in Lithuania and the importance of legumes in them and to compare the place of these systems and the legumes themselves in the agricultural system at the European level. Also, after getting acquainted with the current situation, in a discussion with Lithuanian specialists, we sought to anticipate and discuss possible future prospects for bean-based crop systems, taking into account the forecasted scenarios for the development of the European economy. The assessment formulated during the discussion was presented to complement the Common European Research Base for Bean Systems, which is being developed by a group of scientists from the international project LEGVALUE.



Participants of the seminar, June 30, 2020

Projects of LIFE programme



Research methodology was discussed in a working meeting, August 25, 2020



Project in Latvia was awarded in the category "The greatest contribution to tackling climate change problems"



Biomass of poplars prepared for analysis

1. "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt).

Coordinator in the Institute of Forestry Dr. Kęstutis Armolaitis. 2019–2023.

The aim of the project is implementation of innovative Climate Change Mitigation (CCM) measures in nutrient-rich organic soils in Temperate Cool and Moist (TCM) climate region to contribute to the United Nations Framework Convention of Climate Change (UNFCCC) Paris agreement, EU policies (Regulation (EU) 2018/841, LULUCF regulation) and national climate policy targets in post-2020 period by reduction of greenhouse gas GHG emissions from cropland, grassland and forest land on nutrient-rich organic soils.

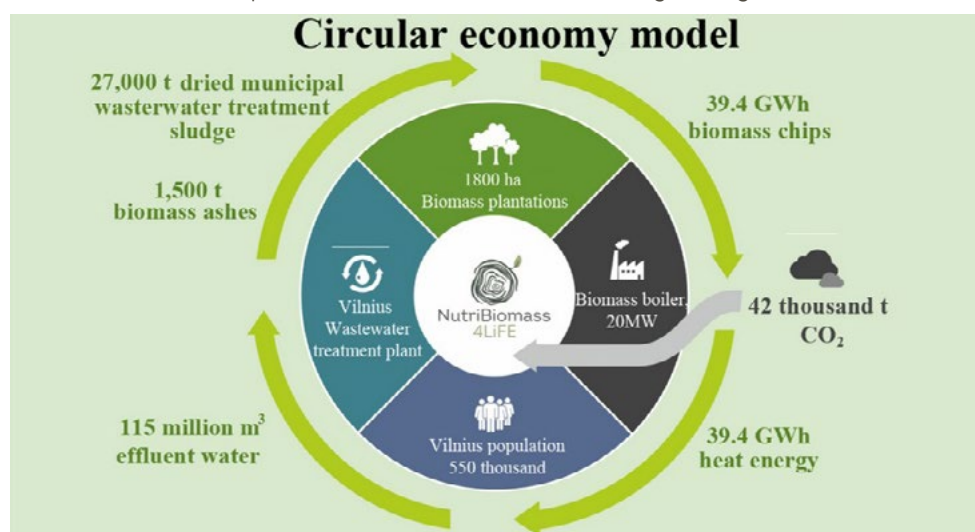
The main objectives: to improve the GHG accounting methods and activity data for nutrient-rich organic soils under conventional management conditions; to identify and demonstrate sustainable, resilient and cost-effective CCM measures applicable in nutrient-rich organic soils; to provide tools and guidance for elaboration, implementation, and verification of impact of the CCM.

In 2020, study sites were selected in drained and non-drained nutrient rich organic soils (lowland peatlands) with different management conditions. Forest stands of spruce, birch and black alder and perennial grassland as well as winter cereal crops were selected as study sites in drained peatland. Meanwhile, forest stands of birch and black alder, and perennial grasslands as well as shrubs were selected in the undrained peatlands. In addition, the methodology for the collection of greenhouse gas (GHG) emissions, forest floor and soil samples as well as groundwater samples, was also developed this year. The project implemented by the LAMMC together with partners was awarded in the annual event "LIFE Awards 2020" in the category "The largest contribution to solving climate change problems". For more information about the awards, visit <https://www.orgbalt.eu/?p=3252>.

2. "Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy" (NutriBiomass4LiFE).

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

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 the EU countries



Circular economy model



Establishment of soil monitoring sites

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 aim 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.

Results of this year:

- 1) 350 ha of new woody biomass plantations established;
- 2) 4800 dry metric tonnes of pelleted municipal wastewater sludge digestate and 500 t of biomass ashes reused for biomass yield improvement within CE model;
- 3) reused 194 t of total N, 180 t of total P, and 37 t of K;
- 4) the soil quality, in particular carbon and nutrient balance, improved on 480 ha area within the project area;
- 5) soil samples were taken from 24 special soil monitoring sites (established to analyse the impact on different types of soils, represented in targeted area), the results of two years of detailed research are available;
- 6) from 24 lysimeters comprehensive water monitoring was done by taking and analysing water, to assess nutrient leaching from waste;
- 7) 24 special soil monitoring sites were established to analyse heavy metals, total N, P, K and C_{org} accumulation in tree roots, stem, bark and leaves, 96 samples were taken in 2020.

6.3.5. International projects completed in 2020

This section presents descriptions of 5 international projects implemented in 2020.

The 7th Framework Programme Project

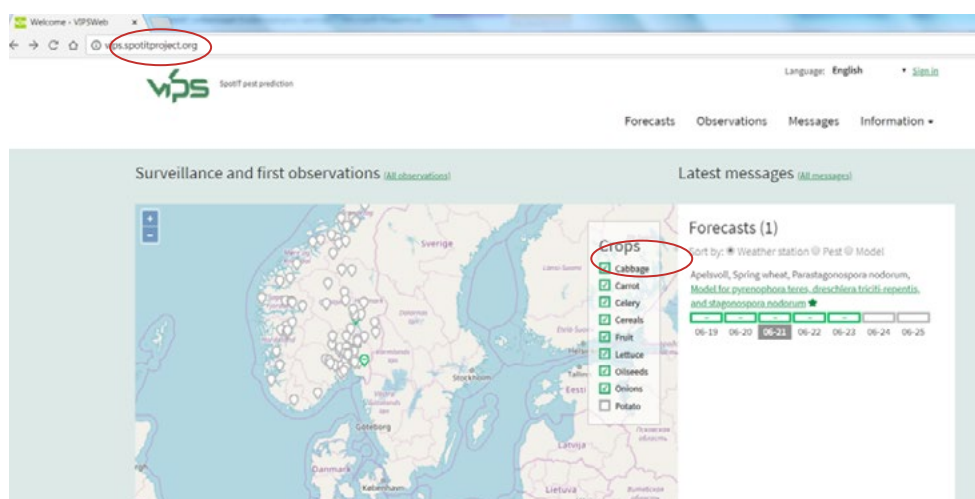
1. FP7-ERANET-2013-RTD “IT-solutions for user friendly IPM-tools in management of leaf spot diseases in cereals” (SpotIT).

Project leader Dr. Antanas Ronis. 2017–2020. Support for international research and technology development projects funded by LR Ministry of Agriculture.



Decision on the need for control of Septoria leaf blotch in wheat by using “Septoria humidity model”.

A web page is opened, crops of interest are selected.



The country is selected, the nearest weather station is identified, crop growth stage is selected, spray application date is entered, fungicide action time is selected, “Run model” is pressed.

When the model shows that fungicide treatment is needed and a spray is carried out, it is assumed that the crop is subsequently protected for 10 days. After the 10 days, the models shall be used again to assess if there is further need for control.



The aim of the project was to provide cereal growers, consultants and other stakeholders with free access to locally adapted models for predicting the spread of leaf spotting diseases. The models would be hosted on a single international platform, and all would be translated into the national language to ensure the availability and popularity of the models.

According to the results of the study, a single spray of fungicide when applied to winter wheat from the beginning to the middle of the heading growth stage (BBCH 51–55) gave an average of 23 EUR profit. Spraying according to the recommendations of disease prediction models also was profitable and varied from 11 to 20 EUR.

In spring barley, a single spray with fungicides when the flag leaf (BBCH 37–39) appeared gave an average 6 EUR profit. However, single spraying with fungicides at later growth stages (BBCH 51–55) and especially double spraying with fungicides (at BBCH 37–39 and at BBCH 51–55) were not profitable. Net blotch predictive models did not recommend fungicide spraying either in 2018 or 2019.

Projects of other EU programmes supporting research



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

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

The focus is to strengthen pre-breeding cooperation, validate available germplasm resources by genetic and phenotypic characterization in order to make a wider choice for crossings aimed at increasing diversity for targeted traits. The scientists from seven Nordic and

Baltic countries and the Netherlands evaluated germplasm resources and created genetic and phenotypic information, in order to widen the parental pool to be used in breeding for targeted traits. Phenotyping protocols for evaluating both disease resistance, e.g., apple canker and fruit rots in apple and crown rot in strawberry, and fruit quality traits were standardized and validated. Specially designed core and diversity collections well representing the most important cultivars as breeding parents and covering broad genetic variation, respectively, were characterized phenotypically and by high-density molecular markers, to validate the already known marker-trait associations and to find new ones. Within this project, we also enhanced and developed the genetic competence among breeders as well as initiated the process of integration of modern genetic tools into the breeding programmes.

2. 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. Alfas Pliūra. 2017–2020.

The aim of the programme was to investigate the genetic resistance of common ash to ash dieback disease caused by the pathogen *Hymenoscyphus fraxineus* (anamorph *Chalara fraxinea*) and to select disease-resistant ash planting material. In 2018 and 2020, testing and assessment of the resistance of 860 Irish ash plus tree clones to *H. fraxineus* was performed in 2 clonal trials established in the Dubrava nursery of the SFE in Lithuania. Based on the complex resistance and growth indicators, the 50 best clones were selected for vegetative propagation, establishing seed orchards and further tree breeding for disease resistance. In the ash progeny trials of the European RAP series, which were established in Lithuania (Telšiai, Kėdainiai and Pajiesys) in 2005–2008, 46 individuals representing the 18 European populations were selected as the most resistant to the disease. Samples of their cuttings were collected for the vegetative propagation. A containerized collection of the most disease-resistant ash individuals selected in clonal and other trials was accumulated aiming at vegetative propagation and cross breeding. The technology of



- ▶ The most pathogen-resistant ash genotypes from 24 foreign and Lithuanian populations are selected at the Kėdainiai international RAP experiment

rejuvenation and vegetative propagation of the most resistant genotypes by green cuttings was improved. Genetic variation, heritability, genetic correlations, and other genetic and eco-genetic indicators of resistance traits and their dynamics over 3 years were evaluated in clonal trials. A scientific report and a scientific article were prepared together with foreign project partners.



