ADOP 2021

First International Conference on

Agriculture Digitalization and Organic Production

ADOP - 2021

Conference Programme and Abstracts

June 07-09, 2021
St. Petersburg
Russia

SPC RAS

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

DWIH Moskau
Land der Ideen

Russian Agricultural Bank

Springer

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- St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS, St. Petersburg, Russia)
- Technische Universitat Kaiserslautern (TU Kaiserslautern, Kaiserslautern, Germany)

In cooperation with the German Centre for Research and Innovation (DWIH, Russia)

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- Russian Agricultural Bank

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- Academician Alexander Kostyaev, SPC RAS

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Conference at a glance

Monday, June 07, 2021	
08:00-09:30	**On-line Registration**
09:30-10:00	**Opening Ceremony:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09
10:00-12:00	**Plenary session 1:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09
	Introduction words of DWIH Representative
	Introduction words of Rosselkhozbank Representative
	Keynote lecture 1: *Alexander Petrikov.* Directions and Mechanisms of Innovative Development of the Russian Agro-Industrial Complex
	Keynote lecture 2: *Sergey Yakhnyuk.* State' Place in the Innovative Development of Agriculture in the Non-Black Earth Region of Russia
	Keynote lecture 3: *Olga Abramova*. Specifics of Government Support for Organic Production
	Keynote lecture 4: *Alfiya Kuznetsova.* Innovations in Agriculture of the Countries of the Eurasian Economic Union
12:00-12.10	**On-line Joint Photography of Conference Participants**
12:10-13:00	**Lunch break**
13:00-15:00	**Oral Session 1: Organic Agriculture**
15:00-15:30	**Coffee break**
15:30-17.30	**Oral Session 2: Digital Technologies, Manufacturing and Organic Markets**
18:00-20:00	**Social event**
Tuesday, June 08, 2021	
10:00-12:00	**Plenary session 2:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09
	Keynote lecture 5: *Johannes Egbert and Walter Weymann.* Automation and Digitization Has Found its Way into Milk Production
	Keynote lecture 6: *Jeroen Keijzer.* 30 Years of Improving the Robotic Milking System: Experience, Problems, Solutions
	Keynote lecture 7: *Ivan Perov.* Robotic Dairy Systems – Change in Management Paradigm
	Keynote lecture 8: *Sergey Baranov.* Digitalization of Deep Milk Processing and Dairy Plants Management
12:00-13:00	**Lunch break**
13:00-15:00	**Oral Session 3: Digital Technologies and Automation in Dairy Farming**
15:00-15:30	**Coffee break**
15:30-17.30	**Oral Session 4: Digital Technologies and Agriculture Development**
Wednesday, June 09, 2021	
10:00-11:00	**Plenary session 3:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09
	Keynote lecture 9: *Nikolay Gryaznov.* The Concept of Functionally Distributed Agrobot Control for the Implementation of Autonomous Mode
	Keynote lecture 10: *Tim Dellmann and Karsten Berns.* Towards a Realistic Simulation for Agricultural Robots
11:00-13:00	**Oral Session 5: Robotics in Agriculture**
13:00-14:00	**Lunch break**
14:00-16:00	**Oral Session 6: Digital Technologies in Agriculture**
16:00-16:30	**Closing Ceremony:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09

Conference Programme

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	Introduction words of DWIH Representative
	Introduction words of Rosselkhozbank Representative
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	Keynote lecture 2: *Sergey Yakhnyuk.* Government Role in the Innovative Development of Agriculture in the Non-Black Earth Zone of Russia
	Keynote lecture 3: *Olga Abramova*. Specifics of Government Support for Organic Production
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	Speech of Rosselkhozbank Representative
	Oleg Mironenko. The State and Prospects of Development of Organic Agriculture in Russia
	Sergey Korshunov. Regulatory and Legal Regulation of Organic Agriculture in Russia and the World
	Valentina Kundius. Formation of The Basis for the Development of Organic Agriculture in Russia
	Galina Nikonova. Problems of Organic Production in the Context of the Provisions of Institutional Economic Theory
	Natalya Osipova and Rustam Idrisov. Review of Organizational and Legal Problems in the Field of Agro-Industrial Complex: Public-Private Partnership, Production Digitalization
	Stanislav Siptits, Irina Romanenko, and Natalia Evdokimova. Strategies of Land Use in the Regional Food Systems of Russia under Climate Change
	Olga Abramova, Petr Akmarov, and Olga Knyazeva. The Development of Digitalization of Agricultural Production as the Factor in Improving Living Standard of the Rural Population
	Alexander Spesivtsev, Nelya Domshenko, Vasiliy Spesivtsev, and Yuri Tilichko. Fuzzy-Possible Approach to Agriculture Intellectualization Models
15:00-15:30	Coffee break
15:30-17.30	**Oral Session 2: Digital Technologies, Manufacturing and Organic Markets:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Mikhail Arkhipov**
	Natalia Nikonova and Alexey Nikonov. Analysis of Potential Demand in the Market of Organic Milk and Dairy Products
	Alexey Minin. Digital Transformation in the Agricultural Sector: from Agricultural Producers to Global Trade Players
	Vladislav Minin, Elena Valkama, Dmitrij Maksimov, and Anton Zaharov. The Method for Formation of "Smart" Organic Farming
	Inna Tsyganok. Prospects for the Use of Horse Breeding Resources in Organic Agriculture
	Natalia Lunina and Olga Prozorovskaya. Personnel for the Digitalization

	of Agriculture and Organic Production
	Vyacheslav Kozlov and Nikolay Platonovskiy. Problems and Solutions for the Development of Digitalization in Agriculture
	Svyatoslav Loskutov, Jan Puhalsky, Alexey Mityukov, Vladimir Rybakin, and Natalia Ignatieva. Effects of Ultradisperse Humic Sapropel Suspension on Exudation of Organic Acids in Different Families of Plants
	Abusupyan Dibirov and Khapsat Dibirova. Prospects and Problems of Digitalization of the Agricultural Economy
18:00-20:00	**Social Event**
Tuesday, June 08, 2021	
10:00-12:00	**Plenary session 2:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Vladimir Surovtsev**
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	Keynote lecture 7: *Ivan Perov.* Robotic Dairy System – Change in Management Paradigm
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12:00-13:00	Lunch break
13:00-15:00	**Oral Session 3: Digital technologies and automation in dairy farming:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Elena Payurova**
	Danila Kozlov. Robotic Farm in Russia. Practical Experience
	Lidiya Koroleva. Modern Technologies of Cost Control at a High-Tech Dairy Complex
	Igor Dyu. Digitalization of Organic Dairy Farming in Russia
	Elena Tyurenkova and Olga Vasilyeva. New Needs and Additional Opportunities of Digital Technologies in Decision-Making in Animal Husbandry
	Elena Yildirim, Larisa Ilina, Georgy Laptev, Valentina Filippova, Evgeniy Brazhnik, Natal'ya Novikova, Dar'ya Tiurina, Nikolai Tarlavin, and Ekaterina Ponomareva. Quantitative Analysis of Bacterial Genes Expression as Prognostic Markers of Metabolic Disorders with the Aim of the Dairy Cattle's Health Monitoring
	Vladimir Surovtsev, Yulia Nikulina, and Elena Payurova. Development of Organic Milk Production in Russia: Preferred Regions from the Perspective of Sustainability
15:00-15:30	**Coffee break**
15:30-17.30	**Oral Session 4: Digital technologies and agriculture development:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Kasim Laishev**
	Aleksey Ivanov, Aleksandr Konashenkov, and Zhanna Ivanova. Spatial Heterogeneity of Lithogenic Mosaic of Sod-Podzolic Soils of Chudskaya Lowland and Efficiency of Precision Fertilization System
	Larisa Ilina, Valentina Filippova, Elena Yildirim, Georgy Laptev, and Kasim Laishev. Profiling of Reindeer's Rumen Microbial Communities: Characteristics and Age-Related Analysis
	Kasim Laishev and Alexandr Prokudin. Results of Study of Brucella Circulating in Natural Center of Brucellosis of Reindeer on Taimyr
	Andrew Dubrovin, Nikolai Tarlavin, Evgeni Brazhnik, and Veronika Melikidi. Terminal RFLP and Quantitative PCR Analysis to Determine the Poultry Microbiota and Gene Expression Changes while Using Probiotic Strains
	Marina Politova. Digital Platforms as a Tool for Supporting Breeding Progress in Horse Breeding
	Mikhail Arkhipov, Yuri Tyukalov, Tatyana Danilova, Nikolay Potrakhov, Nikolay Staroverov, and Sergey Letunov. Managed Grain Production as an Element of Rational Nature Management, Ensuring the Production of Economically Valuable

