NJF

26th NJF Congress:
Agriculture for the Next 100 Years
27-29 June, 2018 Kaunas r. Lithuania

PROGRAMME AND SUMMARIES OF PRESENTATIONS

Akademija, 2018

26th NJF Congress: Agriculture for the Next 100 Years is organised by the Lithuanian National Association of the Nordic Association of Agricultural Science in participation and collaboration with:

Aleksandras Stulginskis University

Aleksandras Stulginskis University

Lithuanian Academy of Sciences

Lithuanian Research Centre for Agriculture and Forestry

LAMMC

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

Nordic Association of Agricultural Science

NJF

SPONSOR:

The Ministry of Agriculture of the Republic of Lithuania

LIETUVOS RESPUBLIKOS ŽEMĖS ŪKIO MINISTERIJA

Dear NJF members and colleagues,

I am on behalf of NJF happy to welcome you to our Congress in Kaunas, Lithuania on June 27th -29th 2018!

As you know the NJF – Nordic Association of Agricultural Science was founded in 1918 to promote scientific cooperation cross the borders of Scandinavia. Today, a century later, we are still committed to our mission to encourage exchange of knowledge in agriculture between our Nordic-Baltic countries. In 1918 the world was suffering from the horrors of an ongoing war and food supply was scarce in many countries. The initiative of an independent agricultural association joining competence in the Scandinavian countries was obvious, and on September 24th 1918 the NJF was founded in Copenhagen.

Today, food supply, water management and environmental issues are still in focus, but not only for Scandinavia - for our entire planet. The competence of NJF is still needed, but worldwide.

The 26th Congress is the first one in Lithuania and I would like to express my sincere thanks to our host, the Aleksandras Stulginskis University and our local organizers of the NJF in Lithuania. They have through hard work made this congress possible.

Our congress is an excellent opportunity to present ongoing research and collaborations within a wide range of topics. It will also be a possibility to meet colleagues and find new partners for development of agriculture in a broad perspective. Take some extra minutes to contact a participant that you haven't met earlier. Maybe this first contact will end up in a joint project or a friend for life

Although the conference has a Nordic-Baltic perspective, we welcome participants from all countries to take part and enjoy the hospitality of our Lithuanian colleagues and their beautiful country.

Welcome to the 26th NJF Congress!

Fredrik FOGELBERG

President of NJF

ORGANIZING COMMITTEE

Chairperson:

Linas STABINGIS
Head of NJF National Association in Lithuania, Aleksandras Stulginskis University, Lithuania

Members:

Aušra BLINSTRUBIENĖ
Dean of Faculty of Agronomy, Aleksandras Stulginskis University, Lithuania
Gintaras BRAZAUSKAS
Director of Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Lithuania
Jonas ČĖSNA
Vice-Dean of Faculty of Agricultural Engineering, Aleksandras Stulginskis University, Lithuania
Zenonas DABKEVIČIUS
Chairman of the Division of Agricultural and Forestry Sciences, Lithuanian Academy of Sciences, Lithuania
Fredrik FOGELBERG
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Chairperson of NJF National Association in Sweden, Swedish University of Agricultural Sciences, Sweden
Guðrún LÁRUSDÓTTIR
Chairperson of NJF National Association in Iceland, Agricultural University of Iceland, Iceland
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Secretary General of NJF, Sweden
Antanas MAZILIAUSKAS
Rector of Aleksandras Stulginskis University, Lithuania
Jarkko NIEMI
Chairperson of NJF National Association in Finland, Natural Resources Institute Finland, Finland
Rasa PAKELTIENĖ
Vice-Dean of Faculty of Economics and Management, Aleksandras Stulginskis University, Lithuania
Baiba RIVZA
Chairperson of NJF National Association in Latvia, Latvia University of Agriculture, Latvia
Oliver SADA
Chairperson of the NJF National Association in Estonia, Estonian University of Life Sciences, Estonia
Roma SEMAŠKIENĖ
Deputy Director for Experimental Development, Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Lithuania
Egidijus ŠARAUSKIS
Head of Research Department, Aleksandras Stulginskis University, Lithuania
Kirsty MCKINNON
Chairperson of NJF National Association in Norway, Norwegian Centre for Organic Agriculture, Norway
Alastair James WARD
Chairperson of NJF National Association in Denmark, Aarhus University, Denmark

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Chairperson Mantvydas STABINGIS
UAB "Stilit"
Member Nijolė MARŠALKIENĖ
Aleksandras Stulginskis University
Member Aurelija MARKELYTĖ
Aleksandras Stulginskis University

SCIENTIFIC COMMITTEE

Chairman:

Arvydas POVILAITIS
Aleksandras Stulginskis University, Lithuanian Academy of Sciences, Lithuania

Members:

Birgitta ÅHMAN
Swedish University of Agricultural Sciences, Sweden
Vilija ALEKNEVIČIENĖ
Aleksandras Stulginskis University, Lithuania
Helena ARONSSON
Swedish University of Agricultural Sciences, Sweden
Biruta BANKINA
Latvian university of Agriculture, Latvia
Gints BIERZIETIS
Latvia University of Agriculture, Latvia
Vaclovas BOGUŽAS
Aleksandras Stulginskis University, Lithuania
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Lithuanian Research Centre for Agriculture and Forestry, Lithuania
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Norwegian Centre for Organic Agriculture, Norway
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Natural Resources Institute Finland (Luke), Finland
Liga PAURA
Latvia University of Agriculture, Latvia
Algirdas RADZEVIČIUS
Aleksandras Stulginskis University, Lithuania
Asta RAUPELIENĖ
Aleksandras Stulginskis University, Lithuania

KEYNOTE SPEAKERS

Prof. dr. Antanas MAZILIAUSKAS

Rector of the Aleksandras Stulginskis University, Lithuania

He is currently (since 2011) Rector of the Aleksandras Stulginskis University. He has served (1997-2001) as Director of Agriculture and Food Department, Ministry of Agriculture of the Republic of Lithuania. Participated in consultancy and project evaluation missions for the World Bank and FAO in Nigeria, Ivory Cost, Kazakhstan, Uganda, Mali and Yemen. During last decades has extensively participated in the EU enlargement process, taking part in the multilateral and bilateral working meetings with the EU Commission, including preparation of documents for the use of EU Structural funds. His main professional themes are land and water resources management, irrigation and drainage and policy development in the agriculture and food sectors.

Dr. Gintaras BRAZAUSKAS

Director of the Lithuanian Research Centre for Agriculture and Forestry

His research focuses on the utilization of plant genetic resources through classical breeding methods and modern DNA technologies to develop advanced plant varieties with enhanced abiotic stress resistance. G. Brazauskas has co-authored the development of 7 varieties in winter wheat and takes an active part in the breeding of perennial ryegrass. Key research interests: functional genomics, pan-genomics, plant phenotyping, new breeding techniques. G. Brazauskas actively collaborates with ETH Zurich, Aarhus university, Norwegian university of Life Sciences, SLU and other.

Prof. dr. Baiba RIVZA

Latvia University of Agriculture

She is a Vice president, Latvian Academy of Sciences, and professor of Latvia Academy of Agriculture, Faculty of Economics and Social Development. The professor is a expert from the European Academy of Sciences Academic Advisory Board (EASAC) in the field of economics, also coautor of Research „Circular economy: a commentary from the perspectives of the natural and social sciences". She is a mentor of Standing Committee on Agricultural Research (SCAR) Common Agricultural and Wider Bioeconomy reaearch agenda (CASA) Training and Mentoring programme, 2017-2020. She has experience in international projects and programs. Her main professional themes are economic analysis of regions, support politics and good practice of entrepreneurship in rural areas and regions (mentoring, microcredit), market research, analysis of local cultural heritage.

Prof. dr. Alan MATTHEWS
Trinity College Dublin, Ireland

He is a former President of the European Association of Agricultural Economists and is currently a member of Ireland's Climate Change Advisory Council. His research interests are in the areas of agricultural policy and international trade policy, including their implications for development and food security. He is a regular contributor to the blog capreform.eu on issues relating to the EU's Common Agricultural Policy.

Prof. dr. Vaclovas BOGUŽAS
Aleksandras Stulginskis University, Lithuania

He is professor and head of Institute of Agroecosystems and Soil Sciences at Aleksandras Stulginskis University. Research interests: sustainability of agroecosystems, sustainable and organic farming systems, soil quality, soil tillage, biodiversity, weed control, catch crops, crop rotations. All activities are formulated within the framework of climate change adaptation and mitigation - and sustainable food production. Dissemination: >70 scientific publications, >50 popular papers without referee system. He has experience as coordinator or participator of >20 research projects. He was mirror group member of European technology platform „Food for life", member of Lithuanian expert group of scientific research and experimental development area „Food, Agriculture, Fisheries, and Biotechnology", member of expert group in Lithuania for establishment of Joint Research Centre of Agriculture and Forestry and development of its infrastructure.