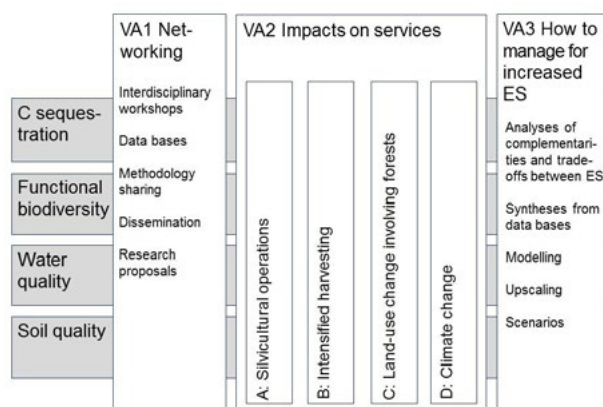
- ▶ Viewing of collection of grafts of pathogen-resistant ash genotypes selected at RAP experiments in the Irish TEAGASC Research Centre

3. 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.

The project aimed to collect data and knowledge on the impact of forest management on environmental services (carbon sequestration, biodiversity, water and soil quality); to strengthen cooperation between the forest scientists and stakeholders of this region, to promote interest in sustainable forestry and environmental services provided by forests, and to initiate research projects.

In 2020, the work planned in the project was continued, online discussions on relevant topics and issues of carbon sequestration, biodiversity, water and soil quality took place, and experience in preparing publications was shared. The final work of the project, the preparation of the report and the conference were postponed to 2021 due to the COVID-19 pandemic.



- ▶ A scheme of organisation of project scientific activities



► Field experiment of the diploid perennial ryegrass

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

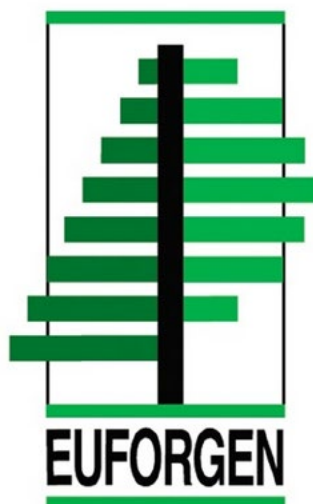
Coordinator in the Institute of Agriculture Dr. Gintaras Brazauskas. 2014–2020.

The project aimed at improving the winter hardiness, persistence and other important perennial ryegrass traits for northern Europe. It will also make plant breeding in northern Europe more prepared to meet new demands due to climate change, political decisions, or consumer demand.

Perennial ryegrass field trials, established in 2018, were assessed and scored for herbage and dry matter yield, plant height, heading date, winter survival, spring growth and regrowth after cuts, tolerance to diseases. The seeds of the most promising diploid genotypes were collected for further use in the breeding programme.

6.3.6. Results of long-term projects and programmes in 2020

This section presents the descriptions of 5 long-term international projects ongoing in 2020.



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

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

The EUFORGEN is an international cooperation programme that promotes the conservation and sustainable use of forest genetic resources in Europe as an integral part of sustainable forest management.

The EUFORGEN programme has identified priorities for future forestry research in Europe. The main research priorities in the field of forest genetics have been identified:

1. Implementation of forest genetic monitoring at European and national level, integrating it into other forest monitoring schemes.
2. Establishment of series of field trials at European level.
3. Carrying out the “right tree in the right place” research (provenance / origin research).
4. Increased focus on tree plasticity and epigenetics research.
5. Transition from single candidate gene studies to full genome sequencing in search of genes and their groups related to tree adaptation.
6. Risk management in a changing climate – dissemination and practical application of research.
7. Communication – ensuring dialogue between scientists, politicians, the public and foresters.
8. Control of the distribution and transfer of forest tree propagating material.



► Experimental site

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

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

The aim of 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 consists 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. The main problem is to raise 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 to everybody.

3. “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 2020, the winter wheat breeding programme, conducted together with Estonian Crop Research Institute since 2000, was continued. According to the targets of this programme, the winter wheat lines developed in Lithuania are transferred to Estonian Crop Research Institute in Jõgeva.

In 2020, 8 breeding lines were selected for investigations in Estonian Crop Research Centre. Fifteen lines, developed at Institute of Agriculture and selected under Estonian growing conditions in 2010–2019, were investigated in Estonian wheat breeding programme in 2020.



► Tall-stemmed wheat is better suited for Estonian conditions

4. “European plant genetic resources conservation programme”.

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

The aim of the programme is to accumulate and study genetic resources for plant breeding programmes in order to ensure development of competitive varieties. In 2020, the activities under the “European plant genetic resources conservation programme” were continued. The plant genetic resources of all plant species, bred according to the plant breeding programmes approved by LAMMC, were collected and investigated. They will be a useful genetic material for further breeding programmes.

In total, 210 winter wheat, 307 spring barley, 300 spring wheat, 289 oat varieties were studied, of which five, three, two and three, respectively, were transferred to the National Plant Gene Bank for long-term storage.

In the pea collection, 168 varieties were collected and studied; their yield, resistance to lodging and diseases were determined. One variety will be transferred to the National Plant Gene Bank for long-term storage.

In 2020, a numerous collection of grasses, including a total of 5882 varieties and breeding lines of ryegrass, *Festulolium*, meadow fescue, cocksfoot, Kentucky blue grass, clovers, and alfalfa were collected and investigated. Thirteen most valuable perennial grass varieties and breeding lines will be transferred to the National Plant Gene Bank for long-term storage.



► Spring barley genetic collection before harvesting

5. “Research on winter wheat winterhardiness and diseases”.

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

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

In 2020, the long-term project, conducted together with the Danish Sejet Plant Breeding Station since 1994, was continued.

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

In 2020, 488 breeding lines of winter wheat and triticale from Sejet breeding programmes were investigated. A total of 25 breeding lines of winter triticale were investigated for winter hardiness and disease resistance in replicated yield trials.



► Western European wheat is short and characterised by erectophylic leaves



6.4. PLANT BREEDING

LAMMC conducts breeding programmes for the major field crops, vegetables, pomefruits, stonefruits and berries. In 2020, the following varieties were included in the Lithuanian National List of Plant Varieties: winter wheat 'Silva' and 'Taurija', oats 'Frekula D', winter garlic 'Dangiai' (protected variety), sweet pepper 'Gabija'. The winter wheat varieties 'Silva' and 'Taurija', winter garlic variety 'Dangiai' and sweet pepper variety 'Gabija' were included in the EU Common Catalogue of Varieties of Agricultural Plant Species.



Winter wheat 'Silva'.

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

The winter wheat variety 'Silva' was developed at Institute of Agriculture, LAMMC. According to grain quality traits, the variety belongs to E quality group. The mean grain yield was 9.3 t ha^{-1} in the official state variety testing during 2017–2019. The grain quality traits under intensive cultivation correspond to E, or 1st, grain quality class standards. The mean protein content was 12.3%, sedimentation 39 ml, gluten 24.5%, 1000 kernel weight 44.4 g, and hectolitre weight 807 g l^{-1} .

The variety is characterized by high tolerance to cold, short plant height, high resistance to lodging, and medium resistance to grain pre-harvest sprouting. The variety is medium resistant to leaf spot diseases and Fusarium head blight and resistant to powdery mildew and leaf rust. The recommended sowing time is the second half of September. Intensive fertilization and pesticide application are recommended when cultivating the variety in fertile soils.



Winter wheat 'Taurija'.

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

The winter wheat variety 'Taurija' was developed at Institute of Agriculture, LAMMC. According to the grain quality traits, the variety belongs to B quality group. The mean grain yield was 9.56 t ha^{-1} in the official state variety testing during 2017–2019. The grain quality traits under intensive cultivation correspond to the 1st to 3rd grain quality class standards. The mean protein content was 11.8%, sedimentation 34 ml, gluten 23.2%, 1000 kernel weight 43.4 g, and hectolitre weight 802 g l^{-1} .

The variety is characterized by high tolerance to cold, short vegetation period, short plant height, high resistance to lodging, medium resistance to grain pre-harvest sprouting. The variety is medium susceptible to leaf spot diseases, Fusarium head blight, powdery mildew, and leaf rust. The recommended sowing time is the second half of September. Intensive fertilization and pesticide application are recommended when cultivating the variety in fertile soils.



Oat 'Frekula DS'.

Breeders: Dr. Vida Danytė, Dr. Andrii Gorash.

The oat variety 'Frekula DS' was developed at Institute of Agriculture, LAMMC. The average yield in 2019 at Plungė Plant Variety Testing Station (PVTs) was 7.26 t ha^{-1} . The average yield in the especially unfavourable year 2019 at Plungė, Kaunas and Kaišiadorys PVTs was 6.0 t ha^{-1} . Plant height is shorter than average. The plants are resistant to lodging. Grains have medium protein and high fat content. Grain hectolitre weight is 512–551 g l^{-1} , 1000 grain weight 39.4–43.5 g, husk content 22.4–27.9%.

In 2019, at Estonian Crop Research Institute Jogeva Plant Breeding Station the average yield was 7.7 t ha^{-1} , hectolitre weight 527 g l^{-1} and husk content 24.2%. The medium-early oat variety 'Frekula DS' is resistant to loose smut and crown rust, moderately resistant to leaf blotch.



Garlic 'Dangiai' (protected variety).

Breeders: Dr. Danguolė Juškevičienė, Dr. Rasa Karklelienė.

The garlic variety '**Dangiai**' was developed at Institute of Horticulture, LAMMC. Garlic 'Dangiai' is a mid-early variety forming the foliage of up to 1.4 m in height and flower stem with the flower head of up to 1 m. The colour of foliage is intensive green. Bulbils and some generative flowers form in the flower head. The size of bulbils is similar to that of maize grains, and their number is up to 50 and more in a flower head. The shape of bulb is transverse elliptic, and the colour of external scale is light purple with dark purple stripes on it. The bulb consists of 5–7 same sized cloves that are arranged in a circle around the flower stem. The average weight of a clove is 5–10 g. The colour of the clove skin is brownish purple. The flesh is yellowish white. The variety is tolerant to adverse wintering conditions.