	Grain with a Minimum Level of Hidden Damage
	Natalya Sevostyanova, Elena Shkodina, Olga Trezorova, and Maria Zhukova. The Effect of Laser Stimulation on the Yield and Quality of Oat Grain
	Lyudmila Zhichkina, Vladimir Nosov, Kirill Zhichkin, Olga Musina, Larisa Meleshkina, and Elena Artemova. Ecological Aspects of Seasonal Dynamics of Wheat Thrips and Trophic Relationships in Wheat Agrocenoses
Wednesday, June 09, 2021	
10:00-11:00	**Plenary session 3:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Andrey Ronzhin**
	Keynote lecture 9: *Nikolay Gryaznov.* The Concept of Functionally Distributed Agrobot Control for the Implementation of Autonomous Mode
	Keynote lecture 10: *Tim Dellmann and Karsten Berns.* Towards a Realistic Simulation for Agricultural Robots
11:00-13:00	**Oral Session 5: Robotics in Agriculture:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Roman Meshcheryakov**
	Christian Kötting, Eike Gassen, and Karsten Berns. A Robot Platform for Steep Slope Vineyards
	Maksim Nikolaev, Ivan Nesmiianov, Viktor Zhoga, and Aleksei Ivanov. Justification Parameters and Planning Capture Trajectories for Robotic Loading and Transport
	Rashid Kurbanov and Natalia Zakharova. Determination of Spring Barley Lodging Area with Help of Unmanned Aerial Vehicle
	Alexander Smirnov and Nikolay Teslya. Robot Coalition Coordination in Precision Agriculture by Smart Contracts in Blockchain
	Roman Meshcheryakov, Alexander Salomatin, Dmitry Senchuk, and Aleksandr Shirokov. Scenario of Search, Detection and Control of Invasive Plant Species Using Unmanned Aircraft Systems
	Hacı Mehmet Güzey, Alparslan Güzey, and Mehmet Mutlu Akıncı. Optimal Energy Consuming on Spraying an Agricultural Field by Using Multiple UAVs
	Gleb Tevyashov, Mark Mamchenko, Andrey Migachev, Rinat Galin, Konstantin Kulagin, Petr Trefilov, Nikolay Goloburdin, Rodion Onisimov. Algorithm for Multi-drone Path Planning and Coverage of Agricultural Fields
13:00-14:00	Lunch break
14:00-16:00	**Oral Session 6: Digital Technologies in Agriculture:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Anton Saveliev**
	Mikhail Vinogradov, Igor Kan, and Irina Vatamaniuk. Architecture of Distributed Sensor System for Automated Greenhouse Complex
	Tomáš Tureček, Pavel Vařacha, Alžběta Tutečková, Václav Psota, Peter Janků, Vít Štěpánek, Adam Viktorin, Roman Šenkeřík, Roman Jašek, Bronislav Chramcov, Ioannis Grivas, and Zuzana Komínková Oplatková. Scouting of Whiteflies in Tomato Greenhouse Environment Using Deep Learning
	Eugene Eremchenko and Alena Zakharova. Cattle's Magnetic Alignment Case: Understanding Visual Aberrations of Satellite Imagery
	Alexey Stepanov, Tatiana Aseeva, and Konstantin Dubrovin. Forecasting Soybean Yield in Agricultural Regions of the Russian Far East Using Remote Sensing Data
	Galina Kamyshova, Dmitrii Soloviev, Nadezhda Terekhova, and Dmitrii Kolganov. Development of Approaches to the Intellectualization of Irrigation Control Systems
	Elena Pavlovskaya, Alena Zakharova, and Dmitrii Titarev. Algorithm for Calculating Doses of Mineral Fertilizers Based on Linear Optimization Model
	Marina Astapova, Anton Saveliev, and Yury Markov. Method for Monitoring Growth of Microgreens in Containers Using Computer Vision in Infrared and Visible Ranges
16:00-16:30	**Closing Ceremony:** https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09 **Chair: Andrey Ronzhin**

Abstracts

Plenary session 1

Keynote lecture 1

Alexander Petrikov, Head of All-Russian Institute of agrarian problems and Informatics named after A. A. Nikonov – branch of FSBSI Federal Scientific Center for Agrarian Economy and Social Development of Rural Areas VNIIESKH, Moscow, Russia.

Lecture Title: Directions and Mechanisms of Innovative Development of the Russian Agro-Industrial Complex.

Abstract: The assessment of the level and main problems of innovative development of the agri-food sector in the context of ensuring its sustainable development is carried out. The directions and mechanisms of improving the scientific and technological policy in the agro-industrial complex in order to reduce its dependence on technology imports and the uneven innovative development of large and small businesses are considered. The proposals to develop the public and private sectors in agricultural science and a system for implementation of research results into production based on private-public partnership.

Keynote lecture 2

Sergey Yakhnyuk, Deputy of the State Duma of the Federal Assembly of the Russian Federation, member of the State Duma Committee on Agrarian Issues, electoral district of Kingisepp No. 112, Leningrad region, Russia.

Lecture Title: State' Place in the Innovative Development of Agriculture in the Non-Black Earth Region of Russia.

Abstract: Innovation and the pace of development of agricultural sectors in the Non-Black Earth Region. Leningrad region as a region of advanced innovative development of the agricultural sector. Effectiveness of federal and regional support for investment and innovation in the agricultural sector of the region.

Keynote lecture 3

Olga Abramova, Deputy Prime Minister of the Udmurt Republic - Minister of Agriculture and Food of the Udmurt Republic, Russia.

Lecture Title: Specifics of government support for organic production.

Abstract: Trends in the development of organic agriculture in the Udmurt Republic are presented. The experience and effectiveness of promotion on the domestic and world markets of organic products produced in the region are analyzed. The possibilities of using digital technologies in the production of organic products are considered. Particular attention is paid to the analysis of the effectiveness of the system of state regulation and support for the development of organic agriculture in the Udmurt Republic.

Keynote lecture 4

Alfiya Kuznetsova, Deputy Director for Research, Institute for Strategic Research of the Republic of Bashkortostan, Ufa, Russia.
Lecture Title: Innovations in agriculture of the countries of the Eurasian Economic Union.
Abstract: The report analyzes the dynamics of the use of organic fertilizers in the Russian Federation. Revealed a significant differentiation in the use of organic fertilizers when growing between crops. The positive influence of an increase in the volume of applied organic fertilizers on the possibilities of developing the production of organic products has been determined. Particular attention is paid to the problems of heterogeneity of investments and innovative development of the production of agricultural products, including organic ones, in the countries of the Eurasian Economic Union (EAEU). A comparative analysis of the competitive advantages of innovative development of organic agriculture in the countries of the Eurasian Economic Union is presented.

Plenary session 2

Keynote lecture 5

Johannes Egbert, Principal Dairy Consultant, GEA Farm Technologies RUS, Moscow, Russia,
Walter Weymann, Feeding expert; Specialist for herd management in milk production at GEA FT, Germany.
Lecture Title: Automation and Digitization Has Found its Way into Milk Production.
Abstract: Large herds require standardized work processes for humans and animals to make work easier. Management processes are supported or enabled by modern applications (sensors).This leads to proactive management, which, through the early detection of problems, leads to a reduction in the use of medication, less time required for treatments and less milk loss. Extensive data on the whole milking process provide information about the work of the staff to standardize the processes as a basis for food safety combined with socio-economic relief.

Keynote lecture 6

Jeroen Keijzer, General director of Lely Rus. Moscow region, Russia.
Lecture Title: 30 years of improving the robotic milking system: experience, problems, solutions.
Abstract: Successful implementation of dairy automation in Russia and on global scale: real milk yield increases, staff reduction, more healthy cows on farms of different sizes – large and small ones. Practical farmers experience, features of the interaction between animals and robots, maintenance, and farm management issues.

Keynote lecture 7

Ivan Perov, DeLaval Herd Management Specialist, Honour Ph.D Student of Faculty of Veterinary Science, Adelaide University, Australia.

Lecture Title: Robotic Dairy Systems – Change in Management Paradigm.

Abstract: The introduction of robotic milking systems requires a qualitative change of the existing skills and experience in managing a dairy farm. Maximum realization of the new opportunities of building all farm routines around the needs of the cow, her comfort and behaviors in order to minimize stress from interaction with humans and equipment on the farm. Improving the quality of decisions based on daily data of each individual cow creates conditions for the implementation of a pro-active model of farm management, fundamentally change the work with the herd and, as a result, increase the productive longevity of the herd.

Keynote lecture 8

Sergey Baranov, Head of Russian office Kieselmann Fluid Process Group, Moscow, Russia.

Lecture Title: Digitalization of deep milk processing and dairy plants management.

Abstract: New challenges for dairy industry. Dairy products demand structure changes. New products for new customers. Innovative solutions for deep milk processing in "future dairy products" production. The role of digital technologies in quality management improvement, international standards compliance and sustainability for dairy products quality and environmental safety of production. Import substitution and production localization for Kieselmann Group.

Plenary session 3

Keynote lecture 9

Nikolay Gryaznov, St. Petersburg State Marine Technical University, St. Petersburg, Russia.

Lecture Title: The concept of functionally distributed agrobot control for the implementation of autonomous mode.

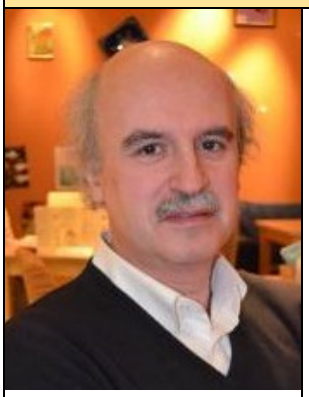
Abstract: The supervisory mode of agrobot control involves minimizing operator intervention, which requires expanding the range of permissible conditions for autonomous functioning. The division of functions between subsystems and modules makes it possible to bring the cybernetic architecture of the robot as close as possible to the model of biological objects behavior. The adoption of technical analogs of instincts, reflexes and emotions from the point of view of ensuring (technological, environmental, physical) safety can provide a transition to a new level of reliability.