MAINSTREAM OVERVIEW OF EVENTS

26th of June 2018		
10:00 – 16:00	Pre-congress subject tour to Lithuanian Research Centre for Agriculture and Forestry (Dotnuva, Kėdainiai r.)	
27th of June 2018		
8:30 – 10:00	Registration (Central building of ASU)	
10:00 – 12:00	Plenary session (Ceremony hall of ASU)	
12:00 – 13:30	Lunch (5th floor lobby)	
13:30 – 15:00	Plenary session (Ceremony hall of ASU)	
15:00 – 15:30	Coffee / refreshment break (Lobby of ceremony hall)	
15:30 – 17:10	Subject tour to laboratories of ASU	Parallel session of the Section B** (Ceremony hall of ASU)
17:20 – 18:30	Meeting of the members of NJF	
18:30 – 19:00	Oak planting for the memory of NJF jubilee (arboretum of ASU)	
19:00 – 22:00	Welcome reception	
22:00	Departure to hotels	
28th of June 2018		
8:30 – 10:10	Sessions in the sections (Central building of ASU)	
	Section A*: 505 auditorium	Section B**: 503 auditorium
10:10 – 10:40	Coffee / refreshment break (5th floor lobby)	
10:40 – 12:20	Sessions in the sections (Central building of ASU)	
	Section A*: 505 auditorium	Section B**: 503 auditorium
12:20 – 13:30	Lunch (5th floor lobby)	
13:30 – 15:10	Sessions in the sections (Central building of ASU)	
	Section A*: 505 auditorium	Section B**: 503 auditorium
15:10 – 15:40	Coffee / refreshment break (5th floor lobby)	
15:10 – 16:30	Poster session (5th floor lobby)	
15:40 – 16:30	Meetings of members of NJF sections (according request)	
16:30	Departure from ASU to hotels	
18:30	Departure to Birštonas SPA resort for Gala dinner at restaurant KURHOUS	
19:15 – 20:00	Walk tour by visiting remarkable places of Birštonas	
20:00 – 23:00	Gala dinner at restaurant KURHOUS	
23:00	Departure from Birštonas to hotels	
29th of June 2018		
9:00 – 11:00	Sessions in the sections (Central building of ASU)	
	Section A*: 505 auditorium	Section B**: 503 auditorium
11:00 – 11:30	Coffee / refreshment break (5th floor lobby)	
11:30 – 12:30	Concluding plenary session and closing ceremony (505 auditorium)	
12:30 – 13:30	Lunch (5th floor lobby)	
13:30	Departure to hotels or cultural tours at Kaunas City	

* – SECTION A: SUSTAINABILITY OF AGROEKOSYSTEMS
** – SECTION B: BIOECONOMY AND INNOVATIONS

PLENARY SESSION

27th of June 2018 Central building of ASU

10:00 – 12:00 **Ceremony hall of ASU**
Chair **Linas STABINGIS**

10:00 – 10:20 ***Opening ceremony and welcome words***
prof.dr. Antanas Maziliauskas, Rector of ASU; Viktoras Pranckietis, Speaker of Parliament of the Republic of Lithuania; Fredrik Fogelberg, President of NJF; Giedrius Surplys, Minister of Agriculture and other invited guests

10:20 – 10:40 ***NJF from 2018 until now and in the future***
Dr. Fredrik Fogelberg, President of NJF, Sweden

10:40 – 11:00 ***Research and innovation in agriculture: from the past to the future***
Prof. dr. Antanas Maziliauskas, Aleksandras Stulginskis University, Lithuania

11:00 – 11:30 ***The CAP after 2020 – the road ahead***
Prof. Alan Matthews, Trinity College, Ireland

11:30 – 12:00 ***Nordic-Baltic collaboration to boost plant breeding for the future climate***
Dr. Gintaras Brazauskas, Lithuanian Research Centre for Agriculture and Forestry, Lithuania

LUNCH

12:00 – 13:30 **Central building of ASU, 5th floor lobby**

PLENARY SESSION

27th of June 2018 Central building of ASU

13:30 – 15:00 **Ceremony hall of ASU**
Chair **Svein SKØIEN**

13:30 – 14:00 ***Rural Territories as Space for Sustainable and Smart Development***
Prof. Baiba Rivza, Latvia University of Life Sciences and Technologies, Latvia

14:00 – 14:30 ***Sustainability of Agroekosystem and Carbon Sequestration as Effect of Long-term Measures***
Prof. Vaclovas Bogužas, Aleksandras Stulginskis University, Lithuania

14:30 – 15:00 ***Food Security in Norway – Legitimacy and Policy Design***
Dr. Sjur Spildo PRESTEGARD, Norwegian Institute of Bioeconomy Research (NIBIO), Norway

SESSIONS OF THE SECTIONS

28th of June, 2018 Central building of ASU

Section A
SUSTAINABILITY OF AGROECOSYSTEMS

Length of presentation and discussion – 20 minutes

8:30 – 10:10 **505 auditorium**
Chair **Fredrik FOGELBERG**

1 **Iris DAHLIN, Velemir NINKOVIC**
CULTIVAR MIXTURE – A MULTIFUNCTIONAL CROPPING SYSTEM LINKING PLANT-PLANT AND PLANT-INSECT INTERACTIONS

2 **Anne Kjersti UHLEN, Shiori KOGA, Katherine Ann Gredvig NIELSEN, Heidi Udnes AAMOT, Ulrike BÖCKER, Eva VEISETH-KENT, Ingerd Skow HOFGAARD**
INVESTIGATING ENVIRONMENTAL FACTORS CAUSING VARIATION IN GLUTEN QUALITY

3 **Rita ARMONIENĖ, Gintaras BRAZAUSKAS, Aakash CHAWADE**
BALTICWHEAT NETWORK FOR SUSTAINABLE WHEAT PRODUCTION IN THE BALTIC SEA REGION

4 **Biruta BANKINA, Gunita BIMŠTEINE, Ingrīda NEUSA-LUCA, Antons RUŽA**
DEVELOPMENT OF WINTER WHEAT DISEASES DEPENDING ON AGRONOMIC PRACTICE

5 **Renaldas ŽYDELIS, Lutz WEIHERMÜLLER, Michael HERBST, Anne KLOSTERHALFEN, Sigitas LAZAUSKAS**
SIMULATION OF GRAIN MAIZE DEVELOPMENT UNDER WATER AND TEMPERATURE STRESS

28th of June, 2018 Central building of ASU

Section A
SUSTAINABILITY OF AGROECOSYSTEMS

Length of presentation and discussion – 20 minutes

10:40 – 12:20 **505 auditorium**
Chair **Virginijus FEIZA**

1 **Hannele PULKKINEN, Jouni NOUSIAINEN, Sanna HIETALA, Kristiina REGINA, Perttu VIRKAJÄRVI, Juha-Matti KATAJAJUURI**
NEED FOR MORE DETAILED GREENHOUSE GAS EMISSION MODELS TO ESTIMATE CARBON FOOTPRINTS OF AGRICULTURAL PRODUCTS

2 **Kaspars NAGLIS-LIEPA, Dina POPLUGA, Arnis LENERTS, Dzidra KREISMANE, Peteris RIVZA**
MARGINAL ABATEMENT COST CURVES IN ANALYSING GHG EMISSIONS FROM AGRICULTURAL HOLDINGS IN LATVIA: THE CLUSTER APPROACH

3 **Barbro ULÉN, Elisabet LEWAN, Katarina KYLLMAR, Maria BLOMBERG, Stefan ANDERSSON**
IMPACT OF NORTH ATALANTIC OSCILLATION ON SWEDISH WINTER CLIMATE AND NUTRIENT LEACHING FROM ARABLE LAND

4 **Jūratė ALEINIKOVIENĖ, Jakub HOFMAN, Kęstutis ARMOLAITIS, Vaclovas BOGUŽAS**
SOIL BIOLOGICAL PROPERTIES IN FOREST AND AGRICULTURAL ECOSYSTEMS

5 **Dagnija LAZDINA, Sarmīte RANCĀNE, Andis BĀRDULIS, Arta BĀRDULE, Kristaps MAKOVSKIS, Mudrīte DAUGAVIETE**
DEMO AGROFORESTRY SYSTEMS OF TREES AND PERRENIAL GRASES

28th of June, 2018 Central building of ASU

Section A
SUSTAINABILITY OF AGROECOSYSTEMS

Length of presentation and discussion – 20 minutes

13:30 – 15:10 **505 auditorium**
Chair **Oiva NIEMELÄINEN**

1 **Virginijus FEIZA, Dalia FEIZIENĖ, Aleksandras VELYKIS, Danutė KARČAUSKIENĖ, Jonas VOLUNGEVIČIUS, Antanas SATKUS, Mykola KOCHIIERU**
CAPABILITY OF TILLAGE PRACTICES FOR WATERLOGGING RISK REDUCTION IN TWO SOIL TYPES OF GLACIAL GENESIS

2 **Aleksandras VELYKIS, Antanas SATKUS**
LONG –TERM IMPACT OF REDUCED TILLAGE UNDER CLAYEY SOIL CONDITIONS IN NORTHERN LITHUANIA

3 **Danutė KARČAUSKIENĖ, Regina REPŠIENĖ, Dalia AMBRAZAITIENĖ, Regina SKUODIENĖ, Ieva JOKUBAUSKAITĖ, Žilvinas KRYŽEVIČIUS**
CHANGES IN THE MAIN HEALTH INDICATORS OF A RETISOL UNDER DIFFERENT MANAGEMENT HISTORY

4 **Dalia FEIZIENĖ, Virginijus FEIZA, Agnė VERŠULIENĖ, Daiva JANUŠAUSKAITĖ, Šarūnas ANTANAITIS**
THE INFLUENCE OF LONG-TERM TILLAGE AND RESIDUE MANAGEMENT ON TOPSOIL QUALITY IN SOILS WITH DIFFERENT TEXTURE