Sweet pepper 'Gabija'.

Breeders: Nijolė Maročkienė, Dr. Audrius Radzevičius.

The sweet pepper variety '**Gabija**' was developed at Institute of Horticulture, LAMMC. 'Gabija', a medium early annual sweet pepper (*Capsicum annuum* L. subsp. *macrocarpum* var. *acuminatum* Fingerh.) variety, was created by using the breeding method of cross combination 'Early Red Sweet' × N-08-8 and individual selection. The variety is recommended for growing in the unheated greenhouses and under cover. The plant reaches up to 80–90 cm height and is firm and compact. The foliage is lush, the leaves are of medium size. Fruits are cone shaped with pointed tips. Fruit weight is 70–80 g, the length 11–13 cm and diameter 4–5 cm. Fruit walls are firm, 4–5 mm in diameter. External skin is shiny and smooth. The fruits are green before maturity and turn orange when they reach biological maturity. Harvested fruits maintain good taste for a long time. One plant produces 25–30 fruit. The first fruit matures 135–140 days after seed germination. The duration of pepper fruiting is 62 days. The total fruit yield is 6.5–7 kg m⁻² when planted in rows with a 70 × 40 cm distance. The average marketable yield makes up 93%.

7. RESEARCH INTERNSHIPS



Dr. Viktorija Vaštakaitė-Kairienė at Michigan State University's Controlled Environment Lighting Laboratory

Internship of Dr. Viktorija Vaštakaitė-Kairienė at Michigan State University, USA

May 1, 2019 – April 30, 2020. **Dr. Viktorija Vaštakaitė-Kairienė**, a senior researcher of LAMMC Institute of Horticulture, Laboratory of Plant Physiology, implemented a research project "Photophysiological and technological aspects of producing leafy greens indoors under light-emitting diodes (LEDs)" at Michigan State University, College of Agriculture & Natural Resources, Department of Horticulture, Controlled Environment Lighting Laboratory (USA), which was funded by Baltic-American Freedom Foundation (BAFF). The researcher was working together with Prof. Dr. Erik S. Runkle.

This research project aimed to utilize narrow- and broad-band LEDs to produce high-quality leafy greens (lettuce, spinach, etc.) indoors, in a productive, predictable, and efficient manner. Experiments were performed with lettuces at different growth stages to determine the effect of white LED light in combination with additional red, green, UV-A and blue LED light on growth and biochemical parameters, quality retention during short-term storage. Also, experiments were performed with two varieties of spinach to evaluate the influence of different ratios of blue and red LED light on growth and biochemical parameters, mineral element accumulation.

Based on the results of the performed experiments, manuscripts will be prepared for scientific journals with a citation index. During the internship, the researcher participated

in the following scientific events: seminar “Instrumental Agricultural Analysis” (LECO, Saint Joseph), seminar “Academic Careers – Growing Horticulturists: Being Successful in Your Career”, Las Vegas, and the Conference of the American Society of Horticulture (ASHS), Las Vegas.

Internship of PhD student Mohammad Almogdad at University of South Bohemia, Czech Republic

January 13 – February 21. **Mohammad Almogdad**, a junior researcher and PhD student of LAMMC Institute of Agriculture, Department of Plant Pathology and Protection did an internship at Faculty of Science of the University of South Bohemia, in České Budějovice city, the Czech Republic under supervision of Assoc. Prof. Oldřich Nedvěd.

The laboratory experiments were focused on the role of the environmental factors and the effect of their interaction with pea aphid *Acyrtosiphon pisum* incidence on the growth of faba bean plants. The method of artificial mass rearing of the aphid was mastered. Four experiments with modifications of the rearing procedure were performed: the role of light intensity, water supply, initial number of aphids infested on plants and the time of infestation.

The collection of ladybird beetles (Coleoptera: Coccinellidae) maintained by Dr. Oldřich Nedvěd and the aphid microscope slides made by Dr. Jaroslav Holman,

maintained in the Institute of Entomology, Biology Centre, Czech Academy of Sciences were studied. Making stacked photographs with deep focus on the beetles and their morphological characters using stereomicroscope, digital camera and controlling software was learned. A meeting with the world-leading expert in the research of Coccinellidae Dr. Ivo Hodek and other entomologists in the Institute and Faculty was attended. The results of this research will be published.

Internship of the PhD student Lina Šernaitė at the University of Natural Resources and Life Sciences (BOKU), Austria

March 1 – April 29. **Lina Šernaitė**, a junior researcher and PhD student of LAMMC Institute of Horticulture, Laboratory of Plant Protection did an internship at the University of Natural Resources and Life Sciences (BOKU), Tulln, Austria.

The aim of the internship was to investigate the process of pathogenesis management in plants and the inhibition of the infection spread with plant extracts. During the internship, experience was gained working with fungi from the pathogen collection of the Institute of Plant Protection of BOKU University, such as *F. culmorum*, *F. oxysporum* f. sp. *basilici*, *F. oxysporum* f. sp. *lycopersici*, *Monilinia laxa*, *F. graminearum* and *T. basicola*. Experiments were performed with tomatoes as model plants in the greenhouse. During the internship, contacts were established with Austrian scientists working in the field of biological plant protection.

Internship of Dr. Gražina Statkevičiūtė at the Swedish University of Agricultural Sciences (SLU)

March 8 – July 7. Dr. **Gražina Statkevičiūtė**, a researcher of LAMMC Institute of Agriculture, Department of Plant Breeding visited the Swedish University of Agricultural Sciences (SLU).

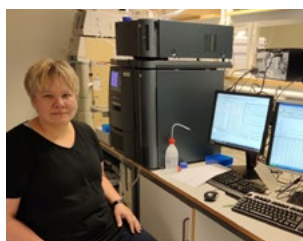
The aim of the visit was to apply size-exclusion high performance liquid chromatography (SE-HPLC) to investigate protein polymer and monomer composition of 12 winter wheat cultivars and 38 breeding lines, grown in the field trials with conventional and low fertilisation rates during 2018–2019 at Institute of Agriculture, LAMMC. A significant association was estimated between the *Glu-A1* and *Glu-D1* alleles, encoding high molecular mass glutenin subunits, and the ratio of large polymeric proteins in the flour samples. Eight breeding lines were chosen for the subsequent analysis of the impact of growing conditions on the rheological properties of the whole-grain flour dough.



► Internship of PhD student Mohammad Almogdad at University of South Bohemia



► PhD student Lina Šernaitė at the greenhouse of BOKU Plant Protection Institute



► Dr. Gražina Statkevičiūtė at the Swedish University of Agricultural Sciences (SLU)



8. DISSEMINATION OF SCIENTIFIC KNOWLEDGE

Due to the worldwide spread of the COVID-19 virus, the year 2020 has become a challenge for organizers of events devoted to dissemination of scientific knowledge. Nevertheless, LAMMC organized both contact and remote national and international events: conferences, seminars, project meetings, field days. The scientific conference “European Green Deal: Challenging Opportunities for Agro- and Forest Science and Business” dedicated to the 10th anniversary of the Lithuanian Research Centre for Agriculture and Forestry received a lot of attention from the scientific community. In addition to organizing events, publications were prepared for the scientific community and public at large.

8.1. INTERNATIONAL SEMINARS AND MEETINGS



March 9–10. A working meeting of the Nordic Forest Research Co-operation Committee (SNS) network PROFOR (Promoting Sustainable Forestry in a Growing European Bioeconomy) “History of Nordic Forestry” in Vilnius.

Nineteen scientists from Finland, Sweden, Norway, Lithuania, Latvia, and Estonia took part in the meeting. Four oral presentations were given on sustainable forestry, Lithuania’s progress in the bioenergy sector, contribution of genetics to sustainable forest management, and carbon stocks in aspen stands.

The event discussed the following issues: the further activities of the network, the content of the forthcoming review article on the forestry sector in the Nordic and Baltic countries, and other relevant issues of the network’s activities.



June 17. Remote seminar on the application of climate change mitigation measures in nutrient-rich organic soils **of the international LIFE OrgBalt project “Demonstration of climate change mitigation potential in nutrient-rich organic soils in the Baltic States and Finland”.**

In order to introduce the aim and tasks of the project, the seminar was addressed to Lithuanian stakeholders. It was attended by representatives of the country’s ministries, the State Forest Enterprise, the Lithuanian Fund for Nature, Lithuanian research institutions, the Latvian State Forest Research Institute Silava, the Latvia University of Agriculture, the Ministry of Agriculture of the Republic of Latvia, BaltCoasts and other institutions. The aim of the project is to contribute to the sustainable development of land use, agriculture, and forestry by developing tools for climate change mitigation measures intended for nutrient-rich organic soils. The project will develop guidelines for the implementation of these measures.



August 25–26. Meeting of the LIFE OrgBalt project “Demonstration of climate change mitigation potential in nutrient-rich organic soils in the Baltic States and Finland” “Presentation of prepared protocols in established reference plots in Lithuania” in Kaunas. It was attended by representatives of the project countries from Lithuania, Finland, Estonia, and Latvia.

Researchers of the Institute of Forestry presented the project situation in Lithuania, made a presentation on terrestrial biomass production. Representatives of the Finnish Institute of Natural Resources LUKE provided information on the preparation of the study plot for the monitoring of heterotrophic carbon dioxide emissions, the preparation of the test plot for the measurement of litter and decomposition, and the sampling of soil and water. In addition, it was discussed when, how many and how often soil and water samples are to be taken from one plot.

On August 26, the participants of the meeting visited the reference plots of drained spruce and crop, black alder, perennial grasslands established in the territory of Dubrava Regional Branch of the State Forest Enterprise and the plots of undrained birch, black alder, and perennial grasslands of Amalva.



8.2. NATIONAL CONFERENCES, SEMINARS



January 28. LAMMC 10th Scientific Reporting Conference “Agricultural and Forestry Sciences: the Latest Research Results and Innovative Solutions” at the Institute of Agriculture. The event attracted almost 300 participants from various academic, government agencies, businesses, and other organizations as well as many farmers.