Keynote lecture 10

Karsten Berns and Tim Dellmann, Professors of Technische Universitaet Kaiserslautern, Kaiserslautern, Germany.

Lecture Title: Towards a Realistic Simulation for Agricultural Robots.

Abstract: These days, agricultural tasks are getting more and more complex due to the increasing world population. Much research is going on in the area of mobile agricultural robots that can take over applications to accomplish the demand for higher productivity and the lack of manpower. The downside of developing autonomous systems in this very area is the fact that testing of these is strictly limited depending on the season and the application itself. Such testing and improving the robustness can be achieved by working in a simulated environment first which is as well a complex task as a model of the real world is simply impossible to create. This paper gives an overview of typical agricultural tasks and effects that need to be simulated and how to approach a suitable realism of simulation environments. Further, ways are described which steps are to be taken to optimize results.

Oral Session 1: Organic Agriculture	
	**Oleg Mironenko**, Executive Director of National Organic Union of Russia, Moscow, Russia. **Lecture Title:** The State and Prospects of Development of Organic Agriculture in Russia. **Abstract:** The report will analyze market development environment of the organic market in the framework of the implementation of Federal Law 280 on organic products in Russian Federation. Also, there will be considered Russian export possibilities of organic products to key markets and import possibilities of foreign organic products into Russian Federation. The report presents a comparative analysis of the legislation of the Russian Federation and the EAEU countries from the point of view of the possibility of organizing a single organic market of the EAEU countries is presented.
	**Sergey Korshunov**, Chairman of the Board of the Union of Organic Agriculture, Member of the Public Council of the Ministry of Agriculture of the Russian Federation, Moscow, Russia. **Lecture Title:** Regulatory and Legal Regulation of Organic Agriculture in Russia and the World. **Abstract:** Legal and regulatory frameworks of organic agriculture - differences in different countries. The main generally accepted world standards for organic products are those of the EU and the USA (the two largest markets for organic products), and Japan. The legal framework of Russia in the field of organic agriculture – Federal Law No. 280-FZ, four national standards. Issues of mutual recognition of standards between countries, algorithms for selecting standards for certification, export. The system of certification of organic products in Russia.
	**Valentina Kundius**, The Department of the Altai State University, Barnaul, Russia. **Lecture Title:** Formation of the Basis for the Development of Organic Agricultural in Russia. **Abstract:** The development of organic agriculture is a modern and strategic trend in the agricultural sector and agribusiness not only in foreign countries, but also in the Russian economy. The report presents the results of scientific research on the resource potential of organic agriculture in the regions of southern Siberia, the formation of the basis for the development of production and the market of organic products. The results of the analysis and vectors of development of the local market, technologies of production of organic products, a questionnaire survey of consumers and producers about the prospects of organic agricultural production, its regulatory support, the components of the concept of development of organic agriculture based on biointensive technologies.

	Galina Nikonova, Institute of Agrarian Economics and Rural Development of the St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), St. Petersburg, Russia. Lecture Title: Problems of Organic Production in the Context of the Provisions of Institutional Economic Theory. Abstract: The production of organic products is not only a problem of maintaining an optimal balance between economic activity and conservation of nature. It is necessary to ensure both compliance with technological requirements and the required level of competitiveness of products in the market. Within the framework of the institutional paradigm, the current risks of commodity producers and their opportunities to overcome barriers to entering the food market are considered. The types of production and transaction costs that determine the degree of sustainability of production, possible qualitative changes and the choice of a specific strategy for the activities of farms are determined.
	Natalya Osipova, Rustam Idrisov, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), St. Petersburg, Russia. Lecture Title: Review of Organizational and Legal Problems in the Field of Agro-Industrial Complex: Public-Private Partnership, Production Digitalization. Abstract: In Russian legislation, the unity of the economic space, the creation of sustainable socio-economic growth of the country's population, social, political and economic solidarity are included in the fundamental and significant rights. Therefore, positive changes in the economy and improving the well-being of the population are unacceptable without modern development of agriculture. The article deals with the main legal, social and economic problems of the agro-industrial complex of the Russian Federation. A diagram of three groups of urgent problems of the agro-industrial complex of Russia is presented. The article analyzes the legal regulation of the agro-industrial complex, the activities of public authorities. The institution of public-private partnership, options for the use of digital technologies in agriculture, the impact of agro-acropolis on the agro-industrial complex are investigated. The question of the legal nature of agrarian law in legal science is considered. The experience of foreign countries in solving organizational and legal problems of the development of the agro-industrial complex is also discussed. Prospects for eliminating problems are proposed, taking into account the results in the field of agricultural development.

Stanislav Siptits, **Irina Romanenko**, **Natalia Evdokimova**, All-Russian Institute of Agrarian Problems and Informatics n/a A.A. Nikonov, branch of Federal Scientific Centre for Agrarian Economy and Social Development of Rural Territories - All-Russian Research Institute for Economics of Agriculture, Moscow, Russia.

Lecture Title: Strategies of Land Use in the Regional Food Systems of Russia under Climate Change.

Abstract: The article describes a method for determining the targeted directions of the land use strategy in the regional agri-food systems of Russia under climate change, algorithm, and mathematical model to substantiate an effective land use strategy. It is shown in the article that agro-ecological potential replacement by arable land can be an effective strategy for some regions. The alternatives are productivity growth and a combination of extensive and intensive strategies. The process of agri-food system adaptation to climate changes can be presented as a sequence of steps: collection and processing of large amount of data characterizing regional agri-food systems; yields forecast; construction of the socio-economic scenario depending on the regional agri-food system targeted direction of development in the case of agro-ecological potential decrease under climate change; selection of strategy on the basis of the economic and mathematical model decisions analysis. The development of digital platforms can help the process of adaptation of agri-food systems to climate change.

Olga Abramova, Ministry of Agriculture and Food of the Udmurt Republic, Izhevsk, Russia.

Petr Akmarov, Olga Knyazeva, Izhevsk state agricultural Academy, Izhevsk, Russia.

Lecture Title: The Development of Digitalization of Agricultural Production as the Factor in Improving Living Standard of the Rural Population.

Abstract: The economic development of the region has influenced the standard of living of the population. The regions of Russia with a high level of socio-economic development and lagging regions are highlighted. The trends and causes of uneven development of individual territories of the country are revealed. The authors propose a new approach to the assessment of regional development, based on taking into account the industry specifics of the development of territories. Using the methods of cluster analysis, agricultural regions are identified and the features of the formation of their potential are shown. The influence of investments as the main factor of agricultural production development is proved on the basis of regression models. The role of modern technologies and digitalization in the agro-industrial complex is highlighted. The article provides an assessment of the reserves for the growth of agricultural production and the possibility of improving the standard of living of the rural population. The authors conclude that the effectiveness of regional management should be determined depending on regional characteristics based on the assessment of the level of use of the existing potential of territorial development.

Alexander Spesivtsev, **Vasiliy Spesivtsev**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), St. Petersburg, Russia,
Nelya Domshenko, Federal State Budgetary Educational Institution of Higher Education “Saint-Petersburg State University”, St. Petersburg, Russia,
Yuri Tilichko, Mozhaisky Military Space Academy, St. Petersburg, Russia.

Lecture Title: Fuzzy-Possible Approach to Agriculture Intellectualization Models.

Abstract: In agriculture, where practically all the main decisions on the management of technologies and production are made by humans, there is a need to develop fundamentally new methodological approaches and mathematical methods for assessing the state of socio-ecological bio-systems. The proposed fuzzy-probability approach is one of the most convenient ways to extract and formalize the intellectual knowledge of an expert in analytical expression. At the same time, the fuzzy-probability model, by definition, has the property of an intellectual mathematical model, since it directly represents the expertise of highly qualified specialists in their field. In addition, the analytical expression gives the possibility of its computer use and the ability to extract additional information about the process or phenomenon being studied. The study is illustrated with two examples from various fields of agriculture as proof of the versatility of the proposed method for building intelligent mathematical models in the situation of uncertainty. So, when evaluating places for the construction of technical stations for servicing agricultural production or determining the degree of anthrax epizootic, factor spaces in which problems are solved, together with quantitative ones, also contain non-quantitative ("virtual") variables. An invaluable property of the fuzzy-probability approach, along with the use of knowledge in the absence of data, is significant - by orders of magnitude – time and cost saving for building an intelligent mathematical model.

Oral Session 2: Digital Technologies, Manufacturing and Organic Markets	
 	**Natalia Nikonova**, **Alexey Nikonov**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Institute of Agricultural Economics and Rural Development, Pushkin, St. Petersburg, Russia. **Lecture Title:** Analysis of Potential Demand in the Market of Organic Milk and Dairy Products. **Abstract:** The relevance of the study is predetermined by the global trend in the spread of organic food production and the changing preferences of the population in favor of a healthy diet. The purpose of the study is to determine the potential financial capabilities of households in the Russian Federation for the formation of a sustainable demand for organic products and to study this issue in more detail in relation to the market of milk and dairy products in St. Petersburg. The study is based on the economic and statistical analysis of data from Rosstat and Petrostat, as well as the results of processing the materials of a questionnaire survey of residents of St. Petersburg in January-February 2021. In accordance with the objectives of the study, the trends of changes in monetary income and expenses for the purchase of food, taking into account the number of children in families, were identified in the Russian Federation as a whole. At the same time, there is a low level of availability of traditional dairy and other food products for families with 2 or more children under 16, which indicates a low potential demand for organic products. It was determined that the offer of organic food products in the food market of the country and St. Petersburg does not differ in diversity, as confirmed by the survey data.
	**Alexey Minin**, Associated partner MHP – A Porsche company Digital products and services accelerator, Germany. **Lecture Title:** Digital Transformation in the Agricultural Sector: from Agricultural Producers to Global Trade Players. **Abstract:** Digital transformation enables companies not only to save costs and improve process efficiency, but also to better plan for the next seasons, prepare for market challenges and trade more efficiently. Approaches to creating a unified digital system for production data generation and analysis and planning are examined: from farms and agroholdings to the Ministry of Agriculture and the Government. The directions of digitalization aimed at optimizing the foreign trade activities of agricultural producers and traders, providing a significant increase in income of economic entities and the state from the global trade in agricultural commodities, are analyzed in the most detail.