5 **Aldis KARKLINS**
INTERNATIONALIZATION OF SOIL CLASSIFICATION – OBJECTIVES AND POSSIBILITIES

29th of June, 2018 Central building of ASU

Section A
SUSTAINABILITY OF AGROECOSYSTEMS

Length of presentation and discussion – 20 minutes

9:00 – 11:00 **505 auditorium**
Chair **Vaclovas BOGUŽAS**

1 **Till SEEHUSEN, Anne Kjersti UHLEN**
YIELD GAP IN NORWAY - AGRONOMIC KNOWLEDGE FOR INCREASED CEREAL PRODUCTION BASED ON NORWEGIAN RESSOURCES

2 **Rimantas VELIČKA, Aušra MARCINKEVIČIENĖ, Rita PUPALIENĖ, Marina KEIDAN, Lina Marija BUTKEVIČIENĖ, Zita KRIAUČIŪNIENĖ, Robertas KOSTECKAS, Sigitas ČEKANAUSKAS**
THE EFFECT OF NON-CHEMICAL WEED CONTROL METHODS ON WINTER OILSEED RAPE CROP WEEDINESS AND PRODUCTIVITY

3 **Livija ZARINA, Liga ZARINA, Dace. PILIKSERE, Jevgenija NAČAJEVA**
CONTROL OF PERENNIAL WEEDS IN SPRING CEREALS THROUGH CROPPING SYSTEM

4 **Jere KAIVOSOJA, Oiva NIEMELÄINEN, Jussi NIKANDER, Markku KOISTINEN, Mikko LAAJALAHTI, Niko VILJANEN, Eija HONKAVAARA, Roope NÄSI, Teemu HAKALA**
DEVELOPING DRONE IMAGING BASED METHODOLOGIES FOR APPLICATIONS IN GRASS SWARD MANAGEMENT

5 **Nijolė MARŠALKIENĖ**
PROTEIN CONTENT VARIATION IN GRASS OF SPONTANEOUS VETCH AND SWEET PEA SPECIES

6 **Una ĪLE, Aija ZIEMEĻNIECE**
THE LANDSCAPE SPACE OF THE HISTORIC CENTER OF AIZPUTE

27th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

Length of presentation and discussion – 20 minutes

15:30 – 17:10 **Ceremony hall of ASU**
Chair **Arvydas POVILAITIS**

1 **Vilija ALEKNEVIČIENĖ, Vlada VITUNSKIENĖ**
BIOECONOMY DEVELOPMENT IN LITHUANIA: TENDENCIES AND DRIVERS

2 **Aldona ZAWOJSKA, Tomasz SIUDEK**
THE PATH TO BALANCED RURAL DEVELOPMENT IN THE VISEGRAD AND NORDIC-BALTIC COUNTRIES OF THE EUROPEAN UNION

3 **Vilma ATKOČIŪNIENĖ, Alvydas ALEKSANDRAVIČIUS**
RESILIENT FARMING SYSTEMS AND FARMERS MARKET DIFFERENTIATION

4 **Agnar HEGRENES, Leif Jarle ASHEIM**
MODERN LIVESTOCK POLICY IN NORWAY

5 **Heldur PETERSON**
THE LIVONIAN PUBLIC WELFARE AND ECONOMIC SOCIETY - ONE OF THE OLDEST OF ITS KIND IN EUROPE

28th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

Length of presentation and discussion – 20 minutes

8:30 – 10:10 **503 auditorium**
Chair **Kęstutis NAVICKAS**

1 **Lise GRØVA, Boris FUCHS , Emma BRUNBERG, Unni Støbet LANDE, Kristin SØRHEIM, Svein Olav HVASSHOVD, Solveig Marie STUBSJØEN**
SENSOR TECHNOLOGY TO DETECT TICK-BORNE FEVER IN SHEEP ON RANGE PASTURE?

2 **Emma BRUNBERG, Lise GRØVA, Emma EYTHÓRSDÓTTIR, Ólafur R. DÝRMUNDSSON**
CAN THE ALERTNESS OF ICELANDIC LEADERSHEEP HELP TO PROTECT SHEEP FLOCKS AGAINST PREDATORS?

3 **Katriina HEINOLA, Maria RÖNNQVIST, Ville VÄLTTILÄ, Jukka RANTA, Pirkko TUOMINEN, Jarkko NIEMI**
COSTS AND BENEFITS OF PIG FEED SALMONELLA CONTROL PROGRAMME IN FINLAND

4 **Nurettin GÜLŞEN, Muhammad Naeem TAHIR, Huzur Derya ARIK, Mustafa Selcuk ALATAS**
EFFECTS OF MONOCULTURES OF *E. CAUDATUM* AND *M. ELSDENII* INOCULATION ON *IN VITRO* FERMENTATION, METHANE PRODUCTION AND PREVENTION OF SUB-ACUTE RUMINAL ACIDOSIS

5 **Timo LÖTJÖNEN, Arto HUUSKONEN**
TRITICALE, BARLEY AND WHEAT AS A RAW MATERIAL OF WHOLE-CROP SILAGE

28th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

Length of presentation and discussion – 20 minutes

11:40 – 12:20 **503 auditorium**
Chair **Oliver SADA**

1 **Arvydas POVILAITIS, Jolanta MATIKIENĖ, Rasa VISMONTIENĖ**
DENITRIFICATION BIOREACTORS – A METHOD FOR REDUCING NITRATE FROM TILE DRAINAGE WATER

2 **Mart HOVI, Alo ALLIK, Artis TEILĀNS, Külli HOVI, Andres ANNUK**
MATHEMATICAL MODELLING OF THE ENERGY BALANCE FOR THE TREATMENT OF SOLID BIOMASS FUEL BY COMPRESSING

3 **Anders LARSOLLE, Daniel NILSSON, Nils-Erik NORDH, Per-Anders HANSSON**
DYNAMIC MODELLING OF YEAR-ROUND BIOENERGY DELIVERY OF SHORT ROTATION COPPICE WILLOW

4 **Alastair WARD**
PILOT SCALE CONTINUOUS THERMAL HYDROLYSIS OF ORGANIC WASTES FOR INCREASED BIOGAS PRODUCTION

5 **Sven BERNESSON, Serina AHLGREN**
TRANSPORT FUELS VIA BLACK LIQUOR GASIFICATION - AN ANALYSIS OF CLIMATE IMPACT WITH LIFE-CYCLE ASSESSMENT METHODOLOGY

6 **Jalal KAFASHAN**
MEHATRONICS APPLICATIONS IN AGRICULTURAL WORLD

28th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

Length of presentation and discussion – 20 minutes

13:30 – 15:10 **503 auditorium**
Chair **Agnar HEGRENES**

1 **Aksel MÕTTUS, Einar MIKSON, Oliver SADA**
THE DEVELOPMENT OF ERGONOMIC LIVESTOCK TECHNOLOGY IN OPTIMAL CONDITIONS FOR LIGHT INDUSTRIAL COMPANIES

2 **Lasma CIELAVA, Daina JONKUS, Sandija ZĒVERTE-RIVŽA, Baiba RIVŽA**
DAIRY COW LONGEVITY IN VOLUNTARY MILKING SYSTEM

3 **Oliver SADA, Arvo LEOLA**
AUTOMATIC TECHNOLOGY TRENDS IN ESTONIA DAIRY FARMS

4 **Jalal KAFASHAN**
DEVELOPMENT TREND OF APPLES SORTING MACHINES IN THE WORLD

5 **Kirsty MCKINNON, Reidun POMMERESCHE, Kristin SØRHEIM, Sissel HANSEN, Ola SVAN, Erland BJÖRKLUND**
SAFE RECYCLING OF HORSE MANURE FOR AGRICULTURAL PURPOSES

29th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

Length of presentation and discussion – 20 minutes

9:00 – 11:00 **503 auditorium**
Chair **Vilija ALEKNEVIČIENĖ**

1 **Daniel NILSSON, Håkan ROSENQVIST**
CHARACTERIZATION OF MARGINAL AGRICULTURAL FIELDS IN SWEDEN - AREAS, SHAPES, LOCATIONS, TRANSPORT DISTANCES AND TIME DEMAND FOR MACHINE OPERATIONS

2 **Agnė MIKELIONIENĖ, Danutė VAIČIUKYNIENĖ, Algirdas RADZEVIČIUS, Aras KANTAUTAS**
REMOVAL OF AMMONIUM IONS BY USING ZEOLITIC WASTES

3 **Jarkko NIEMI, Gun WIRTANEN, Ilkka LATOMÄKI, Maija KARHAPÄÄ, Antti PASILA, Risto LAUHANEN, Seliina PÄÄLLYSAHO**
INSECTS – A POTENTIAL PROTEIN SOURCE FOR FEED OR FOOD

4 **Fredrik FOGELBERG**
THE HORTICULTURE HERITAGE OF THE SWEDISH STATE RAILWAY - A BASIS FOR A GREENER ENVIRONMENT IN PUBLIC TRANSPORTATION