Participants were able to attend 4 parallel sessions:

- Plant biopotential and quality for multifunctional use;
- Harmful organisms in agro-forest ecosystems (KOMAS);
- Productivity and sustainability of agricultural and forest soils;
- Study of the genetic nature of the traits and characteristics of agricultural and forest plants, targeted change of genotypes for the development of modern varieties.

The event, which attracted a lot of attention, provided the visitors with the latest knowledge about agricultural and forestry sciences and encouraged them to think about the consequences of climate change.



February 20. Scientific conference “European Green Deal: Challenging Opportunities for Agro- and Forest Science and Business” devoted to the 10th anniversary of the Lithuanian Research Centre for Agriculture and Forestry’s research activities, held at the Lithuanian Academy of Sciences (LMA).

The conference was attended by the representatives of ministries, research, education, and consulting institutions. LAMMC director Dr. Gintaras Brazauskas emphasized that the 10-years of operation for a research institution is not much, but its history has been going on for almost 100 years, since the origins of agricultural science in Lithuania. Former director, academician Zenonas Dabkevičius presented the history of agricultural science, the results of LAMMC reorganization and the most important achievements. Scientific reports were made: Dr. Gintaras Brazauskas introduced the European Green Deal, academician Dr. Žydrė Kadžiulienė dealt with the issues of sustainable soil use and efficient crop production, Dr. Audrius Sasnauskas discussed the importance of agrobiological resources and functional food, Dr. Marius Aleinikovas presented sustainable forestry in the conditions of climate change. Remigijus Lapinskas, President of the World Bioenergy Association, discussed agricultural and forest biomass resources and their contribution to the bioeconomy. Dr. Edvardas Makelis presented the possibilities of synergy of science and knowledge dissemination for innovative agriculture.



September 25. Final conference of the project “Diversification of crop rotations and optimization of agrotechnologies for restoration of biological diversity and agroecosystem functions” (No. 14PA-KK-17-1-01532-PR001, carried out under the activities of the Lithuanian Rural Development Programme 2014–2020 measure “Knowledge transfer and information activities” “Support for demonstration projects and information activities”), Institute of Agriculture.

Farmers, scientists, consultants, and other agricultural specialists were presented with the results of demonstration field trials established in various regions of Lithuania. All experiments were combined with the aim to demonstrate to farmers the benefits of increasing crop diversity in crop rotation. Field trials were performed according to the methodology developed by the project promoters for a specific region of the country, taking into account soil characteristics, farming practices and farm specialization. After three years of field trials, the researchers provided recommendations that are useful for a specific region of the country.



October 8. Final conference of the project “Quality and risk assessment of conserved feed for ensuring the completeness and welfare of dairy cattle feeding” (No. 14PA-KK-17-1-01503-PR001, carried out under the Lithuanian Rural Development Programme 2014–2020 measure “Knowledge transfer and information” activity “Support for demonstration projects and information activities”), Institute of Agriculture.

The event presented the results of three years of field trials, key strategy



▶
Project implementers



documents (European Green Deal and EU Biodiversity Strategy) to farmers, scientists, students, consultants, and other agricultural professionals. The researchers provided recommendations on how to prepare good quality conserved feed for the benefit of cattle farmers in a specific region and other agricultural entities in the country.

October 15. Virtual final conference of the project “Targeted Implementation of Integrated Pest Management in Intensive Farming Conditions” (No. 35BV-KK-17-1-03770-PR001) carried out under the Lithuanian Rural Development Programme 2014–2020 measure “Cooperation” activity “Support to creation of EIP activity groups and development of their activities”.

Farmers, scientists, students, consultants, and other agricultural specialists were presented with the results of winter wheat and oilseed rape research carried out during the project. Diseases and pests of winter wheat and oilseed rape were reviewed, the problem of weed resistance to herbicides and the importance of proper selection of herbicides and growth regulators were discussed, and project recommendations were presented.

October 16. Final conference of the project “Implementation and Dissemination of Innovative Technologies in Cultivation of Populus Hybrid Clone Nurseries in Non-Agricultural Lands” (No. 14PA-KK-18-1-03442-PR001) carried out under the Lithuanian Rural Development Programme 2014–2020 measure “Knowledge Transfer” and “Support activities for demonstration projects and information activities”), Institute of Forestry. The selection of aspen (*Populus tremula* L.) in Lithuania, the main principles of nurseries of populations of *Populus* trees, the practice and perspectives of plant breeding and other issues relevant to scientists and other natural or legal persons engaged in agricultural or forestry activities were reviewed.

In 2020, over 70 seminars, discussions, field days, and experience sharing group meetings were organized. Provided below are descriptions of some of the events.



January 22. Seminar “Scientific visits abroad - an impulse for the researcher’s career” at the Institute of Agriculture. Five researchers and doctoral students (Dr. Jurga Miliauskienė, Dr. Valda Araminienė, Dr. Renaldas Žydelis, Donata Drapanauskaitė and Kristina Bunevičienė) shared with the seminar participants not only their experience, research results, but also further plans and answered the questions. LAMMC director Dr. Gintaras Brazauskas encouraged scientists and doctoral students to go on internships abroad, to look for opportunities for cooperation there, to acquire new knowledge that could be applied in Lithuania.



February 12. Seminar “Importance of fibre hemp and other plants for an efficient organic farm” for owners of organic farms, held at Institute of Agriculture. The seminar shared the latest knowledge and research results of LAMMC scientists on organic farming, the impact of crop rotations on soil quality, focused on fibre hemp and its cultivation technologies. Representatives of UAB Aurora Hemp Europe introduced the technologies of fibre hemp cultivation and presented the activities of this company as well as the news of 2020 season and commercial offers for farmers. The participants of the seminar gained useful knowledge about organic farming. Event organizers: UAB Aurora Hemp Europe, LAMMC.



August 7. Scientific event to commemorate the 85th anniversary of Vėžaičiai Branch. Director of Vėžaičiai Branch Dr. Danutė Karčauskienė presented the activities of the branch, expressed her joy about the experience gained over a long scientific journey and passing on knowledge from generation to generation, and the opportunity to cooperate in projects with foreign research institutions. In addition, at the event, LAMMC Vėžaičiai Branch long-term researcher Dr. Vytautas Gipiškis, who celebrated his 90th anniversary in 2020, presented the manuscript of the monograph “Investigations of Acid Soil Liming in Lithuania”. Chairman of the Lithuanian Soil Science Society (LSSS) under



the Lithuanian Academy of Sciences Assoc. Prof. Dr. Jonas Volungevičius evaluated the importance of Dr. Vytautas Gipiškis scientific ideas and, on behalf of the LSSS Board awarded the title of honorary member of the LSSS and passed on the speaker of the Seimas, Prof. Dr. Viktoras Pranckietis' commendation for his long-term and purposeful scientific activity and significant contribution to the development of the country's agricultural science and herbology.

November 5. Remote seminar “Non-traditional use of agricultural plant biomass – opportunities and challenges”, organized in relation to the implementation of the Ministry of Agriculture of the Republic of Lithuania's Agricultural, Food and Fisheries research and development project “Production of alternative biomass sources in primary agriculture: technological solutions, their use for bioeconomy development purposes – energy, feed, and food”, No. MT-20-3. Researchers from LAMMC and the Lithuanian Energy Institute made presentations at the event, discussed the use of traditional and alternative agricultural plant species in food production and pharmaceuticals, agricultural waste and its efficient use in the context of circular bioeconomy, the use of non-food agricultural crops and waste biomass for energy. More than 40 participants from research and studies institutions, the Ministry of Agriculture of the Republic of Lithuania, and the Lithuanian Association of Biotechnologists participated in the seminar and actively discussed the possibilities of using plant biomass.



December 4. Remote seminar “Living and Healthy Soil” to commemorate the World Soil Day attracted more than 130 participants. The event was attended by representatives of scientific institutions, the Ministry of Agriculture, the State Forest Service, the country's agricultural companies and Lithuanian non-arable sustainable agricultural associations, academicians, agricultural consultants, farmers, and other persons interested in soil problems. The event discussed international projects carried out and research conducted by LAMMC. The discussion emphasized that research results must be applied as widely as possible in agriculture in order to achieve closer cooperation between researchers and farmers. Only on the basis of research can good tillage practices be developed. It is also important to reconcile both the economic aspect and the political and environmental requirements for agriculture. According to the participants of the seminar, more similar discussions are needed, more frequent sharing of knowledge and experience.

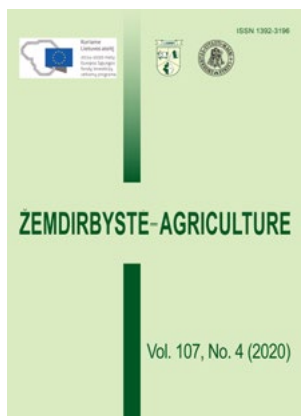


8.3. PUBLISHING

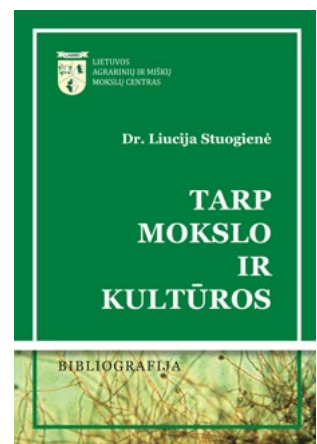
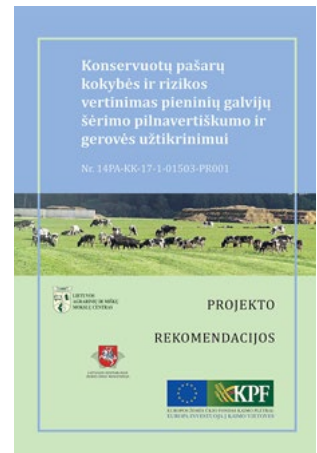
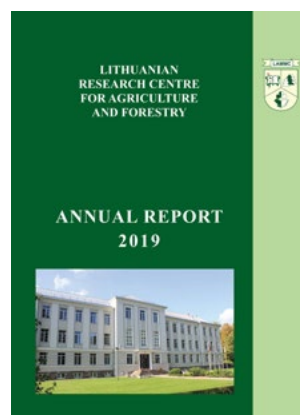
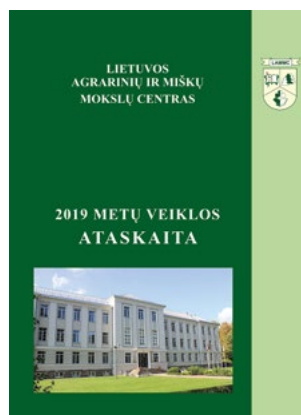
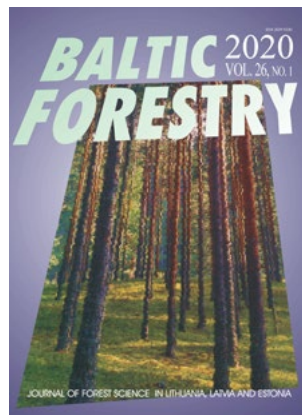
LAMMC together with partners publishes the following scientific journals: “Zemdirbyste-Agriculture” (IF 2019/2020 – 0.833), “Baltic Forestry” (IF 2019/2020 – 0.772) “Miškininkystė”, “Agronomy Research”. The publishing of “Zemdirbyste-Agriculture” is supported by the LMA project “Publishing of Periodical Scientific Publications and its Coordination”, funded by the EU Social Fund.