Vladislav Minin, Representative of the Russian Federation in the HELCOM group of sustainable development of agriculture,
Dmitrij Maksimov, deputy director for research,
Anton Zaharov, IEEP – BRANCH OF FSAC VIM, St. Petersburg, Russia.
Elena Valkama, Finish Institute of Natural Sciences, Helsinki, Finland.
Lecture Title: The Method for Formation of "Smart" Organic Farming.
Abstract: The main task of competitive organic production is to ensure high productivity in optimal terms with high accuracy and minimum resource consumption. Its solution is possible on the basis of digitalized technologies, including the development of two interrelated directions: 1) Creation of an information management system of agriculture (IMS) that uses the results of environmental monitoring and controls the implementation of technological operations based on electronic production descriptions in accordance with the prevailing conditions; 2) Formation and filling of a knowledge base on the cultivation of agricultural crops, which will provide the necessary data for the IMS.

Inna Tsyganok, The Department of Horse Breeding of the Russian State Agrarian University – Moscow Agricultural Academy named after K.A. Timiryazev, Moscow, Russia.
Lecture Title: Prospects for the Use of Horse Breeding Resources in Organic Agriculture.
Abstract: The potential of using the resources of horse breeding in solving the problem of organic nutriment. Horse meat production in conditions of diet food and the providing environmental protection with ensuring life cycles of nature. Innovative methods of using horse traction to increase labor productivity in the farms. Improving the efficiency of agricultural production using the live draft power in permaculture. The importance of digitalization in productive horse and working horse breeding for successful management in agrarian sector and ensuring food security of the country.

 	**Natalia Lunina**, General Director AGRO-JOB Ltd, **Olga Prozorovskaya**, Head of Recruitment, AGRO-JOB Ltd, Voroneg, Russia. **Lecture Title:** Personnel for the Digitalization of Agriculture and Organic Production. **Abstract:** Digitalization in agriculture also imposes additional requirements on the personnel of the agroindustrial complex. The impact of new standards in relation to the "human factor" is considered. Additional requirements for professional competencies and psychological features of the personnel are analyzed. Particular attention is paid to the analysis of practices and problems of mastering modern Internet technologies of recruitment and professional development, digitalization of personnel work, which can provide effective personnel management in high-tech farms. The peculiarities of personnel work in organic farms, as a nascent specialized direction of the agroindustrial complex, were determined.
 	**Vyacheslav Kozlov**, **Nikolay Platonovskiy**, the Russian state agrarian University – Moscow Timiryazev agricultural Academy, Moscow, Russia. **Lecture Title**: Problems and Solutions for the Development of Digitalization in Agriculture. **Abstract:** The report reveals the institutional environment for creating conditions for innovative development of the country's agriculture, including digital technologies. Relying on the theory of the development of socio-economic systems and the use of PEST analysis allowed us to reveal the key problems of personnel support for innovative development and digitalization in agriculture. The necessity is justified and proposals for the development of the institutional environment are given. In particular, it is revealed that to solve these problems, it is necessary to develop agricultural universities in the regions to the level of 3.0 (science – education – extension activity) with their transfer to the subjects of the federation, the creation of regional grant funds to support science and innovation.
	**Svyatoslav Loskutov**, **Jan Puhalsky**, **Alexey Mityukov**, **Vladimir Rybakin, Natalia Ignatieva,** St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Institute of Limnology of the Russian Academy of Sciences, St. Petersburg, Russia. **Lecture Title:** Effects of Ultradisperse Humic Sapropel Suspension on Exudation of Organic Acids in Different Families of Plants. **Abstract:** Currently, in agricultural practice, approaches to growing crops based on the techniques of biologizing agriculture are widely used. The rejection to use synthetic pesticides and the limited use of mineral fertilizers will reduce the negative load on agrocenoses while

	maintaining crop volumes. Among these alternatives, an environmentally friendly source of increasing commodity production is sapropel. The use of sapropel in agriculture has a long history of possessing good convenient fertilizing properties and content of a large amount of organic substances. The paper presents an experimental assessment of the possibility of using 1.0% ultradisperse humic sapropel suspensions (UDHSS), added to the main working mineral medium, on the indicators of seed germination of plants from different families. The exposure was 7 days. Before planting in vessels, the seeds of all plants were superficially treated with a 5.0% sodium hypochlorite solution for 5 min, and then thoroughly washed with distilled water. The specifics of the significant formation of lateral roots in radish and maize during germination on a medium with UDHSS at an early stage of ontogenesis are noted. An increase in exudation of citric acid in seedlings of all plants was shown when they were treated with HS. In total, the greatest effect from the use of UDHSS was observed in Solanum lycopersicum plants, where the total share of root excretions of organic acids increased 3 times.
 	**Abusupyan Dibirov**, **Khapsat Dibirova**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Institute of Agricultural Economics and Rural Development, Pushkin, St. Petersburg, Russia. **Lecture Title:** Prospects and Problems of Digitalization of the Agricultural Economy. **Abstract:** Currently large agricultural holdings are the drivers of digitalization, thanks to which it is possible to partially neutralize the negative influence of the human factor and the opportunistic behavior of employees. The low financial potential of most medium and small commodity producers limits investment opportunities for purchasing software, modern technology with the ability to connect to telemetry platforms and internet of things. For this group of enterprises, as the first stage of digitalization, the digital model of an agricultural organization, developed by us on the basis of spreadsheets in the Microsoft Excel program using macros, is successfully used. The electronic model of the agricultural organization "as is" allows for getting the real state of affairs in the transformation of resources into the final product, to identify the contribution of each unit to the creation of a commercial product. Further, in the "as is" model, gradually improving the main parameters on the basis of the proposal of system analysts, a new vision and the introduction of rational technologies are formed, a target electronic model of an agricultural organization is created - "as it should be". If the value of variable factors in the source data changes, then the entire cost chain is automatically recalculated in the technologic plan. The program allows for drawing up budgets for all divisions of an agricultural enterprise, to analyze the sensitivity of the model depending on the change in each factor and its constituent elements, both as a whole and separately.

Oral Session 3: Digital technologies and automation in dairy farming	
	**Danila Kozlov**, Deputy Director ZAO "Sovhoz imeni Lenina", Moscow region, Russia. **Lecture title:** Robotic Farm in Russia. Practical Experience. **Abstract:** Robotic milking technology has been widely used around the world since 1994. More than two million cows are milked every day without human intervention. CJSC "Lenin Sovkhoz" is one of the first enterprises to launch robots in Russia. We have been working for five years without milkmaids on a farm in the Moscow region. The average productivity of the herd is about 11 thousand liters of milk per forage cow per year. What was the reason for reconstructing the complex and changing the type of milking? What are the pros and cons of robotization? Why are robots so slow to conquer Russia and is it possible to work with them on a regular farm? Practical experience with the introduction of robots and the results of the transition to a new technology.
	**Lydia Koroleva**, Deputy General Director for Animal Husbandry, LTD. "AGROFIRMA TRIO", Lipezk region, Russia. **Lecture title:** Modern Technologies of Cost Control at a High-Tech Dairy Complex. **Abstract:** The weakening of the national currency, rise in grain prices and concentrated feed aggravated the problem of controlling the costs of capital-intensive production on the high-tech dairy complexes. The methods of planning and control of the main item of costs - feed, including the use of digital technologies, are analyzed. At the stage of planning the following are considered in detail: selection of a cattle feeder by volume, calculation of cycle and tact, development of schedule and sequence of feed distribution, as well as methods of control of feed consumption in the production process: control of accuracy of loading of ration ingredients and remains of feed on the feed table, selection and control of key daily and weekly "control points".
	**Igor Dyu,** Project Leader of MOK LLC (Milk Organic Company), Leningrad region, Russia. **Lecture title:** Digitalization of Organic Dairy Farming in Russia. **Abstract:** A new trend in cattle breeding is being formed in Russia - organic milk production. Approaches and first experience of building a new industry and minimizing the human factor are considered. Particular attention is paid to the following issues: How can the developments of ROSCOSMOSA help to manage a modern farm? How can the know-how of domestic science and business help ensure management at "critical points" of the farm and dairy plant? Digitalization of the entire production chain, from the field to the store, makes it possible to implement an industrial approach in organic dairy farming, which is the goal of the ambitious Project ŧDOC.

Elena Tyurenkova, Director, **Olga Vasilyeva**, Deputy Director for Development, LLC " RC "PLINOR", St. Petersburg, Russia.