5 **Alina DANILOWSKA**
CREDIT SUPPORT FOR AGRICULTURAL LAND PURCHASE IN POLAND - EVOLUTION AND PERFORMANCE

6 **Linas STABINGIS, Daiva RIMKUVIENĖ**
ENTREPRENEURIAL INTENTION AMONG STUDENTS OF BALTIC REGION

POSTER SESSION

28th of June, 2018 Central building of ASU

Section A
SUSTAINABILITY OF AGROECOSYSTEMS

15:10 – 16:30 **5th floor lobby**

A01 **Aida ADAMAVIČIENĖ, Sidona BURAGIENĖ, Kęstutis ROMANECKAS, Egidijus ŠARAUSKIS, Vita SMALSTIENĖ, Rita ČEPULIENĖ**
RELATIONS BETWEEN SOIL PROPERTIES AND CO_2 GAS EMISSIONS FROM DIFFERENTLY TILLED MAIZE CULTIVATION

A02 **Aleksandrs ADAMOVICS, Irina SIVICKA**
AGROECONOMIC EVALUATION OF AROMATIC AND MEDICINAL PLANTS USED FOR THE ENRICHMENT OF GRASSLANDS

A03 **Aleksandrs ADAMOVICS, Rasma PLATACE, Skaidrite BUMANE**
ANALYSIS OF MOISTURE CONTENT AND GROSS CALORIFIC VALUE IN THE MIXTURES OF GRASS AND TIMBER BIOMASS FOR PRODUCTION OF SOLID FUEL

A04 **Vita ALLE, Anita OSVALDE, Uldis KONDRATOVICS, Mara VIKMANE**
INFLUENCE OF LEAD ACCUMULATION ON PHYSIOLOGICAL PARAMETERS AND MINERAL ELEMENT (Mg, Fe, Mn) UPTAKE IN CROP PLANTS

A05 **Rita ČEPULIENĖ, Zita KRIAUČIŪNIENĖ, Simonas MEŠKAUSKAS, Sandra JUCEVIČIŪTĖ**
ALLELOPATHIC INFLUENCE OF WINTER OILSEED RAPE RESIDUES WITH BIO-PREPARATIONS ON GERMINATION OF *SINAPIS ARVENSIS* L.

A06 **Ólafur R. DÝRMUNDSSON**
CHALLENGES AND PROSPECTS OF ORGANIC AGRICULTURE IN ICELAND

A07 **Viktorija GEČAITĖ, Aušra ARLAUSKIENĖ**
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A08 **Oleg GORYANIN, Alexey VASIN, Sergey SHEVCHENKO, Elena SHCHERBININA, Baurzhan DZHANGABAYEV**
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A09 **Birger HJELM, Tord JOHANSSON, Per-Ove PERSSON**
EVALUATION OF FERTILIZATION EFFECT AT PRODUCTION OF STUMP SHOOTS IN POPLAR STANDS

A10 **Hannes KECK, Achim GRELLE, Katharina MEURER**
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A11 **Mykola KOCHIIERU, Virginijus FEIZA, Dalia FEIZIENĖ, Alvyra ŠLEPETIENĖ, Jonas VOLUNGEVIČIUS**
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A12 **Nijolė MARŠALKIENĖ, Liuda ŽILĖNAITĖ, Birutė KARPAVIČIENĖ**
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A13 **Anna MÅRTENSSON**
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A15 **Lina SKINULIENĖ, Vaclovas BOGUŽAS, Marija BUTKEVIČIENĖ, Ingė AUŽELIENĖ**
INFLUENCE OF LONG-TERM CROP ROTATION ON WINTER AND SPRING CEREAL PRODUCTIVITY

A16 **Merili TOOM, Enn LAURINGSON, Liina TALGRE, Sirje TAMM, Lea NARITS**
THE EFFECT OF SOWING DATE ON COVER CROP BIOMASS PRODUCTION

A17 **Vasily VASIN, Alexey VASIN, Irina KOSHELEVA**
PHOTOSYNTHETIC ACTIVITY INDICATORS AND YIELD POTENTIAL OF CORN HYBRIDS WITH MINERAL NUTRITION AND GROWTH STIMULATORS TREATMENT

A18 **Ivo VOOR, Viacheslav EREMEEV, Maarika ALARU, Evelin LOIT**
THE FIELD PEA YIELD AND NITROGEN BALANCE DEPENDING DIFFERENT FERTILIZER RATES

A19 **Vasily VASIN, Alexey VASIN, Arina KOZHAEVA, Irina KARLOVA**
PRODUCTIVITY OF GRASS AND LEGUMES MIXTURES WITH *POTERIUM POLYGAMUM* TREATED WITH GROWTH STIMULATORS

POSTER SESSION

28th of June, 2018 Central building of ASU

Section B
BIOECONOMY AND INNOVATIONS

15:10 – 16:30 **5th floor lobby**

B01 **Anna ANDERSONE, Alexander ARSHANITSA, Sarmite JANCEVA, student Kristaps MAKOVSKIS, Dagnija LAZDINA**
BIOMASS OF SOFTWOOD AND HARDWOOD TREES GROWING ON AFORESTATED FARM OR DEGRADED LANDS FOR BLENDED FUEL PELLETS PRODUCTION

B02 **Katarina ARVIDSSON SEGERKVIST, Anders KARLSSON, Jan HULTGREN**
IS SLAUGHTER AT A MOBILE ABATTOIR BENEFICIAL FOR MEAT QUALITY

B03 **Örjan BERGLUND, Kerstin BERGLUND**
EFFECTS OF FOUNDRY SAND ADDITION ON TRAFFICABILITY, YIELD AND CO_2 EMISSION FROM A CULTIVATED PEAT SOIL

B04 **Alexey BOBRYSHEV**
ESSENCE AND PECULIARITIES OF MONITORING OF SOCIO-ECONOMIC AND SPATIAL DEVELOPMENT OF THE REGION

B05 **Madara DARGUŽA, Zinta GAILE**
WHEAT YIELD AND ENERGY PRODUCED BY IT

B06 **Tlektes ESPOLOV, Asan BAIBOLOV, Yerbol SARKYNOV, Algirdas RADZEVICIUS, Dana TUNGATAR**
RESULTS OF TESTS OF LABORATORY INSTALLATION OF MICROHPP

B07 **Daiga GĀLIŅA, Anda VALDOVSKA**
CHALLENGE OF THE PROBIOTICS ON GROWTH PERFORMANCE AND INTESTINAL HEALTH IN PIGLETS

B08 **Vitaly GRINCHENKO, Maxim MASTEPANENKO, Sergei PIVOVAROV, Zalim GUKEPSHEV**
CONTROL OF TRANSIENT PROCESSES IN MILKING MACHINES

B09 **Lise GRØVA, Inger Anne BOMAN**
WOOL QUALITY OF NORWEGIAN WHITE SPÆL SHEEP BREED

B10 **Aija ILGAZA, Dace KEIDANE, Gita OZOLA**
IVERMECTIN RESISTANCE OF HORSE DIGESTIVE STRONGYLES

B11 **Ismail ISMAILOV, Anna MORGUNOVA, Nina TREGUBOVA, Elena GRUDEVA**
TECHNOLOGY DEVELOPMENT OF PROTEIN-FAT EMULSION AND ITS USE IN FOOD PRODUCTION

B12 **Daina JONKUS, Lāsma CIELAVA, Solvita PETROVSKA**
THE CHANGES OF MILK PRODUCTIVITY AND QUALITY OF LATVIAN LOCAL BREED DAIRY COWS

B13 **Sintija JONOVA, Aija ILGAŽA, Inga GRĪNFELDE, Maksims ZOLOVS**
IMPACT OF THE FLOUR OF JERUSALEM ARTICHOKE ON PRODUCTION OF METHANE AND CARBON DIOXIDE AND WEIGHT GAIN IN CALVES'

B14 **Laima LIEPA, Jurijs BRENTE**
CORRELATION BETWEEN DAIRY COWS' RUMINATION ACTIVITY, PRODUCTIVITY INDICES AND HEALTH

B15 **Alexander LYSAKOV, Gennady NIKITENKO, Evgeny KONOPLEV, Vitaly GRINCHENKO, Anastasia CHAPLITSKAYA, Yaroslav TARASOV, Igor DEVEDERKIN**
THE RESULTS OF STUDIES OF THE CLEANING DEGREE OF AN ELECTROSTATIC AIR CLEANER

B16 **Alexander LYSAKOV, Gennady NIKITENKO, Evgeny KONOPLEV, Vitaly GRINCHENKO, Larisa KIRINA, Yaroslav TARASOV, Igor DEVEDERKIN**
ELECTROPHYSICAL WAYS TO REDUCE POTATO LOSSES

B17 **Maarit MÄKI, Elina HIRVISALO, Heikki ROININEN, Jaana SORJONEN, Pertti MARNILA, Nora PAP, Bengt LINDQVIST, Maija KARHAPÄÄ, Maria TUISKULA-HAAVISTO, Hilkka SILJANDER-RASI**
CHEMICAL AND MICROBIOLOGICAL QUALITY OF *TENEBRIO MOLITOR* AND THEIR POTENTIAL FEED

B18 **Bartosz MICKIEWICZ, Wojciech BROCKI**
CONFLICTS IN BALTIC FISHERIES

B19 **Elin STENBERG, Viktoria OLSSON, Karin WENDIN, Anders KARLSSON, Katarina ARVIDSSON SEGERKVIST**
HOW FOUR TYPICAL SWEDISH PRODUCTION SYSTEMS FOR LAMBS AFFECT SENSORY ATTRIBUTES OF THE MEAT