Other publications issued in 2020:

- “LAMMC Annual Report for 2019”;
- Recommendations of the project “Targeted implementation of integrated pest control in the conditions of intensive farming”;
- Recommendations of the project “Diversification of crop rotations and optimization of agrotechnologies for restoration of biological diversity and agroecosystem functions”;
- Recommendations of the project “Quality and risk assessment of conserved feed for ensuring the completeness and welfare of dairy cattle feeding”;
- “The latest recommendations for agriculture and forestry”;
- Informational publication “Research and Services”;



- Proceedings of the scientific conference “Agricultural and Forestry Sciences: The Latest Research Results and Innovative Solutions”;
- “Dr. Liucija Stuogienė. Between science and culture. Bibliography”.



9. EVALUATION OF RESEARCH ACTIVITIES

The winners of the Lithuanian Science Prizes 2019 were awarded at the Lithuanian Academy of Sciences

In the category of biomedicine and agricultural sciences, prizes were awarded to the researchers of the Institute of Horticulture Prof. Dr. habil. **Vidmantas Stanys**, Dr. **Tadeušas Šikšnianas**, Dr. **Dalia Gelvonauskienė** and Dr. **Audrius Sasnauskas** for the series of research and development works "Genetic and biotechnological research for the development of garden plant varieties".

In this series of works, genetic and biotechnological plant research that enables a better understanding of the patterns of plant functioning, development, and formation of valuable properties. The authors have developed 26 varieties of horticultural plants. In their works, the authors presented data on morphological, genetic, and biochemical polymorphism of horticultural plants, identified the markers of the examined properties that allow fast selection of plants with desirable properties. Based on molecular studies carried out with Western European researchers, the authors developed decentralised working plant collections. They demonstrated the potential of distant hybridisation for creation of target plant forms. They were first to develop distant hybrids of the black currant with higher levels of stable anthocyanins. The scientists identified new anthocyanin biosynthetic pathway genes expressed differentially in the fruits of the genera *Prunus* and *Ribes*. They also determined the regularities of low-temperature adaptation and frost resistance of plants, developed the world's first varieties of the black currant resistant to the blackcurrant gall mite, were first to detect the proteome of the interaction of the differential nucleus of the apple tree with the pathogen *Venturia inaequalis*, and isolated endophytic microorganisms that reduce plant stress.



► Winners of the Lithuanian Science Prizes 2019 Dr. Audrius Sasnauskas, Dr. Tadeušas Šikšnianas, Dr. Dalia Gelvonauskienė and Prof. Dr. habil. Vidmantas Stanys / photo by V. Valuckienė

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

The award of Lithuanian Academy of Sciences 2019 for young scientists and doctoral students in the competition of the best scientific works was presented to the researcher of the Laboratory of Agrobiobiology of the Institute of Agriculture Dr. **Karolina Barčauskaitė** for the research work "Amounts of polychlorinated biphenyls and polycyclic aromatic hydrocarbons in compost produced in Lithuania, their influence on soil and plants".

The winners of Lithuanian Academy of Sciences 2019 award of the competition for research works of higher education students were Vytautas Magnus University's master students **Aušra Bakšinskaitė** and **Urtė Stulpinaitė**, who conducted research at the Lithuanian Research Centre for Agriculture and Forestry. Aušra Bakšinskaitė was awarded for the work "Biomass of herbaceous agricultural plants – raw material for bioplastics and part of the circular bioeconomy", Urtė Stulpinaitė – for the work "Granulation of hardwood chips, improving the quality of pellets" (supervisor Dr. Vita Tilvikienė).



► Winner of Lithuanian Academy of Sciences 2019 for young scientists and doctoral students competition Dr. Karolina Barčauskaitė / photo by V. Valuckienė



► Winner of Lithuanian Academy of Sciences 2019 award of the competition for research works of higher education students Urtė Stulpinaitė / photo by V. Valuckienė



► Winner of Lithuanian Academy of Sciences 2019 award of the competition for research works of higher education students Aušra Bakšinskaitė / photo by V. Valuckienė

Lithuanian Academy of Sciences' scholarships for young scientists

On September 8, two LAMMC researchers were awarded scholarships for young scientists of the Lithuanian Academy of Sciences for the period 2020–2021. The scholarships aim to promote scientific creative activity and competition of young scientists, to support their research work.

The winners are the researcher of the Laboratory of Agrobiolgy of the Institute of Agriculture: Dr. **Karolina Barčauskaitė**, research topic "Extraction of plant nutrients (N, P) from modelled wastewater solutions using a low soluble magnesium source ($MgCO_3$)", and the researcher of the Forest Protection and Hunting Research Department of the Institute of Forestry Dr. **Adas Marčiulynas**, research topic "Diversity of mycobiota found in the roots of different common pine (*Pinus sylvestris*) genotypes: attention to root sponge (*Heterobasidion annosum* (Fr.) Bref.) and its incidence and severity".



▶ Dr. Karolina Barčauskaitė was awarded scholarship for young scientists of the Lithuanian Academy of Sciences



▶ Dr. Adas Marčiulynas was awarded scholarship for young scientists of the Lithuanian Academy of Sciences

LAMMC researchers have been awarded the title of the Merited Agronomist of Lithuania and the Honorary Member of Lithuanian Union of Agronomists (LAS)

On July 16, to commemorate the Day of Agronomy, the best agronomists of the country, including scientists of the Lithuanian Research Centre for Agriculture and Forestry, were awarded during the congress of the Lithuanian Union of Agronomists (LAS).

The title of the Merited Agronomist of Lithuania was awarded to the head of the Department of Orchard Plant Genetics and Biotechnology of Institute of Horticulture, academician Prof. Dr. habil. **Vidmantas Stanys**. The professor has been working in the field of plant genetics, biotechnology, agronomy for more than 40 years, is a researcher and practitioner of plant adaptability, variability,

realization and change of genetic information. He has developed new plant breeding methods, introduced a healthy garden planting material propagation system in Lithuania. He is a breeder and co-breeder of over 20 varieties of strawberry, black currant, sweet cherry, and cherry. The monographs, scientific and science-popularizing articles written by V. Stanys are important for the academic society and the progress of the country's agriculture. The academician has twice been awarded the Lithuanian Science Prize for scientific activities and has received other significant awards.

The title of the Honorary Member of LAS was awarded to the senior researcher of Joniškėlis Experimental Station Dr. **Aušra Arlauskienė** for her fruitful scientific activities, support for farmers' self-governing bodies, dissemination of agronomic knowledge, which make a significant contribution to the activities of LAS. Her research interests include legume crops, enhancement of plant diversity, green manure application technologies, and research into fertilization systems under organic and sustainable farming conditions.



▶ Title of the Merited Agronomist of Lithuania was awarded to Prof. Dr. habil. Vidmantas Stanys



▶ Title of the Honorary Member of LAS was awarded to Dr. Aušra Arlauskienė



▶ A new member of the Young Academy of LMA Dr. Viktorija Vaštakaitė-Kairienė

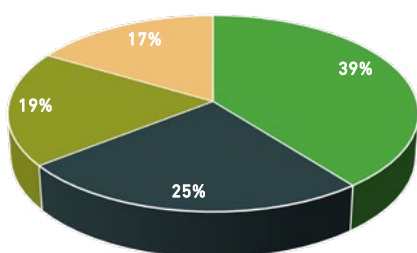
Members of the Young Academy of the Lithuanian Academy of Sciences

On November 20, 2020, a senior researcher of LAMMC Institute of Horticulture Dr. **Viktorija Vaštakaitė-Kairienė** was elected a new member of the Young Academy of the Lithuanian Academy of Sciences (LMA) by the commission of LMA, and on December 1, 2020 her membership was approved by the Resolution of LMA Presidium for a period of 4 years.

Currently, of the 30 elected members and 6 members representing the field of agricultural sciences, 4 members are young scientists of LAMMC. Members of the Young Academy of the Lithuanian Academy of Sciences are elected by means of a competition. The eligible candidates are scientists, who have achieved significant scientific results and are active in their professional activities and have obtained a doctoral degree not more than 10 years ago and are not more than 40 years of age before the election day.

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, lease of premises, etc.) (Figure 4). In 2020, LAMMC revenue amounted to 11 million 834 thousand Eur.



► Figure 4.
Funding
sources

- State budget appropriations
- Funds from projects
- Funds from contract work for Lithuanian and foreign economic entities
- Income from other activities

Major expenditure in 2020: salaries/wages and social insurance (73%), goods and services (17%).

Other expenditure: public utility services and communications, business trips, maintenance of transport means/vehicles, doctoral scholarships, royalties, etc.