Lecture Title: New Needs and Additional Opportunities of Digital Technologies in Decision-making in Animal Husbandry.

Abstract: In our work we look into existing modern methods and technologies of accounting, reporting, analysis and forecasts in livestock sector. We focus on principles and possibilities of forming a vertical management system in animal husbandry from collecting raw data on individual animals to analytical information on the level of farms, regions and breeds. Our work deals with possibilities of expanding information on milk quality and quantity, animal weight, movements, calvings, inseminations and intergrating it from different systems, reducing human factor. We present analysis of the effect of information reliability factor on quality of solutions both: in farm management and on the level of region management, breeds and associations in assessments of animals breeding value.

Georgy Laptev, Elena Yildirim, Larisa Ilina, Valentina Filippova, Evgeniy Brazhnik, Natal'ya Novikova, Dar'ya Tiurina, Nikolai Tarlavin, Ekaterina Ponomareva, BIOTROF Ltd., Pushkin, St. Petersburg, Russia.

Lecture Title: Quantitative Analysis of Bacterial Genes Expression as Prognostic Markers of Metabolic Disorders with the Aim of the Dairy Cattle's Health Monitoring.

Abstract: The aim of the study was to study the expression of bacterial genes associated with the main metabolic enzymes in the rumen in relation to different physiological periods in dairy cows. The experiment was carried out in JSC "Agrofirm Dmitrova Gora" of the Tver region. The study of gene expression of the rumen microbiome was carried out on animals from five groups: group I - dry, II - fresh-calf, III - during the period of milk, IV - during the stabilization of lactation, V - during the decline of lactation. The results showed that the level of expression of the studied genes changed depending on the different physiological periods in dairy cows. For example, there was an increase in the expression level of genes PFK, PEPK and cla-r of the rumen microbiome of cows in the new calving period (group II) up to 2.6 times and the period of stabilization of lactation (group III) up to 3.3 times compared with dry animals ($p \leq 0.05$). On the other hand, a reverse trend was observed in cows from groups III and IV (compared with animals of group I) (at $p \leq 0.05$) in the level of expression of the scpA gene associated with the synthesis of methylmalonyl CoA mutase. Such changes in the level of gene expression may be associated with the influence of a combination of stress factors on the animal's body, such as calving, the onset of lactation, negative energy balance, adaptation to the modification of changing ratios of nutrient pools.



Surovtsev Vladimir, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Institute of Agricultural Economics and Rural Development, Pushkin, St. Petersburg, Russia,
Nikulina Yulia, **Payurova Elena**, National Research University Higher School of Economics, St. Petersburg, Russia.
Lecture Title: Development of Organic Milk Production in Russia: Preferred Regions from the Perspective of Sustainability.
Abstract: The article proposes methods of assessment and identifies regions of Russia that have highest potential for sustainable development for organic milk production. Regions of the European part of Russia are divided into groups based on their production potential and the dynamics of development of selected sub-sectors of agriculture. These regions were grouped and assessed for their comparative advantages of milk production relative to crop production. Comparative advantage index has been applied. Specific requirements for organic milk production were considered in the developed system of indicators. Regions were ranked in accordance to these indicators and assessed for the prospects of the development of organic production. The calculated index of comparative advantage as well as the rating results showed that the regions of the Northern Black Earth region have a comparative advantage of organic milk production and objective prerequisites for a sustainable increase in its production. Potential investors may consider this as an argument in a decision for the location of organic milk production. Those comparative advantages will support regional authorities decision in prioritizing support for agricultural sub-sector and will increase the efficiency of budget funds.

Oral Session 4: Digital technologies and agriculture development

Aleksey Ivanov, **Zhanna Ivanova**, Agrophysical Research Institute, St. Petersburg, Russia,
Aleksandr Konashenkov, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance, Pushkin, St. Petersburg, Russia.
Lecture Title: Spatial Heterogeneity of Lithogenic Mosaic of Sod-podzolic Soils of Chudskaya Lowland and Efficiency of Precision Fertilization System.
Abstract: Spatio-temporal heterogeneity of agroecological conditions is a fundamental factor of the crop production process in agricultural landscapes. A comprehensive study was launched to search for the most effective precision fertilization systems for the landscape–ecological conditions of the Chudskaya Lowland's undulating plain, which has a soil cover of a lithogenic mosaic of sod-podzolic soils. Under production conditions in 2007, a precision soil survey of

	the agricultural landscape was carried out, and a landscape field experiment was laid in a vegetable crop rotation on sod-podzolic soils from sandy to medium loamy granulometric composition. The precision fertilization system based on preliminary differentiated soil cultivation provided an increase in the productivity of the vegetable crop rotation by 132% relative to the control and by 37% relative to the traditional mineral fertilization system, with a profitability of 63%. The system improved the quality of the main products of the vegetable crop rotation, increasing the content of crude protein by 19%, potassium by 32%, and vitamins by 62% and decreasing the spatial variability of the most sensitive properties 1.5–2.1 times. Nitrates accumulated in potato tubers 14% less than in the variant of the uniform fertilization system, and the accumulation of starch and vitamin C increased by 6% and 24%, respectively. Against the background of unfavourable physicochemical and agrophysical states of most agricultural soils, the precision mineral fertilization system did not provide a reliable superiority of crop productivity over the traditional uniform fertilization system.
 	Larisa Ilina, Valentina Filippova, Elena Yildirim, Georgy Laptev, BIOTROF+ Ltd., Pushkin, St. Petersburg, Russia, Kasim Laishev, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance, Pushkin, St. Petersburg, Russia. Lecture Title: Profiling of Reindeer's Rumen Microbial Communities: Characteristics and Age-Related Analysis Abstract: Reindeer are animals adapted to live in a poor diet and low temperatures in the Arctic regions. The aim of this research was to study the biodiversity of ruminal microorganisms of Rangifer tarandus inhabiting the Murmansk region, Russian Federation. Samples of the ruminal contents from 11 individuals, incl. young (YA, n = 3), mature (MA, n = 4) and old (OA, n = 4) animals were used for the research. The ruminal bacterial community of reindeer was studied using the T-RFLP (Terminal restriction fragment length polymorphism) method. A significant number of DNA sequences in the rumen of Rangifer tarandus were classified as uncultured bacteria (up to 69.88%), the largest share of which was found in groups YA and OA. The representation of several taxa had age differences: in individuals of the MA group, the share of Lachnospiraceae, Eubacteriaceae, Thermoanaerobacteriaceae, Ruminococcaceae increased and in the AO group the share of Clostridiaceae increased. It was important to note in the rumen of reindeer the presence of various diseases pathogens and their association with a certain age of animals: Campylobacteraceae was noted in the YA group; Enterobacteriaceae, Pseudomonadaceae,

	and Pasteurellaceae in the MA group; Staphylococcus sp., Tenericutes, Fusobacteria, Actinobacteria in the OA group. In general, according to the alpha-diversity index values of ruminal microorganisms (taxonomic units, Shannon's index), a tendency towards a decrease in biodiversity and an increase in its homogeneity was revealed increasing age in reindeer.
 	Kasim Laishev, St. Petersburg Federal Research Center of Russian Academy Sciences, Pushkin, St. Petersburg, Russia, Alexandr Prokudin, Krasnoyarsk Scientific Centre of the Siberian Branch of the Russian Academy of Sciences, Krasnoyarsk, Russia. Lecture Title: Results of Study of Brucella Circulating in Natural Center of Brucellosis of Reindeer on Taimyr. Abstract: The properties of brucella isolated from domestic and wild reindeer, as well as other animal species in the natural focus of brucellosis in Taimyr, were studied. It was established that the brucella cultures isolated from domestic and wild reindeer, as well as carnivorous animals, were identical in morphological characteristics and tinctorial properties, and grew well on dense nutrient media. The vast majority of cultures 246 (91.5%) had no signs of dissociation, only 23 (8.5%) - were in varying degrees of dissociation. In the body of laboratory animals, reindeer and carnivores, the administration of brucellosis antigen causes the formation of specific anti-brucellosis antibodies, which react with both homologous and standard (heterologous) antigens. In foci of deer brucellosis in Taimyr, cultures with high, medium, and low virulence were identified. Moreover, the majority (40 out of 45) of brucella cultures isolated from the main hosts (domestic and wild deer) are highly virulent. All deer species brucella cultures, regardless of the source of isolation, represent a homogeneous group and have high urease activity. Brucella cultures isolated from domestic, wild reindeer and carnivores are significantly different from reference strains. Studying the properties of the causative agent of brucellosis isolated in the natural focus of infection from domestic and wild animals, it can be stated that the obtained strains are identical to each other and can be distinguished into a separate group.

Andrew Dubrovin, **Nikolai Tarlavin**, **Evgeni Brazhnik**, **Veronika Melikidi**, BIOTROF Ltd., Pushkin, St. Petersburg, Russia.

Lecture Title: Terminal RFLP and Quantitative PCR Analysis to Determine the Poultry Microbiota and Gene Expression Changes While Using Probiotic Strains.