B20 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Eugeny CHERNOBAY, Tatyana ANTONENKO, Viktor KONOPLEV**
SELECTED METHODS OF FORMATION DESIRABLE PHENOTYPE OF DIFFERENT SHEEP BREEDS

B21 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Nikolay ZLYDNEV, Vitaly MOROZOV, Nikolai BELUGIN, Tatiana ALEKSANDROVA, Elena ZORINA**
GENETIC CAUSES OF BIRTH OF IMPAIRED CALVES AND REPRODUCTION DYSFUNCTION OF A DAIRY HERD

B22 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Nikolay ZLYDNEV, Vitaly MOROZOV, Vladislav ZAKOTIN**
MAINTAINING THE STABILITY OF MILK-YIELD PARAMETERS AND MILK QUALITY IN HIGH PRODUCTION MILK CATTLE

B23 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Evgeny CHERNOBAY, Alexander MARYNICH, Sergey SKLYAROV**
MEAT AND INTERIOR FEATURES OF EWES OBTAINED FROM PARENTS OF DIFFERENT AGE

B24 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Vitaly MOROZOV, Alexander LOSHAKOV, Alexander ESAULKO**
THE USE OF UNMANNED AERIAL VEHICLES IN THE MONITORING OF AGRICULTURAL LAND IN THE STAVROPOL TERRITORY

B25 **Vladimir TRUKHACHEV, Sergey OLEYNIK, Vitaly MOROZOV, Tatiana ALEKSANDROVA, Sergey SKLYAROV, Pavlov ANDREY**
INCREASE OF PASTORALISM EFFICIENCY WITH APPLICATION OF AEROSPACE MONITORING

B26 **Karol TUCKI, Anna BĄCZYK**
THE ASSESSMENT OF THE FUNCTIONING OF PHOTOVOLTAIC INSTALLATION UNDER SMALL HOUSEHOLD CONDITIONS

B27 **Karol TUCKI, Remigiusz MRUK, Katarzyna BOTWIŃSKA, Anna BĄCZYK**
THE DEVELOPMENT OF THE INTERFACE SOLUTION FOR THE ACQUISITION OF INFORMATION FROM THE OBD SYSTEM OF THE VEHICLE

B28 **Yermekkul ZHAPARKULOVA, Madina NABIOLLINA, Balzhan AMANBAEVA, Karlygash KALIYEVA**
THE METHODOLOGY OF PREDICTIVE CALCULATIONS OF BREAKTHROUGH WAVE IN HYDRODYNAMIC ACCIDENTS OF STORAGE DAMS

SUMMARIES OF PRESENTATIONS AT

PLENARY SESSION

NORDIC-BALTIC COLLABORATION TO BOOST PLANT BREEDING FOR THE FUTURE CLIMATE

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Plant breeding in the Nordic and Baltic countries has a long tradition and much in common as it is based on the need to provide plant varieties with specific characteristics to meet the requirements of local growers. Northern Europe represents some of the most northern agricultural areas on Earth wich demands new varieties of crops specially adapted to the unique environmental conditions of the high north. Predicted climate change poses a threat to this long term achievement as rapid rise in temperature will bring new challenges, such as rapid fluctuations in temperature, especially during cold season compromising the snow cover, as well as breach in tight temperature-photoperiod regulation of plant ontogenesis. Given uncertainties will require new idiotypes of plants to meet the challenges of future climate.

In 2008 the Nordic Council of Ministers initiated a mission on defining possible ways of strenghtening Nordic plant breeding. Two years later a Public-Private Partnership (PPP) for Pre-Breeding was established to secure the development of Nordic agricultural plant varieties to meet the demands brought about by climate change and consumer expectations for healthy and tasty products and to contribute to sustainable development of the agricultural sector. Soon after the establishment of the initiative plant breeding institutions from the Baltic countries joined the effort to pool the resources. The success of the PPP is based on four principles: (1) pooled public funding while allowing some countries to move faster; (2) project based participation from plant breeding companies; (3) engagement of the best research environments for the respective projects; (4) 50/50 funding between public sources and industry. Currently four PPP projects are being carried out: Pre-breeding for Future Challenges in Nordic Apples; Combining Knowledge from Field and from Laboratory for pre-breeding in Barley; PPP for Pre-breeding in Perennial Ryegrass and the Public Private Partnership Plant Phenotyping Project (6P). Furthermore the Nordic Plant Phenotyping Network (NPPN) was established to facilitate information exchange and networking of 6P project. In this presentation the experience of the Lithuanian Research Centre for Agriculture and Forestry gained through the collaboration in the established PPP among Nordic and Baltic plant breeding entities will be presented.

Keywords: plant breeding, private-public partnership, climate change.

RURAL TERRITORIES AS SPACE FOR SUSTAINABLE AND SMART DEVELOPMENT

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Rural territory is an important part of the community's living space, moreover, it is a living space for sustainable and smart development. With the growing public demand for a healthy living environment and healthy food, the role of rural territory as a living space for community and the necessity to maintain its sustainable development is increasing. However, the sustainability of the rural territories as a living space will be preserved only when residents will be ready for the changes, brought by the general development trends of the world and if the power structures (state institutions and local governments) are promoting trends politically and practically. The rural space has changed for centuries; however, the challenges of the 21st century impose demands for more rapid change, while demanding skills after innovative and traditional balancing at the same time.

The aim of the research: to assess the economic growth of the rural areas in Latvia for promoting sustainable and smart development direction during 2009-2016.

The EU and Latvian Rural Development Policy for 2014-2020 has been used as the methodological base of the research. The data were processed by quantitative (growth) and qualitative (structural change) statistical analysis, as well as grouping methods.

As information sources for the analysis was used: The Global Competitiveness Index9WEF 2016 – 2017.); Eurostat classification of industries (NACE Rev 2, 2008); LURSOFT and CSB data of changes in national economy; survey results on the contribution of "growth agents" to the sustainable and smart development of rural areas.

The analysis of the information allows making a number of conclusions. Firstly, Latvia has received the lowest competitiveness rating among the countries of the eastern coast of the Baltic Sea (Poland, Lithuania, Latvia, and Estonia). At the same time, it showed the highest growth rates and reduced distances between these countries. Secondly, the reduction of these differences was significantly influenced by the growth rate of the knowledge economy segment in Latvia. Thirdly, the growth of the knowledge economy in the rural territories has been faster than in larger cities, which has reduced the gap between cities and rural areas in the field of smart economy. Fourthly, the rural space has confirmed its suitability for the innovative functioning and growth of the economy, which creates the preconditions for sustainable and smart rural growth.

Keywords: rural territories, sustainable development, smart growth.

FOOD SECURITY IN NORWAY – LEGITIMACY AND POLICY DESIGN

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According to economic theory, market interventions with support and regulations may result in efficiency losses and can, in principle, only be justified by possible market failures. Lack of efficient private commodity and risk markets can cause such failures due to unstable food supplies and large price fluctuations. In affluent countries such as Japan, South Korea, Switzerland and Norway, with high purchasing power, residents will usually have enough and safe food for a healthy diet, even in periods of international food price spikes.

A free competitive economy may fail to "produce" enough public (common) goods compared to the social benefits of the good (for example, cultural landscapes). This can legitimize governmental interventions in the market with support and regulations in order to reach social optimality regarding market solution. Food security or food preparedness can thus be regarded as a public good that agriculture "produces" in addition to food, fibre and different services in the marketplace.

Norwegian food security should be about preparedness for crises where food supplies can be temporarily or more permanently threatened. Short term crises may arise from trade policy measures introduced in other countries, conflicts or war in our region, major environmental and pollution disasters, as well as outbreaks of serious plant and animal diseases. Moreover, earthquakes, volcanic eruptions, over-population, resource shortages and climate change can lead to long-term global food supply failures and require a different handling. Several crises may also occur at the same time. The risk of the different kind of crises may vary significantly but may be said to be small for crises related to conflicts and war in our region.

A well-functioning international trading system can ensure that food and feed imports will be possible in various crises. Storages of agricultural products and inputs (grain, seed and fertilizers) may be of importance in handling short-term food supply crises and provide time for conversion in cases of long-term changes. Storage can be done privately in the value chain for food or in publicly funded warehouses. In more prolonged food emergency situations, domestic production and changes in the diet to more farmed and wild catched fish, potatoes, cereals and horticultural crops and less of livestock products will have to take place.

Keywords: food security, Norway, legitimacy, public good, food supply crises, policy design.

SUMMARIES OF PRESENTATIONS AT

PARALLEL SESSIONS

CULTIVAR MIXTURE – A MULTIFUNCTIONAL CROPPING SYSTEM LINKING PLANT-PLANT AND PLANT-INSECT INTERACTIONS

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Biodiversity in agricultural landscapes has been declined rapidly in recent decades with drastically increased extinction rate of species and threatened ecosystem services as a consequence. If biodiversity is to be restored and opportunities created for sustainable food production, cropping systems must optimize functional diversity instead of minimizing it. Increased plant genotypic diversity in crop fields can promote ecosystem services, but understanding of mechanisms underlying the impact of crop genotypic diversity on productivity and pest responses is limited.

Volatile signals of plants can be exploited by nearby plants as a cue for competitive neighbors, thus inducing growth responses that increase the competitive power of eavesdropping plants. Plants modify their growth in response to different signals by partitioning biomass between above- and belowground. Aphids are sensitive to slight changes in their host plants and might be negatively affected. This PhD project aims to develop high yielding organic cropping systems that are resilient to insect pests and enhance functional biodiversity. We investigated chemical volatile interactions between barley cultivars and how these affect aphids.