11.1. NATIONAL PROJECTS

Research funded by the Research Council of Lithuania

Projects of researchers' teams

1. "Light as a tool of biofortification: photophysiological aspects of essential trace elements management in leafy vegetables". Project leader Dr. Aušra Brazaitytė. 2019–2022.
2. "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.
3. "GrowGene – Genome-wide functional analysis of perennial ryegrass for improved growth under water limiting conditions". Project leader Dr. Kristina Jaškūnė. 2017–2020.
4. "Dynamic light spectrum and intensity modelling and photoresponse in different vegetable morphogenesis stages". Project leader Dr. Giedrė Samuolienė. 2017–2020.
5. "Improvement of apple fruit quality by application of innovative horticultural technologies". Project leader Dr. Darius Kviklys. 2017–2020.

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

1. "Biological plant protection strategies: boosting sustainability-orientated competitiveness in controlled environment horticulture" (BIOCLED). Project leader Dr. Aušra Brazaitytė. 2020–2023.
2. "Development of wood modifying eco-friendly technology for higher value products". Project leader Dr. Marius Aleinikovas. 2017–2021.
3. "Closed plant cultivation system for production of raw materials for peptide nanoengineering applications". Project leader Dr. Danas Baniulis. 2017–2021.
4. "UV-A lighting strategies for controlled environment horticulture: upgrade to sustainable, high-value production". Project leader Dr. Akvilė Viršilė. 2017–2021.
5. "Quality diagnostics of biogas production by-product (digestate) for innovative use as a biofertilizer". Project leader Dr. Alvyra Šlepetienė. 2017–2021.
6. "Development of winter wheat varieties for amylose-free starch and vital gluten processing". Project leader Dr. Gintaras Brazauskas. 2017–2021.
7. "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

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

Post-doctoral internships in Lithuania

1. "Toxicogenicity of *Fusarium graminearum* residing in alternative host-plants to wheat as influenced by the environmental conditions". Research supervisor Dr. Skaidrė Supronienė, post-doc Dr. Sigita Janavičienė. 2020–2022.
2. "Epigenetic and genetic variation of trees, ecogenetic plasticity and adaptation possibilities in climate change". Research supervisor Dr. Alfars Pliūra, post-doc Dr. Valda Gudynaitė-Franckevičienė. 2020–2022.

3. "Adaptation potential of *Alnus glutinosa* in future forests under climate change: genetic monitoring in natural distribution extremes" (ALNUSGENMON). Research supervisor Prof. Dr. Filippas A. Aravanopoulos, post-doc Dr. Rita Verbylaitė. 2020–2022 m.
4. "Evaluation of phytocomponents on the functional and physical properties of silicone caoutchouc composite". Research supervisor Prof. Dr. Pranas Viškelis, post-doc Dr. Aistė Balčiūnaitienė (Lisauskaitė). 2020–2022.
5. "The influence of agrotechnological measures on fibre hemp (*Cannabis sativa* L.) morphological parts phytochemical composition". Research supervisor Dr. Vita Tilvikienė, post-doc Dr. Karolina Barčauskaitė. 2020–2022.

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

1. "Management of greenhouse gas emissions by changing nitrogen flows in the agro-system". Project leader Dr. Vita Tilvikienė. 2020–2021.
2. "Sustainable forage crops productivity under climate extremes: resilience, nutritional quality and implications for future management". Project leaders Prof. Dr. habil. Romualdas Juknys (VDU), Dr. Vaclovas Stukonis (LAMMC). 2020–2021.
3. "Dynamic changes and restoration of soil properties, fungal and insect communities following clearcutting and biomass utilization in pine ecosystems". Project leader Assoc. Prof. Dr. Artūras Gedminas. 2020–2021.

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

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

1. "The impact of *Fraxinus excelsior* and *Populus tremula* *in vitro* cultures and symbiotic bacteria interaction on the development of antipathogenic resistance in these trees". Student Greta Striganavičiūtė, supervisor Dr. Vaida Sirgedaitė-Šėžienė. November 3, 2020 – April 30, 2021.
2. "Characterisation of brown rot pathogens genetic diversity using microsatellite markers". Student Raminta Žukauskaitė, supervisor Prof. Dr. habil. Vidmantas Stanys. November 3, 2020 – April 30, 2021.
3. "In-season prediction of cereals nitrogen status and yield with an unmanned aerial vehicle (UAV)". Student Ardas Kavaliauskas, supervisor Dr. Renaldas Žydelis. November 3, 2020 – April 30, 2021.
4. "Optimization of expression of recombinant peptides in tobacco plants and purification". Student Lukas Budginas, supervisor Prof. Dr. habil. Vidmantas Stanys. October 18, 2019 – April 30, 2020.
5. "Use of substrate recycled in biogas production for plant fertilization – impact on soil, GHG emissions and plant quality". Student Aušra Bakšinskaitė, supervisor Dr. Vita Tilvikienė. October 18, 2019 – April 30, 2020.
6. "The influence of biochar fertilization on spring wheat formation under different watering conditions". Student Urtė Stulpinaitė, supervisor Dr. Dalia Feizienė. October 18, 2019 – April 30, 2020.

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

The agriculture, food and fisheries research and development projects

1. "Evaluation and preparation of fibre hemp products as organic carbon accumulators in long-term products and soil for their application according to IPCC methodology in GHG inventory". Project leader Dr. Egidijus Zvicevičius (VDU), Dr. Vita Tilvikienė (LAMMC). 2020–2022.
2. "Evaluation of factors limiting the yield of beans and peas and their management with IPM tools". Project leader Dr. Roma Semaškienė. 2020–2022.
3. "The state of agricultural crop stands and yield forecast in Lithuania". Project leader Dr. Virginijus Feiza. 2020–2022.
4. "Demonstrating the potential for climate change mitigation in nutrient rich organic soils through research-based national values for greenhouse gas (GHG) emissions from lowland peatlands". Project leader Dr. Kęstutis Armolaitis. 2020–2022.
5. "Development of cultivation technologies for quinoa (*Chenopodium quinoa*), chickpeas (*Cicer arietinum*) and amaranth (*Amaranthus*)". Project leader Dr. Lina Šarūnaitė. 2020–2022.
6. "Evaluation of effectiveness and perspectiveness of different agricultural practices from economic, energy-efficient and environmental viewpoint". Project leader Dr. Dalia Feizienė. 2020–2022.
7. "Glyphosate and AMPA residues and their degradation time in soil and grain". Project leader Dr. Gražina Kadžienė. 2019–2021.
8. "Complex investigation and economic-environment evaluation of no tillage (no-till) technology". Project leader Dr. Virginijus Feiza. 2019–2021.

9. "Production of alternative biomass sources (including alternative protein production sources and technologies) in primary agriculture: technological solutions, their use for bioeconomy development purposes – energy, feed, food". Project leader Dr. Vita Tilvikienė. 2020.
10. "Impact of growing system on the quality and safety of fruit and vegetable production". Project leader Dr. Darius Kviklys. 2019–2020.
11. "Long-term monitoring of soil agrochemical properties". Project leader Prof. Dr. habil. Gediminas Staugaitis. 2016–2020.

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

1. "Implementation and spread of innovative technologies in growing of clonal stands of *Populus* hybrids in the areas that are not suitable for agriculture". Project leader Dr. Virgilijus Baliuckas. 2019–2020.
2. "Crop rotation diversification and agrotechnology optimization for the restoration of biodiversity and agro-ecosystem functions". Project leader Dr. Lina Šarūnaitė. 2017–2020.
3. "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.

EIP activity group projects (Lithuanian Rural Development Programme 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.

Support for Lithuanian beekeeping sector

1. "Identification of protein diversity in honeydew honey". Project leader Dr. Violeta Čeksterytė. 2020.

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

1. "Butt rot impact assessment on sustainability and productivity of Norway spruce stands". Project leader Dr. Povilas Žemaitis. 2020–2022.
2. "Evaluation of soil organic carbon sustainability in forest ecosystems". Project leader Dr. Vidas Stakėnas. 2020–2023.
3. "The influence of initial stand density and early selective thinning on the spruce tree stems quality". Project leader Dr. Marius Aleinikovas. 2020–2022.
4. "Study of possibility to use aspen symbiotic bacteria for biological control of tree-damaging pathogenic fungi". Project leader Dr. Jonas Žiauka. 2020–2022.
5. "The first stage of Scots pine intensive breeding (breeding cycle III), based on crossings and progeny testing – selection of genotypes in the field trials, grafting, cultivation of clones, preparation of project for crossings and crossing methodology". Project leader Dr. Virgilijus Baliuckas. 2020–2021.
6. "Conservation measures for pedunculate oak, sessile oak and Wych elm gene pool". Project leader Dr. Virgilijus Baliuckas. 2020–2023.
7. "Preparation of aspen seed plantation project by identifying the sex of aspen plus trees and establishing the most optimal scheme for crossbreeding". Project leader Dr. Rita Verbylaitė. 2020–2022.
8. "Identification of black alder and grey alder F1 generation hybrids and preparation of forest propagating material for field trials". Project leader Dr. Virgilijus Baliuckas. 2020–2022.
9. Studies of the effect of aerial spray with the biological insecticide Foray 76B on non-target entomofauna by killing the black arches (*Lymantria monacha* L.). Project leader Assoc. Prof. Dr. Artūras Gedminas. 2020.
10. "Development of a unified methodology for drawing up fertilization plans". Project leaders: Prof. Dr. habil. Gediminas Staugaitis, Dr. Aistė Masevičienė. 2020–2021.
11. "Preparation facility of the brown hare (*Lepus europaeus*) recovery programme". Project leader Dr. Olgirda Belova. 2020–2021.
12. "Level II intensive forest condition monitoring and level I forest soil survey in European network of forest condition monitoring". Project leader Dr. Vidas Stakėnas. Customer – State Forest Service. 2020–2021.

13. "Adjustment of black alder, small-leaved lime and Norway maple provenance regions using DNA markers". Project leader Dr. Virgilijus Baliuckas. 2018–2020.
14. "Material flow analysis of industrial timber for carbon accumulation and quantitative change in harvested wood products". Project leader Dr. Marius Aleinikovas. 2019–2020.
15. "Survey of the environmental risk assessment of GMOs". Project leader Dr. Algimantas Paulauskas (VDU), coordinator (LAMMC) Dr. Rita Armonienė. 2019–2020.
16. "Preparation of genetic monitoring methodology for Scots pine, Norway spruce, pedunculate oak and silver birch". Project leader Dr. Virgilijus Baliuckas. 2019–2021.