Abstract: The use of biological products that combine the advantages of different strains of microorganisms and beneficial bacterial metabolites to achieve a synergistic effect seems promising. The effect of such drugs may match the antibiotics, but without a negative effect on immunity and intestinal microbiota, accumulation in final products. Such advanced technologies can contribute to an increase in the productivity and duration of the economic use of poultry. In this study we observed the effect of Bacillus megaterium and Enterococcus faecium bacterial strains combined introduction on the intestinal microbiota and genes of immunity and nutrients transport expression in laying hens. An increase in the content of the Bacillaceae family by an average of 36% and of the Veillionellaceae family by an average of 60% while applying bacterial strains been noted. The reduction of pathogenic bacterial species including Enterobacteriaceae (1.25 times), Peptococcaceae (4 times), Mycoplasmataceae (5.5 times), Pasteurellaceae (1.1 times) also been marked. The addition of bacterial strains changed the differential expression of a range of genes. The expression of IL6 genes increased 2.2 times, IL8 5.3 times, AvBD9 increased 10.1 times, AvBD10 5.8 times, IRF7 7.3 times in experimental group compared with the control group. The expression of PTGS2 decreased in the experimental group to 0.68 compared to the control group. The expression of SLC5A1 increased by 2.8 times, Ca2 gene increased 1.9 times, CaBP-D28k also increased 1.6 times in the experimental group.

Marina Politova, Local Representative of Hanoverian Society (Germany), Moscow, Russian.

Lecture Title: Digital Platforms as a Tool for Supporting Breeding Progress in Horse Breeding.

Abstract: The predominance of small-scale enterprises in horse breeding in European countries led to the establishing of breeders' associations with important tasks like marketing and advising breeders. In a pandemic world traditional forms of breeding and marketing activities were not available, which stimulated an expansion of digital solutions in horse breeding too. Since 1992 Russian horse breeding has gone through the stages of downsizing. This requires providing breeders with modern breeding tools on digital base to simplify document management and ensure traceability and reliability of breeding information, taking into account the experience of European horse breeding organizations.

Mikhail Arkhipov, **Yuri Tyukalov**, **Tatyana Danilova**, **Sergey Letunov**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Pushkin, St. Petersburg, Russia,
Nikolay Potrakhov, Nikolay Staroverov, St. Petersburg Electrotechnical University "LETI", St. Petersburg, Russia.
Lecture Title: Managed Grain Production as an Element of Rational Nature Management, Ensuring the Production of Economically Valuable Grain with a Minimum Level of Hidden Damage.
Abstract: The aim of the work is to evaluate the possibilities of X-ray quality control of seed and grain batches to identify hidden ecogenic and technogenic damage, to assess their impact on the economic suitability of grain and the possi- bility of its selection for precision studies of individual samples and mass analysis of grain batches. X-ray signs of hidden damage to the grain of a biogenic and technogenic nature were revealed, which significantly affect the economic suitability of grain batches (fracturing, internal germination, enzyme-mycotic depletion, damage and infestation of the grain with insects, non-fulfillment of the grain). It is shown that in production conditions there are grain defects that are absent in field small-scale experiments. The results obtained are the basis for improving agricultural technologies in order to produce economically valuable grain with a minimum level of hidden damage, as well as to ensure the competitiveness of domestic grain production in the world grain market.

Natalya Sevostyanova, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Novgorod Research Agriculture Institute, Novgorod Region, Russia and NovBiotech, LLC, Veliky Novgorod, Russia,
Elena Shkodina, **Maria Zhukova**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), Novgorod Research Agriculture Institute, Novgorod Region, Russia,
Olga Trezorova, Yaroslav the Wise Novgorod State University, Veliky Novgorod, Russia.
Lecture Title: The Effect of Laser Stimulation on the Yield and Quality of Oat Grain.
Abstract: The paper describes the effect of laser stimulation on the yield and quality of grain of naked and shelled oats in the conditions of the North-West of Russia. The method is based on exposure of red light with a wavelength of 650 nm, a radiation power of 150 MW and an exposure of 30 seconds. The processing was carried out in the tillering stage, while the varieties of naked and shelled oats showed different results. Laser radiation triggers the cascade mechanism for the synthesis of complex organic compounds, increasing the yield of shelled oats by 25%. In addition, the amount of carbohydrates and protein in the grain increases,

	which has a positive effect on its nutritional value. Laser treatment of naked oats had no effect, which is connected with the lack of rainfall during the activation of biochemical processes under the influence of light. The obtained data allow for identifying the optimal growth phase for stimulation of various varieties of oats. The proposed technology can be adapted at the production of forage crops in order to reduce the usage of chemical protection products and fertilizers, as well as at the production of organic products.
 	**Lyudmila Zhichkina**, **Kirill Zhichkin**, Samara State Agrarian University, Kinel, Russia, **Vladimir Nosov**, K.G. Razumovsky Moscow State University of technologies and management, Moscow, Russia, **Olga Musina**, **Larisa Meleshkina**, Polzunov Altai State Technical University, 656038, Barnaul, Russia, **Elena Artemova**, Kuban State Agrarian University Named After I.T. Trubilin, Krasnodar, Russia. **Lecture Title:** Ecological Aspects of Seasonal Dynamics of Wheat Thrips and Trophic Relationships in Wheat Agrocenoses. **Abstract:** Wheat thrips (Haplothrips tritici Kurd.) is the most abundant phytophage in agrocenoses of winter and spring wheat. Small size and life hidden way at all stages development are the reasons for insufficient knowledge of its ecological features. The research aim is to reveal the ecological aspects of wheat thrips seasonal dynamics and trophic relationships in wheat agrocenoses. The research objectives included: - to determine the wheat thrips populations' composition, structure and seasonal dynamics; - to study food connections and relationships of the phytophage with fodder plants; - to analyze the wheat thrips ecology and harmfulness peculiarities in wheat agrocenoses. The studies carried out are devoted to detailed conjugate analysis of the forage plants and wheat thrips populations development, adults and larvae food connections, and their ecological niche. Data were obtained on seasonal dynamics of the thrips populations age spectrum number, wintering, its larvae metamorphosis and harmfulness in the Middle Volga region conditions. The pest adults maximum number reached 2840 pcs/ 100 strokes of a butterfly net in crops of winter wheat, and 15023 pcs/ 100 strokes in crops of spring wheat. The adult thrips number peak on winter wheat coincides with the organogenesis IX stage (the flowering phase), on spring wheat with the organogenesis VIII stage (the heading phase). The age composition of the pest population changed according to the wheat development phases, a large number was noted in winter wheat agrocenoses and amounted to 19.1-20.5 thousand pcs/m2, while in spring agrocenoses - 15.0-18.3 thousand pcs/m2.

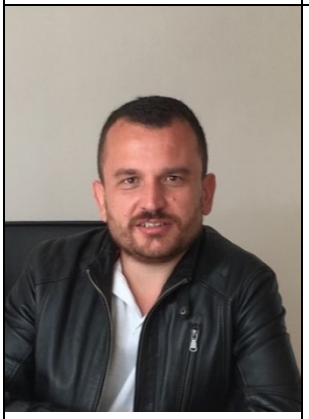
Oral Session 5: Robotics in Agriculture	
 	**Christian Kotting**, **Eike Gassen**, **Karsten Berns**, Technische Universitat Kaiserslautern, Germany. **Lecture Title:** A Robot Platform for Steep Slope Vineyards. **Abstract:** This paper presents the concept of AVOS, a robot vehicle that is designed to operate in steep slope vineyards with vertical cultivation layout. These environments are difficult to operate in for both, human and machine, because of the steep inclinations, poor soil conditions and space restrictions. AVOS should replace manned crawlers, that are typically used for this work. This kind of operation involves health risks for farming personnel and is inefficient with regard to energy usage. The target of the AVOS project is the development of an efficient lightweight platform to support vineyard workers for improved safety and comfort. Its most important function is to apply spraying agent to the grape plants, but it can be equipped with different tools to serve a variety of tasks. The concept is discussed and requirements for the important components of the AVOS platform are defined. These include motor winch, wheel propulsion, steering concept, power supply and spraying tools. The components must not be oversized to meet the weight target. Parts that fulfill the requirements are selected and a possible construction setup is presented.
	**Maksim Nikolaev**, **Ivan Nesmianov**, **Victor Zhoga**, **Alexey Ivanov**, Volgograd state agrarian university, Volgograd, Russia. **Lecture Title:** Justification Parameters and Planning Capture Trajectories for Robotic Loading and Transport. **Abstract:** The review of existing loaders and robotic vehicles used in the agro-industrial complex is carried out. The design and technological scheme of a self-propelled robotic loading vehicle with a manipulator-tripod for bags with vegetables has been developed. A robotic loading transport unit, mounted on a self-propelled chassis and designed for picking up and loading nets with vegetables into the body, has been developed. The structure and kinematic scheme of the manipulator are justified, and the service area of the loading and transport unit is calculated. The parameters of the gripper are justified, in particular, its design scheme is presented, and the necessary holding force is determined when gripping the mesh bag. The choice of drives for a robotic loader is justified. The technological process of collecting and loading nets with vegetables by a loading and transport robotic unit is considered, the criteria for optimal movement of the load-handling body are given. The tasks of automating the process of loading nets with onions are formulated. The technical characteristics of the experimental robotic loader are given, the drive control system is developed, and the device of the loading and transport unit is described. The average time of the bag loading cycle is determined.