The results of laboratory experiments show that plants can perceive the growth pattern of different neighboring genotypes through volatile organic compounds, and adapt their own growth strategy accordingly. These induced growth changes in turn made receiving plants less acceptable for aphid settling. In field experiments barley cultivars were grown in two genotype mixtures and monocultures. We measured plant traits during two growing seasons and studied aphid population development in these systems. Cultivars responded to mixtures with adaptive plasticity in several traits including productivity, and these responses depended on neighbour identity. Further, aphid population development on one cultivar in a mixture was also neighbour-specific, and this was more important for suppression of aphid populations than the overall mixture effect, aphid colonization patterns or natural enemy abundance.

The results of our studies show that combining cultivars in mixtures, based on how they interact with each other, is a promising strategy for the development of sustainable crop production and pest management.

Keywords: adaptability, biodiversity, herbivore suppression, volatile communication, plant plasticity.

INVESTIGATING ENVIRONMENTAL FACTORS CAUSING VARIATION IN GLUTEN QUALITY

Anne Kjersti UHLEN[1,2], Shiori KOGA[2], Katherine Ann Gredvig NIELSEN[1,3], Heidi Udnes AAMOT[3], Ulrike BÖCKER[2], Eva VEISETH-KENT[2], Ingerd Skow HOFGAARD[3]

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Variation in gluten quality due to environmental factors can be substantial, but the causes of this variation and the biological mechanisms are not well understood. This type of variation is however challenging to handel for the value chain which aims to produce wheat flour of optimal and stable gluten quality across batches of wheat. In Norway, the environmental variation in gluten quality in spring and winter wheat has been investigated during the period 2005-2017 by yearly analyzing samples from variety trials from 4-8 locations. The results showed large variation in gluten quality between seasons, and also between field trials within season. In some cases, incidents of very weak gluten quality has been found, linked to some environmental conditions.

Several types of experiments have been carried out to investigate environmental factors that may causes the variation in gluten quality. Experiments in controlled climate chambers were set up to study effects of low temperature on composition and polymerisation of gluten proteins. Characterization of the proteins from field samples having very weak gluten showed incidents of enzymatic degradation. As exogenic proteases from *Fusarium* spp. were suspected, effects of Fusarium Head Blight infestations on gluten quality were investigated. Pot experiments in greenhouse and inoculation with several *Fusarium* spp. at anthesis were carried out. Gluten quality of grain samples were analysed by electrophoretic, chromatographic and rheological methods, and protease activity was detected by zymography. Candidate proteases were identified by proteome analyses. Furthermore, experiments have been conducted in field to follow the accumulation and assembly of glutenin polymers during the later part of grain filling, especially in the desiccation phase after yellow ripeness.

The results showed that a low temperature during grain filling *per see* does not cause the large variations in gluten quality that can be found in field samples. The inoculation experiments with *Fusarium* ssp. confirmed that fungal infestations can cause a substantial weakening of gluten, similar to what was observed in some field samples. This was probably caused by proteases originally released by pathogens to utilize plant proteins as their nutritional sources. Frequent precipitation during the desiccation phase seemed to hinder the assembly of large glutenin polymers.

We conclude that infestations by Fusarium Head Blight pathogens during the grain fylling are a environmental factors causing variations in gluten quality. This needs to be investigated further and should include other pathogens that are commonly infesting wheat grains during grain development and maturation.

Keywords: wheat quality, gluten proteins, environmental factors, Fusarium infestations, proteases.

BALTICWHEAT NETWORK FOR SUSTAINABLE WHEAT PRODUCTION IN THE BALTIC SEA REGION

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Agriculture is one of the main sources of pollution in the Baltic Sea, causing an enrichment of water by nutrient compounds (Eutrophication) due to the leakage of nitrogen and phosphorus from fields and emissions from fertilizers and manure. Wheat (*Triticum aestivum* L.) is the most widely grown cereal crop in the Baltic Sea region and sustainable wheat cultivation is necessary for reducing pollution in the Baltic Sea. The total area under wheat cultivation and wheat production in the region has grown steadily between 2007 and 2016 and increased on average of 1.18% and 1.26% per annum, respectively. The growth in production is attributed to the increase in acreage and adoption of improved wheat breeding and crop management practices. However, available land for wheat is limited and thus sustained high grain yields of wheat should be produced per given area without compromising the environment. Furthermore, increased risk of abiotic and biotic stresses due to Global warming and expected extreme climate conditions cause serious threat for future wheat production.

For sustainable wheat cultivation in the Baltic Sea region, wheat cultivars with stable and high yields and adapted to the local environmental conditions are necessary. These new cultivars should have better tolerance for freezing and drought stresses, improved nutrient use efficiency (NUE), water use efficiency (WUE) and increased resistance to diseases. A combination of improved wheat cultivars and good farming practices can significantly reduce the impact of wheat cultivation on the environment. To accelerate development of improved cultivars, however, integrated transnational collaborations for pre-breeding and technology sharing are necessary. BalticWheat network focused on wheat breeding was established recently by participants from 10 organisations in 7 countries across the Baltic Sea region with an overall goal of identifying strategies to develop wheat cultivars for sustainable agriculture, involving transnational collaboration with academia and industry and utilizing existing resources and modern breeding techniques. In the presentation, major challenges and possible solutions for sustainable wheat cultivation in the Baltic Sea region will be highlighted and discussed.

Keywords: adaptability, Baltic Sea, breeding, wheat, sustainability, yield.

DEVELOPMENT OF WINTER WHEAT DISEASES DEPENDING ON AGRONOMIC PRACTICE

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Soil tillage and crop rotation are described as important tools in wheat disease control; however, the results are different depending on year, site and others factors. The aim of the present study was to determine the effect of the soil tillage and cropping sequence on the level of winter wheat diseases. The development of winter wheat diseases was assessed in a two-factorial experiment at the Study and Research farm "Peterlauki" of the Latvia University of Life Sciences and Technology: A – soil tillage system (A1 – traditional soil tillage with ploughing at the depth of 22–24 cm; A2 – reduced soil tillage with disc harrowing up to the depth of 10 cm); and B – crop sequence (B1 – continuous wheat); B2 – oilseed rape and wheat; B3 – crop rotation where barley and faba beans were included. Trials were started in 2008, but data from 2012 till 2017 were analysed in this study, except for the year 2014, when plots were resown with spring wheat. Incidence (%) of wheat crown rot was assessed visually shortly before harvesting, severity (%) of leaf diseases were notted during all season of vegetation, but total impact of leaf diseases was evaluated by AUDPS (area under diseases progress stairs) calculation.

Severity of all diseases fluctuated depending on year, but impact of agronomic practise have been found.

Tan spot (caused by *Pyrenophora tritici-repentis*) and Septoria tritici blotch (caused by *Zymoseptoria tritici*) were the dominant diseases, also mildew (caused by *Blumeri graminis*) were observed throughout the whole investigation period, althought severity of mildew was too low for evaluation of promoting factors, but other leaf diseases were not detected. Level of Septoria tritici blotch was not influenced by agronomic practise. In opposite, these factors influenced development of tan spot. The level of tan spot was higher in plots without ploughing (except fields with crop sequence). Ploughing mitigated the effect of wheat as a pre-crop or a pre-pre-crop, and short crop rotation decreased the level of tan spot. In ploughed fields, short crop rotation (only wheat and oilseed rape) also provided sufficient control of tan spot, and, in contrast, short rotation was not effective if the fields were not ploughed.

Soil tillage method did not influence development of crown rot, but impact of crop sequence was significant. Continuous wheat sowings promoted development of disease, also short crop rotation, where only wheat and oilseed rape were included did not decreased infection with causal agents of crown rot essentially. Although impact of soil tillage was not proved, but importance of crop rotation was shown more clearly under reduced soil tillage. *Oculimacula* spp. and *Fusarium* spp. were recognized as most important and most widespread causal agents of wheat crown rot.

Soil ploughing and crop rotation have had impact on the some diseases, but did not allow to decrease level of all disesaes, effect of agronomic practise is depending on biological peculiarities of pathogens, also meteorological conditions can mitigate influence of soil tillage and crop rotation.

Keywords: *Pyrenophora tritici-repentis*, *Zymoseptoria tritici*, crown rot, crop sequence.