Technological development project funded by the Agency for Science, Innovation and Technology (MITA)

1. "Creation of prototypes of technology of birch juice industrial extraction and innovative biologically valuable products". Project leader Prof. Dr. Pranas Viškelis. 2019–2020

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

Support for the project 2014–2020 EU Fund Investment Programme Priority 2 "Promotion of Information Society" measure "Development of Advanced Electronic Services"

1. "Modernization and development of informational, advisory and training electronic services for integrated plant protection". Leaders Ilma Rimkevičienė (Lithuanian Agricultural Advisory Service), Dr. Alma Valiuškaitė (LAMMC). 2017–2020.

"RTO Lithuania" projects

1. "Investigation of aerosol black carbon emissions from biomass incineration units and deposition on tree foliage". Project coordinators: Dr. Valda Araminienė (LAMMC), Dr. Steigvilė Byčenkienė (FTMC), Dr. Eugenija Farida Dzenajavičienė (LEI). 18 May – 31 December, 2020.
2. "Development of a database of specific parameters of plant pathogens for disease diagnosis by nondestructive methods". Project coordinators: Dr. Alma Valiuškaitė (LAMMC), Dr. Virginijus Bukauskas (FTMC), Dr. Darius Milčius (LEI). 18 May – 31 December, 2020.

Students' scientific practice

1. "The effect of plant protection products on apple postharvest pathogens and their biocontrol". Student Justinas Masionis (KTU), supervisor Dr. Neringa Rasiukevičiūtė.
2. "Plant extracts of Myrtaceae family for protection of onion from pathogens during storage". Student Aušrinė Paišytė (KTU), supervisor Dr. Alma Valiuškaitė.
3. "Biological control of apple rots with plant extracts". Student Vestina Ramonaitė (KTU), supervisor Dr. Alma Valiuškaitė.
4. "Determination of the antifungal activity of plant-based products *in vitro*". Student Jovita Kybartaitė (VDU), supervisor Lina Šernaitė.
5. "Identification of strawberry pathogen *Colletotrichum* spp. and efficacy of the essential oils *in vitro*". Student Laura Vaidelytė (KTU), supervisor Dr. Neringa Rasiukevičiūtė.
6. "Laboratory research, equipment, and methods in the field of plant protection". Students Vestina Ramonaitė (KTU), Jovita Kybartaitė (VDU), supervisor Lina Šernaitė
7. "Phenology of medical plants". Student Emilija Jokimaitė (VDU), leader Dr. Edita Dambrauskienė.
8. "The estimation of morphobiological features and phenological observation of garlic". Student Ieva Janulevičiūtė (VDU). Supervisor Dr. Danguolė Juškevičienė.
9. "Optimization of expression and purification of recombinant peptides in tobacco plants". Student Lukas Budginas (VDU), leader Prof. Dr. habil. Vidmantas Stanys.
10. "Identification and evaluation of phenotypic traits of toxin-producing *Fusarium* fungi". Student Fausta Beinorytė (VDU), leader Dr. Skaidrė Supronienė.
11. "Evaluation of antagonistic properties of *Rhizobium* bacteria". Student Laura Riaubaitė (VDU), leader Dr. Skaidrė Supronienė.
12. "Evaluation of pathogenicity of different *Fusarium* species to cereals under laboratory and field conditions". Student Giedrė Brazdeikytė (VDU), leader Dr. Skaidrė Supronienė.

13. "The influence of various agrotechnical measures on the accumulation of polyphenolic compounds in fiber hemp (*Cannabis sativa* L.) seeds". Student Daugvilė Vaičiulytė (VDU), supervisor Dr. Karolina Barčauskaitė.
14. "Formation of hemp biomass using different agroecological measures". Student Lukas Šablevičius (VDU), supervisor Dr. Vita Tilvikienė.
15. "Research on renewable energy sources in agriculture". Student Eimantas Masiliūnas (VDU), supervisor Dr. Vita Tilvikienė.
16. "The influence of sowing density on the phytochemical composition of morphological parts of fibre hemp (*Cannabis sativa* L.) at different vegetation stages". Student Toma Petrikaitė (VDU), supervisor Dr. Karolina Barčauskaitė.
17. "Wireworms (Elateridae) harmfulness in sugar beet". Student Algirdas Petrėtis (VDU), supervisor Dr. Roma Semaškienė.
18. "*Myzus persicae* and other aphids in oil seed rape". Student Orestas Makniusevičius (VDU), supervisor Dr. Roma Semaškienė.
19. "Susceptibility of different varieties of beans to diseases". Student Ugnius Paškauskas (VDU), supervisor Dr. Roma Semaškienė.
20. "Changes of physiological indices of spring barley by applying biochar and its combinations with N fertilizers". Student Toma Petrikaitė (VDU), supervisor Dr. Dalia Feizienė.
21. "The influence of inoculation on productivity of leguminous plants in organic farming system". Student Gabija Baltramaitytė (VDU), supervisor Dr. Monika Toleikienė.

11.2. INTERNATIONAL PROJECTS

"Horizon 2020" projects

1. "Towards climate-smart and sustainable soil management" (EJP SOIL). Coordinator in the Institute of Agriculture Dr. Žydrė Kadžiulienė, deputy coordinator Dr. Virginijus Feiza. 2020–2024.
2. "Stepping-up IPM decision support for crop protection" (IPM Decisions). Coordinator in the Institute of Agriculture Dr. Roma Semaškienė. 2019–2024.
3. "Best4Soil". Coordinator in the Institute of Agriculture Dr. Antanas Ronis. 2019–2021.
4. "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. 2017–2021.
5. "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.

LIFE Programme Projects

1. "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt). Coordinator in the Institute of Forestry Dr. Kęstutis Armolaitis. 2019–2023.
2. "Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy" (NutriBiomass4LiFE). Coordinator in the Agrochemical Research Laboratory Dr. Lina Žičkienė. 2018–2022.

EUREKA Programme Project

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

Baltic Research Programme Project

1. "Sustainable use of soil resources in the changing climate" (SUCC). Project coordinators: Dr. Kęstutis Armolaitis (Institute of Forestry), Dr. Jelena Ankuda (Vokė Branch). 2020–2023.

INTERREG Programme Projects

1. "Baltic Phytoremediation" (BAPR). Coordinator in the Vėžaičiai branch Dr. Danutė Karčauskienė. 2019–2022.
2. "Water Management in Baltic Forests Tool Box" (WAMBAF). Coordinator in Lithuania Dr. Olgirda Belova. 2019–2021.

3. "Market driven authentic Non-Timber Forest Products from the Baltic region – focus on wild and semi cultivated species with business potential" (NovelBaltic). Coordinator at Institute of Horticulture Dr. Ramunė Bobinaitė. 2019–2021.

The 7th Framework Programme Project

1. FP7-ERANET-2013-RTD "IT-solutions for user friendly IPM-tools in management of leaf spot diseases in cereals" (SpotIT). Project leader Dr. Antanas Ronis. 2017–2020. Support for international research and technology development projects funded by LR Ministry of Agriculture.

COST Actions

1. CA19116 "Trace metal metabolism in plants" (PLANTMETALS). Coordinators in the Institute of Agriculture Dr. Karolina Barčauskaitė, Dr. Renaldas Žydelis. 2020–2024.
2. CA19125 "EPIgenetic mechanisms of crop adaptation to climate change" (EPI-CATCH). Coordinators in the Institute of Agriculture Dr. Kristina Jaškūnė. 2020–2024.
3. CA18134 "Genomic biodiversity knowledge for resilient ecosystems" (G-BIKE). Coordinators in the Institute of Forestry Dr. Olgirda Belova, Prof. Dr. habil. Alfars Pliūra. 2019–2023.
4. CA18111 "Genome editing in plants – a technology with transformative potential" (PlantEd). Coordinators in the Institute of Horticulture Dr. Danas Baniulis, Institute of Agriculture Dr. Andrius Aleliūnas. 2019–2023.
5. CA18201 "An integrated approach to conservation of threatened plants for the 21st Century" (CONSERVE PLANTS). Coordinators in the Institute of Forestry: Dr. Rita Verbylaitė, Dr. Diana Lukminė. 2019–2023.

Projects of other EU programmes supporting research

1. Programme FACCE SURPLUS project "Biofortified and climate-resilient food and fodder production on marginal soils" (BioFoodOnMars). Project leader Dr. Virmantas Povilaitis. 2020–2023. Support for international research and technology development projects funded by LR Ministry of Agriculture.
2. "Baltic Sea Region network for sustainable wheat production" (BALTICWHEAT). Coordinator at the Institute of Agriculture Dr. Rita Armonienė. 2019–2021.
3. SNS (Nordic Forest Research Co-operation Committee) project "Conservation of resistant ash (*Fraxinus excelsior*) genotypes in Nordic and Baltic regions to maintain the full range of ecosystem-services provided by this keystone species". Coordinators in the Institute of Forestry Dr. Diana Marčiulygienė, Prof. Dr. habil. Alfars Pliūra. 2019–2022.
4. SNS (Nordic Forest Research Co-operation Committee) project "Preventing the spread of new pathogens in Nordic forests to secure sustainable forestry in growing bioeconomy". Coordinator in the Institute of Forestry Dr. Diana Marčiulygienė. 2019–2021.
5. Inter-institutional collaboration project "Ash-Adapt – Evolutionary potential of natural *Fraxinus excelsior* populations challenged by novel pests and pathogens". Coordinator in the Institute of Forestry Dr. Rita Verbylaitė. 2019–2021.
6. European Cooperative Programme for Plant Genetic Resources project "Facilitating use on the European perennial ryegrass collection: improving access to genetic resources and C&E data". Coordinators in the Institute of Agriculture: Dr. Eglė Norkevičienė (2018), Dr. Gražina Statkevičiūtė (2019–2020), Dr. Vilma Kemešytė. 2018–2021.
7. European Food Safety Authority (EFSA) project "European Network of Wildlife" (ENETWILD). Coordinator in the Institute of Forestry Dr. Olgirda Belova. 2017–2023.
8. The Nordic Council of Ministers project "Pre-breeding for future challenges in Nordic fruit and berries". Coordinator in the Institute of Horticulture Dr. Audrius Sasnauskas. 2018–2020.
9. 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. 2017–2020.
10. 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.
11. "Perennial ryegrass breeding research in Nordic and Baltic countries". Coordinator in the Institute of Agriculture Dr. Gintaras Brazauskas. 2014–2020.