	The actual trajectories of movement of the load-handling body are obtained. The actual performance of the robotic loading and transport unit is determined. The energy efficiency of the manipulator actuators is determined. Experimental studies of a robotic loading and transport unit were carried out.
	**Rashid Kurbanov**, **Natalia Zakharova**, Federal Scientific Agroengineering Center VIM, Moscow, Russia. **Lecture Title:** Determination of Spring Barley Lodging Area with Help of Unmanned Aerial Vehicle. **Abstract:** Remote sensing data obtained using an unmanned aerial vehicle allow for creating highly detailed field maps to assess the state of crops. Lodging of crops is highlighted as a significant reason for the reduction in crop yields. Traditional quantitative assessment, satellite images, and data obtained from the UAVs are used to assess the degree of crop lodging. The study examined the Green, Red, Red Edge, and Near-infrared channels and the vegetation indices NDVI and ClGreen. The authors developed an algorithm for determining the spring barley lodging area based on data from the red spectral channel. This algorithm was used to assess the spring barley field. It was found out that the lodging areas on 22 June 2020 and 2 July 2020 were 0,3045 and 0,795 ha, respectively. The investigated algorithm can be applied at the initial stages of spring barley vegetation. This algorithm could be used for the assessment of spring barley losses and the prediction of yield.
 	**Alexander Smirnov**, **Nikolay Teslya**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), St. Petersburg, Russia. **Lecture Title:** Robot Coalition Coordination in Precision Agriculture by Smart Contracts in Blockchain. **Abstract:** Precision farming is becoming a leading area of agricultural development. The driver of this development is global digitalization and robotization of the main functions of agriculture. At the same time, robots (combines, transporters, tractors, quadcopters) are equipped with algorithms that provide a high degree of autonomy in decision-making. In this regard, it is required to ensure the joint work of robots of various types in a single coalition to achieve the maximum effect from the processing of the field that is, growing and collecting the maximum possible yield per hectare. This paper proposes a mechanism for the formation of a coalition of robots based on socio-inspired self-organization. The proposed mechanism was tested in a virtual environment based on Gazebo / ROS to assess the quality of the coalition being formed. Test results show an appropriateness for any coalition type creating. The type of coalition is defined in dynamic way by the environmental state, task type and robots' types. Smart contracts in a distributed ledger based on the HyperLedger Fabric blockchain platform are used to provide trusted interaction between robots during and after coalition formation.

Roman Meshcheryakov, **Alexander Salomatin**, **Dmitry Senchuk**, **Aleksandr Shirokov**, Institute of Control Sciences of the Russian Academy of Sciences, Moscow, Russia.

Lecture Title: Scenario of Search, Detection and Control of Invasive Plant Species Using Unmanned Aircraft Systems.

Abstract: In this publication, according to the results of a comparative analysis, a hypothesis is adopted about a faster and less resource-intensive method of search, detection, and control of invasive plant species on the example of control of Sosnovsky's hogweed by the forces and means of the group operating an unmanned aircraft system (UAS). A typical algorithm for the operation of samples and software models, autonomously operating UAS, consisting of vehicles of different functional purpose, is also proposed. To solve the problem, the specification of the UAS tools used is described. Different echelons of unmanned aerial vehicles for solving tasks and different options of scanning in stripes can be applied. Moreover, three flight trajectories for an unmanned aerial vehicle intended for spraying toxic substances are suggested. The type of take-off and descent is selected based on the terrain data. Finally, the equations of the optimization problem for spraying with the help of UAS are composed depending on the type of the trajectory and the initial data.

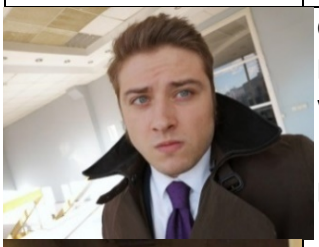
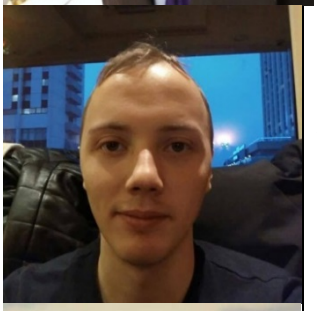
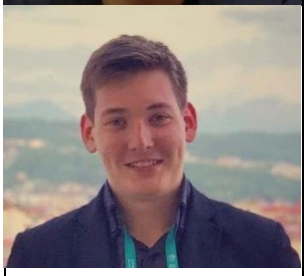


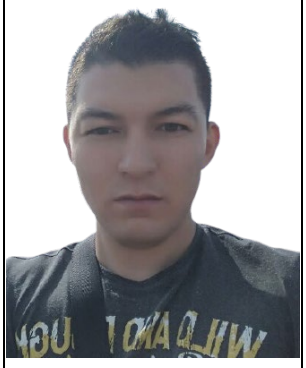
Mehmet Güzey, **Mehmet Akıncı**, Erzurum Technical University, Erzurum, Turkey,

Alparslan Güzey, İstanbul Kültür University, İstanbul, Turkey.

Lecture Title: Optimal Energy Consuming on Spraying an Agricultural Field by Using Multiple UAVs.

Abstract: Recently, agricultural areas are decreasing day by day in the face of the constantly increasing population. As a result, it is inevitable that existing production techniques are made much more efficient. In this study, starting from this point, it was aimed to spray the spraying areas of the pre-determined targets in the agricultural land of autonomous unmanned aerial vehicles in communication with each other with time minimization. For this purpose, 2 scenarios were compared on how to use the drones in the stations placed in all four corners of the field in the most effective way. In the 1st scenario, the field is divided into four equal parts in a classical way. In the second scenario, the field was divided into 2 to 4 regions by using the k-means method according to the areas to be sprayed. The route that the drone will use in spraying has been analysed using the segmental method developed for the traveling salesman problem. For calculations, Julia programming language was used. Each scenario has been examined 100 times for different number of spraying sites. In the light of the results obtained, it was found that the k-means method improved the flight time by an average of 19% compared to classical segmentation. In addition, with the developed method, unnecessary flight times of drones were prevented,

	and their useful lives were extended by finding which stations should be used the least in different situations.
  	**Gleb Tevyashov**, **Mark Mamchenko**, **Andrey Migachev**, **Rinat Galin**, **Konstantin Kulagin**, **Petr Trefilov**, **Nikolay Goloburdin**, V.A. Trapeznikov Institute of Control Sciences of RAS, Moscow, Russia, **Rodion Onisimov**, Bauman Moscow State Technical University, Moscow, Russia. **Lecture Title:** Algorithm for Multi-Drone Path Planning and Coverage of Agricultural Fields. **Abstract:** This article addresses the problem of optimal flight path planning when surveying the field using several unmanned aerial vehicles (UAVs). The trajectories of the drones are configured in order to minimize the time of the sub-areas coverage (assigned to each drone in the group), provided that the whole field is completely covered. The algorithm consists of four stages: converting the coordinates of a given field into Cartesian (metric system); splitting the field into sub-areas assigned to be covered by each drone in the group; forming the flight trajectory (plan) for each drone; and iterative minimization of the maximum time needed to cover the assigned sub-areas. The algorithm for optimal flight path planning is more time-effective than the ones, where the drone moves straight from one end of the field to the other with shifts (moving along the boundary of the field at a certain distance). To implement the developed, an additional software module of the virtual simulator has been developed. The workability and the adequacy of the proposed algorithm were experimentally confirmed, using a three-dimensional model of a real agriculture field in the virtual simulator.

Oral Session 6: Digital Technologies in Agriculture	
  	**Mikhail Vinogradov**, **Igor Kan**, **Irina Vatamaniuk**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS), St. Petersburg, Russia. **Lecture Title:** Architecture of Distributed Sensor System for Automated Greenhouse Complex. **Abstract:** This paper deals with the problem of automating a distributed sensor system in a greenhouse complex. When solving this problem, attention should be paid to a number of factors: stability of the entire system under different conditions, ease of deployment, energy efficiency, cost, scalability, monitoring the state of the system, etc. To solve the problem under consideration, a configurable decentralized system was implemented with a heterogeneous network of star topology. In the proposed architecture, the network consists of three layers. The connection between the first and the second level is organized using Wi-Fi technology, and between the second and third levels – using LoRa technology, with an add-on developed for it that minimizes the amount of transmitted data and organizes the reliability of data transmission. For scalability and simplification of the system installation, a system for configuring nodes was developed, and for the convenience of organizing data storage and replacing faulty modules, unique identifiers assigned by the server are used. According to the proposed solution, a prototype of the system was implemented, used to analyze its capabilities. During operation, it showed that the system complies with the requirements put forward for it, and showed the following transmitter settings, which should be paid attention to in case of a large scale up of the system in a confined space: radio frequency, spreading factor, and bandwidth modulation.
	**Tomáš Tureček**, **Pavel Vařacha**, **Alžběta Turečková**, **Peter Janků**, **Adam Viktorin**, **Roman Šenkeřík**, **Roman Jašek**, **Bronislav Chramcov**, **Zuzana Komínková Oplatková**, Tomas Bata University in Zlin, Zlin, Czechia, **Václav Psota**, **Vít Štěpánek**, NWT a.s., Zlin, Czechia, **Ioannis Grivas**, University of Thessaly General Department (Lamia), Greece. **Lecture Title:** Scouting of Whiteflies in Tomato Greenhouse Environment Using Deep Learning. **Abstract:** This study shows the possibilities of how to replace tedious human labor - scouting of yellow sticky traps (YST) for whiteflies - using artificial cognitive vision, specifically the deep convolutional network (CNN), as a part of the more complex system - BERABOT. The used CNN is the Faster R-CNN trained by deep transfer learning