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SIMULATION OF GRAIN MAIZE DEVELOPMENT UNDER WATER AND TEMPERATURE STRESS

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Lithuanian farmers face significant risks because of low temperatures and occasional water shortage when attempting to benefit from climate warming by expanding maize growing for grain. The aim of this study was to investigate maize development and to analyse the suitability of two models of different complexity to simulate maize growth under temperature and water stress conditions. Field experiments with a short season maize variety AGIRAXX were conducted in 2015 and 2016 at Lithuanian Research Centre for Agriculture and Forestry on a sandy loam. Experimental plots, applied with N 170, were chosen for the simulation to represent non-limited nitrogen nutrition conditions. Total biomass and leaf area of maize were measured periodically at vegetative and reproductive growth stages. The soil water content was measured weekly at depths of 10, 30 and 60 cm. The AquaCrop and AgroC models were calibrated and validated using data sets of cool/dry (2015) and warm/wet (2016) seasons. Both models reproduced the total biomass development during growth period relatively well. In 2015, the RMSE for AquaCrop was 0.69 t ha^{-1} (R^2 = 0.98) and for AgroC the RMSE was negligibly larger 0.86 t ha^{-1} (R^2 = 0.97). In 2016, the corresponding values were 1.33 t ha^{-1} (R^2 = 0.97) and 0.54 t ha^{-1} (R^2 = 0.99) for AquaCrop and AgroC, respectively. The simulated canopy cover values corresponded to the experimental measurements fairly well: for AquaCrop the RMSE for the 2015 and 2016 seasons was 7.0 and 4.0% (R^2 = 0.99 and 0.97), respectively, and for AgroC the RMSE was inappreciably higher 11.7 and 17.0% (R^2 = 0.71 to 0.76), respectively. Soil water content levels were similar to the field measurements. Under climate conditions of the experimental site, AgroC predicted a fairly high potential grain yield of 11.25 – 11.85 t ha^{-1}, while that predicted by AquaCrop amounted to 10.31 – 10.95 t ha^{-1}. Grain yield reduction due to the abiotic stress simulated by AquaCrop was 3.41 t ha^{-1} in cool/dry season and 2.02 t ha^{-1} in warm/wet season. The respective values for AgroC were 4.32 and 2.84 t ha^{-1}. Our study provides experimental evidence of maize grain yield levels above 9 t ha^{-1} for Lithuania in years with favourable temperature and rainfall regime and optimum management. Despite the climate warming, the low temperatures occurring during the vegetative stage, remain the dominant factor for potential yield losses, while the impact of water stress is of secondary importance.

Keywords: AgroC, AquaCrop, potential yield, temperature stress, water stress.

NEED FOR MORE DETAILED GREENHOUSE GAS EMISSION MODELS TO ESTIMATE CARBON FOOTPRINTS OF AGRICULTURAL PRODUCTS

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There are large uncertainties in estimating direct nitrous oxide emissions from soils as well as methane emissions of enteric fermentation of cattle. Still currently, IPCC default factors and methods are widely used in Life Cycle Assessment (LCA). LCA is broadening fast from engineering to agricultural field, and also European Commission is planning environmental information policies based on LCA. But the development of emission models is still on-going and creates large uncertainties. Here, we test new more specific greenhouse gas emission models on beef case study, and analyse their effect.

In national FootprintBeef-project, environmental impacts of Finnish beef production was modelled combining biological animal and crop model with LCA modelling. Direct nitrous oxide emissions from cultivated mineral soils were assessed with IPCC default factor and model 3 presented in Regina et al. (2013). Also two different calculation methods were applied to estimate enteric fermentation emission: 1) methane energy proportion of gross energy as in equation 13 in Ramin and Huhtanen (2013) and 2) gross energy calculation equations based on IPCC 2006 which are also used in Finnish national inventory report (NIR) (Statistics Finland, 2015).

Estimating direct nitrous oxide emissions from mineral soils with a model differentiating between annual and perennial crops increased the emissions of grain cultivation required by a dairy breed bull by nearly 10 per cent while decreasing emissions from silage and pasture by more than 30 percent. In total, the emissions of feed production decreased by 7 per cent in the case study.

Estimating methane emissions of enteric fermentation with a model based on metabolisable energy intake instead of IPCC Tier 2 method based on gross energy intake, increases methane emissions by more than 10%.

With the model of Regina et al. (2013) it was possible to estimate N_2O fluxes from grass and annual spring crops from mineral soils for Finland with more precision than the IPCC default methodology. This is particularly crucial for ruminants, which utilise grass extensively. In the same manner, more detailed and specific models for enteric fermentation are needed. The model by Ramin & Huhtanen (2013) takes into account detailed feed dietary ingredient composition, and thus, seems more robust than methods by IPCC.

Most importantly, the results highlight the importance of developing more specified emissions estimation models to be used in evaluation of products' carbon footprints by Life Cycle Assessment. Consequently they allow more reliable estimates of environmental impacts of agricultural products in the market and can enhance greening production and consumption.

Keywords: greenhouse gas emissions, methane, nitrous oxide, modelling, beef.

MARGINAL ABATEMENT COST CURVES IN ANALYSING GHG EMISSIONS FROM AGRICULTURAL HOLDINGS IN LATVIA: THE CLUSTER APPROACH

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Climate change poses challenges that are relevant to agricultural production both in Latvia and throughout the world. Latvia ranks second in the European Union (EU) by the share of agricultural emissions in total GHG emissions, while agricultural activity in Latvia tended to increase every year, which also contributed to an increase in GHG emissions from agricultural activity. GHG emission reduction measures for Latvia are not new and unusual, as several GHG emission reduction measures are being implemented in the agriculture of Latvia in the long-term, for example, the production of biogas, the incorporation of legumes into crop rotation, and the drawing up of fertilization plans. However, so far, there was a lack of scientific evidence and calculations in Latvia that could demonstrate the potential for reducing GHG emissions, their effectiveness, and whether additional measures are needed in order for Latvia to meet its international obligations. A popular way to analyse GHG emission reduction measures is to use a Marginal Abatement Cost Curve (MACC), which ranks GHG emission reduction measures based on their cost and emission reduction potential. The research analysed 17 measures having GHG reduction potential by using a MACC. In addition, being aware of the diversity of agricultural holdings, the cluster approach was used. The research constructed 5 MACCs for typical groups of agricultural holdings. The research results allow policy makers to develop a precise and effective climate policy in agriculture.

Keywords: GHG emissions, MACC, reduction measures, agriculture.

IMPACT OF NORTH ATALANTIC OSCILLATION ON SWEDISH WINTER CLIMATE AND NUTRIENT LEACHING FROM ARABLE LAND

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Winter climate in the Nordic countries may be influenced by the North Atlantic Oscillation (NAO), commonly defined as the difference in air pressure between northern and southern Atlantic points. Its intensity is expressed as an index (NAO_i). A high index is generally associated with warm humid air. NAO_i has been suggested for use in assessing nutrient leaching from arable land to water and the effects of mitigation measures. Using open data from the Swedish Meteorological Institute (SMHI), we found long-term significant ($p<0.05$) positive linear relationships between winter NAO*i* (November-April) and temperature, and between winter NAO*i* and precipitation, in the period 1950-2016 in south-west Sweden. More recent data (2004-2016) revealed significant ($p<0.05$) positive linear relationships with air freezing/thawing indices (AF_i-AT_i) in southern and central Sweden. In 2004-2016, which included one year with unusually low NAO*i* and three years with unusually high NAO*i,* there were also significant negative linear relationships between NAO*i* and a snow depth index (SD_i). However, the relationship between NAO*i* and precipitation was not consistent. Management (farmer interviews) and nutrient leaching (flow-proportional water sampling) were studied (2004-2016) in two artificially drained agricultural catchments: a mini-catchment (20.7 ha, code 11M, siltyclay loam soil) and neighbouring catchment (788 ha, code M36, sandy hills with central, heavy clay plain) in north-west Scania. Total nitrogen (TN) and total phosphorus (TP) leaching increased significantly with winter NAO_i (November-April) in both catchments. Use of slurry was low in catchment M36 and no slurry was incorporated in winter in recent years in catchment 11M. Very low winter NAO_i (-0.98) gave the highest concentration of dissolved reactive phosphorus (DRP) in catchment 11M, while TP concentration in other forms (other P) was moderate (0.12 mg L^{-1}). Concentration of other P (1.02 mg L^{-1}) was elevated in 11M in 2014/15, after a large (32% of area) internal buffer (unfertilised fallow after grass ley, strategically located in a central ravine) was ploughed down in autumn 2014. No general trend in P or N mineral fertilisation was observed in catchment M36. Thus NAO*i* may affect nutrient leaching and could be integrated into climate-chemical indicators and trend analyses of water quality.

Keywords: air freezing/thawing, snow depth, nitrogen leaching, phosphorus leaching.

SOIL BIOLOGICAL PROPERTIES IN FOREST AND AGRICULTURAL ECOSYSTEMS

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Soil management often results in changes of soil biological properties, particularly, of soil microbial communities. Certainly, the management is closely related to reduction of soil organic matter with reduction not only the nutrient availability but also the soil microbial biomass potentials. However, the retention of soil could lead to reduction of organic carbon. To understand how management can change soil biological properties, we studied soil microbial abundance, microbial biomass in soil and content of amino sugars in microbial biomass under agricultural management (conventional tillage under different soil genesis). The biological properties in selected agricultural sites were compared to that of mature forest sites in Lithuania. It was obtained, that management of agricultural soils was evidentially changing the soil microbial abundance. Further, the microbial abundance was decreasing in correspond to management intensity, on the contrary, increasing in soil under the forest sites. It was also reflected, that microbial abundance in managed agricultural sites not only increased with soil depth but also with coinciding intensive soil mineralogical changes. Either, the soil management influenced on the content of soil microbial biomass. The microbial biomass presented to be high sensible to soil tillage in agricultural sites. Thus, the content of amino sugars in microbial biomass decreased associated with the intensification of soil management. Thus, in forest soils the content of amino sugars was changing not significantly, whereas with different soil genesis, it was more expressed.

Keywords: soil, agriculture, forest, microbial abundance, biomass, amino sugars.