Ongoing projects

1. EUFORGEN: "The European Forest Genetic Resources Programme – VI". Coordinator in the Institute of Forestry Dr. Virgilijus Baliuckas. Since 2010.
2. SNS (Nordic Forest Research Co-operation Committee) project "Northern European database of long-term forest experiments". Coordinator in the Institute of Forestry Dr. Marius Aleinikovas. Since 2008.
3. "Winter wheat breeding, variety testing and marketing in Estonia". Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 2000.
4. "European plant genetic resources conservation programme". Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 1998.
5. "Research on winter wheat winterhardiness and diseases". Coordinator in the Institute of Agriculture Assoc. Prof. Dr. Vytautas Ruzgas. Since 1994.

11.3. MAJOR SCIENTIFIC PUBLICATIONS

Articles in the journals indexed in *Clarivate Analytics Web of Science* database (impact factors for 2019)

1. Agathokleous E., Feng Z., Oksanen E., Sicard P., Wang Q., Saitanis C. J., **Araminiene V.**, Blande J. D., Hayes F., Calatayud V., Domingos M., Veresoglo S. D., Peñuelas J., Wardle D.A., De Marco A., Li Z., Harmens H., Yuan X., Vitale M., Paoletti E. 2020. Ozone affects plant, insect, and soil microbial communities: A threat to terrestrial ecosystems and biodiversity. *Science Advances*, 6 (33): eabc1176. **IF – 13,116**
2. **Bendokas V.**, Skemiene K., Trumbeckaite S., **Stanys V.**, Passamonti S., Borutaite V., Liobikas J. 2020. Anthocyanins: from plant pigments to health benefits at mitochondrial level. *Critical Reviews in Food Science and Nutrition*, 60 (19): 3352–3365. **IF – 7,862**
3. **Drapauskaite D.**, Handler R. M., Fox N., Baltrusaitis J. 2020. Transformation of liquid digestate from the solid-separated biogas digestion reactor effluent into a solid NH_4HCO_3 fertilizer: sustainable process engineering and life cycle assessment. *ACS Sustainable Chemistry & Engineering*, published online 24 December, 2020. **IF – 7,632**
4. Paulikienė S., Venslauskas K., Raila A., **Žvirdauskienė R.**, Naujokienė V. 2020. The influence of ozone technology on reduction of carrot loss and environmental IMPACT. *Journal of Cleaner Production*, 244: 118734. **IF – 7,246**
5. **Viršilė A.**, **Brazaitytė A.**, **Vaštakaitė-Kairienė V.**, **Miliauskienė J.**, **Jankauskienė J.**, **Novičkovas A.**, **Laužikė K.**, **Samuolienė G.** 2020. The distinct impact of multi-color LED light on nitrate, amino acid, soluble sugar and organic acid contents in red and green leaf lettuce cultivated in controlled environment. *Food Chemistry*, 310: 125799. **IF – 6,306**
6. **Šiaudinis G.**, Jasinskas A., **Karčauskienė D.**, **Repšienė R.** 2020. The effect of liming and nitrogen application on common osier and black poplar biomass productivity and determination of biofuel quality indicators. *Renewable Energy*, 152: 1035–1040. **IF – 6,274**
7. **Tilvikienė V.**, **Kadžiuoliene Ž.**, **Liaudanskiene I.**, Zvicevicius E., Cerniauskiene Z., Cipliene A., Raila A. J., Baltrusaitis J. 2020. The quality and energy potential of introduced energy crops in Northern part of temperate climate zone. *Renewable Energy*, 151: 887–895. **IF – 6,274**
8. Sicard P., Paoletti E., Agathokleous E., **Araminienė V.**, Proietti C., Coulibaly F., De Marco A. 2020. Ozone weekend effect in cities: deep insights for urban air pollution control. *Environmental Research*, 191: 110–193. **IF – 5,715**
9. **Slepetiene A.**, **Volungevicius J.**, **Jurgutis L.**, **Liaudanskiene I.**, **Amaleviciute-Volunge K.**, **Slepetys J.**, **Ceseviciene J.** 2020. The potential of digestate as a biofertilizer in eroded soils of Lithuania. *Waste Management*, 201: 494–451. **IF – 5,448**
10. Bobinaite R., Kraujalis P., Tamkutė L., **Urbonavičienė D.**, **Viškelis P.**, Venskutonis P. R. 2020. Recovery of bioactive substances from rowanberry pomace by consecutive extraction with supercritical carbon dioxide and pressurized solvents. *Journal of Industrial and Engineering Chemistry*, 85: 152–160. **IF – 5,278**
11. Liubertas T., Kairaitis R., Stasiule L., Capkauskienė S., Stasiulis A., **Viskelis P.**, **Viškelis J.**, **Urbonaviciene D.** 2020. The influence of amaranth (*Amaranthus hypochondriacus*) dietary nitrates on the aerobic capacity of physically active young persons. *Journal of the International Society of Sports Nutrition*, 17: 37. **IF – 5,068**

12. **Bendokas V., Stanys V., Mažeikienė I.,** Trumbeckaitė S., Baniene R., Liobikas J. 2020. Anthocyanins: from the field to the antioxidants in the body. *Antioxidants*, 9 (9): 819. **IF – 5,014**
13. Bobinaitė R., Grootaert C., Camp J. V., Šarkinas A., **Liaudanskas M., Žvikas V., Viškelis P.,** Venskutonis P. R. 2020. Chemical composition, antioxidant, antimicrobial and antiproliferative activities of the extracts isolated from the pomace of rowanberry (*Sorbus aucuparia* L.). *Food Research International*, 136: 109310. **IF – 4,972**
14. **Kochiieru M., Feiziene D., Feiza V., Volungevicius J., Velykis A., Slepeliene A., Deveikyte I., Seibutis V.** 2020. Freezing-thawing impact on aggregate stability as affected by land management, soil genesis and soil chemical and physical quality. *Soil and Tillage Research*, 203: 104705. **IF – 4,601**
15. **Jaškūnė K., Aleliūnas A., Statkevičiūtė G., Kemešytė V.,** Studer B., Yates S. A. 2020. Genome-wide association study to identify candidate loci for biomass formation under water deficit in perennial ryegrass. *Frontiers in Plant Science* (*in press*). **IF – 4,402**
16. **Kviklys D., Samuoliene G.** 2020. Relationships among the rootstock, crop load, and sugar hormone signaling of apple tree, and their effects on biennial bearing. *Frontiers in Plant Science*, 7 August 2020. **IF – 4,402**
17. **Tamošiūnė I., Gelvonauskienė D., Haimi P.,** Mildažienė V., Koga K., Shiratani M., **Baniulis D.** 2020. Cold plasma treatment of sunflower seeds modulates plant-associated microbiome and stimulates root and lateral organ growth. *Frontiers in Plant Science*, 28 August 2020. **IF – 4,402**
18. Luksiene Z., **Rasiukeviciute N.,** Zudyte B., **Uselis N.** 2020. Innovative approach to sunlight activated biofungicides for strawberry crop protection: ZnO nanoparticles. *Journal of Photochemistry and Photobiology B: Biology*, 203: 111656. **IF – 4,383**
19. **Samuolienė G., Viršilė A., Haimi P., Miliauskienė J.** 2020. Photoresponse to different lighting strategies during red leaf lettuce growth. *Journal of Photochemistry and Photobiology B: Biology*, 2020 Jan; 202: 111726. **IF – 4,383**
20. **Barčauskaitė K., Brazienė Z., Avižienytė D.,** Silva M., **Drapanauskaite D.,** Honer K., **Gvildienė K.,** Slinksienė R., Jancaitiene K., **Mazeika R., Staugaitis G.,** Dambrauskas T., Baltakys K., Baltrusaitis J. 2020. Mechanochemically synthesized gypsum and gypsum drywall waste cocrystals with urea for enhanced environmental sustainability fertilizers. *Journal of Environmental Chemical Engineering*, 8 (4): 103965. **IF – 4,300**
21. **Lynikienė J., Marčiulynienė D., Marčiulynas A., Gedminas A., Vaičiukynė M.,** Menkis A. 2020. Managed and unmanaged *Pinus sylvestris* forest stands harbour similar diversity and composition of the phyllosphere and soil fungi. *Microorganisms*, 8 (2): 59. **IF – 4,152**
22. Zokaityte E., Cernauskas D., Klupsaite D., Lele V., Starkute V., Zavistanaviciute P., Ruzauskas M., Gruzauskas R., Juodeikiene G., Rocha J. M., Bliznikas S., **Viskelis P.,** Ruibys R., Bartkiene E. 2020. Bioconversion of milk permeate with selected lactic acid bacteria strains and apple by-products into beverages with antimicrobial properties and enriched with galactooligosaccharides. *Microorganisms*, 8 (8): 1182. **IF – 4,152**
23. Bartkiene E., Lele V., Starkute V., Zavistanaviciute P., Zokaityte E., Varinauskaite I., Pileckaite G., Paskeviciute L., Rutkauskaite G., Kanaporis T., Dmitrijeva L., **Viskelis P.,** Santini A., Ruzauskas M. 2020. Plants and lactic acid bacteria combination for new antimicrobial and antioxidant properties product development in a sustainable manner. *Foods*, 9 (4): 433. **IF – 4,092**
24. **Šernaitė L., Rasiukevičiūtė N., Valiuškaitė A.** 2020. Application of plant extracts to control postharvest gray mold and susceptibility of apple fruits to *B. cinerea* from different plant hosts. *Foods*, 9 (10): 1430. **IF – 4,092**
25. **Urbanavičiūtė I.,** Liaudanskas M., **Bobinas Č.,** Šarkinas A., Rezgienė A., **Viskelis P.** 2020. Japanese quince (*Chaenomeles japonica*) as a potential source of phenols: optimization of the extraction parameters and assessment of antiradical and antimicrobial activities. *Foods*, 9 (8): 1132. **IF – 4,092**
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