	to substitute human scouting when the low whiteflies infection phase was specifically targeted. The training was conducted on pictures taken inside the heated and lighted tomato production greenhouse of "Bezdínek Farm" in Dolni Lutyne, Czechia. Used pictures were collected in a way planned for future fully automated robotic applications in the BERABOT system. The achieved results were compared with the scouting results of a professional phytopathologist. The trained employee's scouting results against the professional phytopathologist accomplished root-mean-square error (RMSE) equal to 4.23 while the developed CNN model was evaluated to be 5.83. The results presented here open up new frontiers for further CNN model tuning leading to the potential in substituting an employee(s) in the future and make tomato production less expensive and less human labor dependent.
	**Eugene Eremchenko**, Lomonosov Moscow State University, Moscow, Russia, **Alena Zakharova**, Institute of Control Sciences of the Russian Academy of Sciences, Moscow, Russia. **Lecture Title:** Cattle's Magnetic Alignment Case: Understanding Visual Aberrations of Satellite Imagery. **Abstract:** The paper considers the discovery with the help of Google Earth of the cattle magnetic alignment effect (MA effect), meaning the cattle under normal conditions in pastures tend to align the orientation of their bodies with the local direction of the Earth's magnetic field. A paradoxical feature of the detected effect is noted - on the one hand, the convincing demonstration of the effect in space images, on the other hand, the complete invisibility of the effect to the experts in husbandry for millennia. The specific aberrations of space images used in Google Earth are discussed: stroboscopic aberration and shuttering aberration, which inevitably and irreversibly distort the acquisition of data on cattle orientation. It is concluded that these two aberrations may have significantly biased the raw data. These aberrations are discussed as the most parsimonious explanation for the effect detected. It is suggested that MA effect should be verified by independent means in a methodologically correct manner. It is also concluded that there is a need to codify the aberrations of the space images, which is important in the era of digitalization of agriculture.

Alexey Stepanov, **Tatiana Aseeva**, Far-Eastern Agriculture Research Institute, Vostochnoe, Russia,
Konstantin Dubrovin, Computing Center of the Far Eastern Branch of the Russian Academy of Sciences, Khabarovsk, Russia.
Lecture Title: Forecasting Soybean Yield in Agricultural Regions of the Russian Far East Using Remote Sensing Data.
Abstract: Soybeans are the main agricultural crop in the southern part of the Russian Far East. Predicting soybean yield at the regional level is an important task that contributes to the planning of acreage and assessment of risks in fulfilling contractual obligations. Methods based on satellite data have recently begun to be used to solve this problem. To assess the soybean yield at the municipal level, a regression model was built, where the maximum normalized difference vegetation index (NDVI) value for arable land in the district and the number of days with an average daily temperature of more than 10˚C (D) were used as independent variables. The regression model was built using data from 2010 to 2018 for six municipal districts belonging to four regions of the Russian Federation: the Amur Region, Primorskiy and Khabarovsk Territories, and the Jewish Autonomous Region. It was found that the maximum NDVI of arable land in these areas occurred between the 30th and 33rd calendar weeks (late July–mid-August); the D value varied slightly and ranged from 83 to 90 days. The estimation of the method accuracy showed that the mean absolute percentage error (MAPE) of the model was in the range 4.8–9.7%; the root mean square error (RMSE) was 0.05–0.15 t/ha. Using the created model, the soybean yield for 2019 was estimated. The forecast error for the three areas not affected by the 2019 flood did not exceed 10.5%. For areas with flood events, error ranged from 11.7 to 22.0%.

Galina Kamyshova, **Dmitry Solovyev**, **Nadezhda Terekhova**, **Dmitry Kolganov**, Saratov State Agrarian University, Saratov, Russia.
Lecture Title: Development of Approaches to the Intellectualization of Irrigation Control Systems.
Abstract: The article presents the results of the development of an intelligent control system for the irrigation complex. The control system, on the one hand, takes into account the spatial-temporal variability of agro-climatic and biological factors, and on the other hand, it allows optimizing the operational characteristics of irrigation equipment. The Russian agricultural market requires the development of new methods and technologies for the transition to "intelligent", "digital" agriculture, based on the use of automated decision support systems and the development of intelligent control systems for irrigation equipment. This is justified by the need to solve the problem of increasing the economic and environmental efficiency of the operation of irrigated lands. The system is based on digital

	technologies and control methods based on artificial neural networks. The developed intelligent control system for the irrigation complex will find application both in the development of modern sprinklers and in modern digital decision support systems.
 	**Elena Pavlovskaya**, Innopolis University, Innopolis, Russia, **Alena Zakharova,** Institute of Control Sciences of the Russian Academy of Sciences, Moscow, Russia, **Dmitrii Titarev** Bryansk State Technical University, Bryansk, Russia. **Lecture Title:** Algorithm for Calculating Doses of Mineral Fertilizers Based on Linear Optimization Model. **Abstract:** One of the main factors that have a direct impact on the crop yield is correct fertilization for achieving an optimal soil composition. The yield, in turn, is one of the main indicators of the agroeconomic substantiation of intra-farmland use projects. There are many factors to consider when choosing a fertilization schedule. These include, in particular, the planned yield, the fore crop previously cultivated on the sown area, the composition of the soil, the region and the crop planned for sowing, etc. A scientifically substantiated solution to such a problem is impossible without the use of economic and mathematical methods and optimization models. Methods of linear optimization have been widely used in land utilization by now. The article proposes an algorithm for calculating the doses of mineral fertilizers, which consists of two stages: calculating the amount of active substance for three main macroelements and directly calculating the dosage of fertilizers applied, based on a linear optimization model.

Marina Astapova, **Anton Saveliev**, St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS),
Yury Markov, St. Petersburg State University of Aerospace Instrumentation (SUAI), St. Petersburg, Russia.

Lecture Title: Method for Monitoring Growth of Microgreens in Containers Using Computer Vision in Infrared and Visible Ranges.

Abstract: The purpose of this article is to optimize the collection of data on growing container plants. Data collection is carried out using robotic means with a camera mounted above the microgreen container. Finding the position of the camera relative to the container requires matching points in the environment. To solve this problem, an algorithm is proposed that uses camera calibration with respect to fiduciary markers located at the boundaries of the container. After calibration, the platform gradually begins to move and acquires images in the visible and infrared spectra. To get all the information about the green container, the images are stitched together and the NDVI index is calculated. Based on the NDVI index, problem areas of the container are estimated, which correspond to yellow pixels, and green pixels indicate healthy vegetation. The red areas (pixels) refer to the empty space of the container. The article proposes an optimized algorithm that stitches parallel to the movement of the robotic platform, and calculates the NDVI, which helps to reduce memory costs for computing the process. An assessment was made of the ratio of green mass to empty space of containers at each of the image areas (evaluation), as well as the condition of various cultures (assessment), such as carrots, mezuna, turnips, daikon. According to the results of the experiment, containers were found that showed the lowest estimate of the development of greenery, approximately equal to 37.9%, the highest estimate was 94.36%.

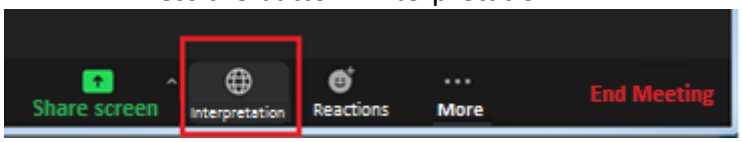
Format of the Conference

Due to measures for prevention of the spread of coronavirus infection on the territory of the Russian Federation, the First International Conference on Agriculture Digitalization of and Organic Production (ADOP 2021) will be held in a hybrid format: face-to-face participation taking place on the basis of St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS) (14th line VO, 39, St. Petersburg) and an on-line video conference. The conference programme with link on video conference is available on the website too:
http://adop.nw.ru/documents/ADOP-2021_Programme+Abstracts.pdf.

The time of the video conference is specified in the time zone of St. Petersburg / Moscow (UTC + 3): https://www.worldtimebuddy.com/utc-to-russia-moscow.
One link for video conference for Opening ceremony, Plenary sessions, Oral sessions, Closing ceremony for participants and listeners is:
https://zoom.us/j/99092250806?pwd=OXA3V2d0aXdYZVVtSWpFSURCUHlYUT09

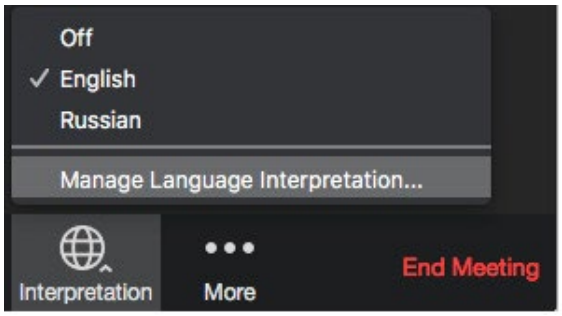
A quick-start guide for language interpretation in Zoom

1. Press the button «Interpretation».



2. **For English <u>speakers</u>:**

Choose English channel for your presentation.



For English <u>listeners</u>:
Choose English channel for listening. Users of interpretation channels can hear interpretation along with original language in the background.

NB: Please, be so kind to write all your questions to speakers in chat.

Contacts

E-mail: conf@spcras.ru Web site: adop.nw.ru