DEMO AGROFORESTRY SYSTEMS OF TREES AND PERRENIAL GRASES

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Agroforestry – as the integration of woody vegetation, crops and/or livestock on the same area of land are not included is Latvia agronomy or forestry statistics and are not mentioned in any rules except translation of EU directives in Latvian. However, Latvia has a unique heritage of traditional agroforestry systems with a high environmental and cultural value - as silvopastural system, meadows with bushes and coppicing trees planted on hedges, anyway Latvia has a high potential for more and innovative modern agroforestry systems. Our experimental demo fields are innovation in Latvia, may be even Baltic scale. We established system where trees are growing between parcels or perennial plants – intercropping for multifunctional use.

Aim of research was test intercropping systems of deciduous trees with perennial plants. Fast growing trees Aspen, Poplar, Tilia, Wild cherry, Maple were planted in intercropping system with Festolium, reed canary grass (RCG), lupin and galega. At least two scenarios are possible for use of biomass - for energy and seed production. Trees were planted 2.5 m by 5 m wide rows, between rows perennial plants were sown in 2.5 m wide strips. Tree kind fertilizers - residues of biogass production, waste water sludge, wood ash were used as initial fertilizers.

Seed yield and biomass of grasses and legumes as well dimensions of trees increases under all kind of fertilisers used. The tree measurements and the results of yield and economical calculations made allow announce that mix of agriculture perennial plants and trees as woody crops promote ingrowing of trees and make positive cash flow already at second or third year. Wood ash and waste water sludge as fertiliser were more suitable for reed canary grass and galega, but mineral fertilisation - for reed canary grass and festulolium, without fertilisation - festulolium and galega. Poplars had better growths when wood ash is used. But waste water sludge and biogass production residue, which are nitrogen rich fertilizers, increased growth of and other tree species planted.

Keywords: aspen, poplar, wild cherry, tilia, galega, festolium, reed canary grass, lupin.

CAPABILITY OF TILLAGE PRACTICES FOR WATERLOGGING RISK REDUCTION IN TWO SOIL TYPES OF GLACIAL GENESIS

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Predicted increase of precipitation at the Baltic Sea region may result in the risk of waterlogging on glacial soils.

Four field experiments were set up on loamy *Dystri-Epihypogleyic Retisol (Retisol* (L)*, Endocalcari-Epihypogleyic Cambisol (Cambisol* (L) and *Cambisol* (SL) of morainic genesis and on clayey *Endocalcary-Endohypogleyic Cambisol* (*Cambisol* (CL/C)) of limnoglacial genesis in Lithuania. Three typical soil management practices were investigated in each experiment: 1) CT - Conventional tillage (stubble cultivation + deep mouldboard ploughing + presowing shallow cultivation), 2) RT - Reduced tillage (shallow stubble cultivation + presowing shallow cultivation), and 3) NT – no soil cultivation in *Cambisols* or ShPL - shallow ploughing in *Retisol*.

The aim of this study was to evaluate capability of tillage methods as management practices contributing to waterlogging reduction.

Data revealed that content of water stable aggregate (WSA) and the ratio between large pores which governs water regime and micropores were lower in soil with limnoglacial than in soils with morainic genesis. The increase in clay content caused the increase in aggregate stability by sequence from upper to deeper topsoil layer in *Cambisols* (L, SL and CL/C) only. Hydraulic conductivity (Ks) significantly depended on water saturation in morainic but not in limnoglacial soil. The increase in WSA content determined the increase in Ks by sequence from deeper to upper layer in morainic *Retisol* (L) only. The increase in clay content reduced water saturation in all soils and reduced Ks in morainic soils by sequence from upper to deeper layer. The action of soil organic carbon (SOC) as driving factor for Ks was clearly pronounced in fine-textured soils (morainic *Retisol* (L) and limnoglacial *Cambisol* (CL/C)). The decrease in SOC content determined the decrease in Ks by sequence from upper to deeper layer. SOC in morainic *Cambisols* (L and SL) acted as indirect factor. Ks and water flow character determined capability of different tillage systems for waterlogging prevention.

In summary, considering to possible climate change scenarious, the controlling of soil management intensity allows to maintain soil physical state and environment sustainability. Reduction of management intensity is advisable by raising the sequence of benefits: *Cambisol* (CL/C) → *Retisol* (L) → *Cambisol* (L) → *Cambisol* (SL). In *Cambisol* (CL/C) long-term CT, in *Retisol* (L) ShPL, in *Cambisol* (L) RT and in *Cambisol* (SL) long-term NT management could be considered as management practices protecting soil from waterlogging.

Keywords: clay, organic carbon, saturation, soil structure, water flow.

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LONG –TERM IMPACT OF REDUCED TILLAGE UNDER CLAYEY SOIL CONDITIONS IN NORTHERN LITHUANIA

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Heavy soils (clay loams and clays) are typical for Northern Lithuania. These soils having poor physical properties by origin require more intensive tillage to maintain proper physical condition for grown crops. On the other hand, intensive tillage often does not meet environmental requirements. Therefore, choose of suitable tillage system and other additional measures are essential for good soil physical state maintenance, suitable crop growth conditions and environmental sustainability. Research objective was to evaluate the long-term agronomic impact of different intensity tillage as well as its combinations with supplementary practices on improving of soil physical conditions and crop productivity. The experiment, established in 2006, examined the influence of deep and shallow ploughing, shallow ploughless tillage, combinations of ploughless tillage with incorporation of lime sludge and cover crop for green manure and application of the same cover crop for mulch during winter without autumn tillage (no tillage) under spring and winter crop growing conditions on clay loam Endocalcary-Endohypogleyic Cambisol (siltic, drainic). Application of cover crop winter mulch without tillage in autumn, shallow ploughless tillage and shallow ploughing causes the compaction of lover (15-25 cm) topsoil layer. However, due to ploughless tillage the soil dry bulk density in subsoil (25-35 cm) layer is less compared to deep ploughing. Soil structure in the seedbed (0-5 cm) and in the upper (0-15 cm) topsoil layer is usually worse when applying the ploughless tillage or no tillage in autumn with cover crop mulch. Incorporation of lime sludge by ploughless tillage helped to avoid the compaction and structure worsening in upper topsoil layer, as well as increase aggregate stability. Application of ploughless tillage increased soil water content at upper topsoil layer immediately after spring crop sowing. However, due to shallow reduced tillage the water content in all topsoil markedly decreased when droughty periods lasted for a long time. It is expedient to use reduced ploughless tillage for winter cereals in clayey soils. Spring crops are more sensitive to reduced tillage than winter crops. Susceptibility (based on productivity) of spring crops due to reduction of tillage increased as follows: spring barley → spring rape → field pea. Spring crop yield decreased most when cover crop was left for mulching without tillage in the autumn. The use of lime sludge in combination with reduced tillage often increased the yield of spring and winter crops compared to the ploughless tillage alone. Combination of reduced tillage with cover crop for green manure and no tillage with cover crop for mulch is significant for preserving the environment. Such application of cover crops reduces the leaching of mineral nitrogen into the deeper soil layers and environmental pollution. This work was supported by the National Science Program "The effect of long-term, different intensity management of resources on the soils of different genesis and on other components of the agro-ecosystems" (grant number SIT-9/2015) funded by the Research Council of Lithuania.

Keywords: cover crop, crop yield, lime sludge, mineral nitrogen, soil physical state.

CHANGES IN THE MAIN HEALTH INDICATORS OF A RETISOL UNDER DIFFERENT MANAGEMENT HISTORY

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Soil health refers to the ecological equilibrium, functionality and capacity to maintain a well balanced agroecosystem. To use soil health as a tool for sustainability, physical, chemical and biological properties must be employed to verify which of them respond to different soil management. This research focused on an integrative view on indicators of a Retisol health to be used as tools of agroecosystem sustainability. The paper presents achievements of long term research (long-term liming, organic fertilization and tillage of different intensity) carried out in Vezaiciai Branch of Lithuanian Research Centre for Agriculture and Forestry. The study site is LAMMC, Vezaiciai Branch situated in West Lithuania, eastern fringe of the coastal lowland (55°43‘N, 21°27‘E). The object of investigation is a naturally acid soil Bathygleyic Dystric Glossic Retisol (texture – moraine loam with a clay-sized particle content of 12-14%) and the same soil exposed for more than ten years to tillage of different intensity (deep and shallow ploughing and shallow tillage with and without deep loosening every 4 years) and for half a century exposed to different periodic liming (0.5 rates every 7 years and 1.0 and 2.0 rates every 3-4 years) whose rates are calculated accoring to soil hydrolytic acidity and liming (1.0 rate every 5 years) in combination with famyard manure (40 and 60 t ha^{-1}).

Different soil uses (long-term tillage, liming and manuring) were found to lead to changes in Retisol chemical, physical and biological properties under moderately warm and humid West Lithuania’s climatic conditions. The intensive soil tillage (deep ploughing and its combination with deep loosening) disturbs some attributes associated with soil health - decreases organic carbon, deteriorates structure and decreases the stocks of main nutrients, while the less aggresive soil management was shallow soil tillage without deep loosening.

The obtained research findings suggest that soil pH, exchangeble Al and Ca, water soluble aluminium, organic matter and nutrient levels are the main chemical attributes correlated with plant yields and allow a quick improvement by proper liming and its combination with manuring. Soil pH is a key indicator in assesing Retisol’s health because it directly correlates with nutrient availability, dissolved organic carbon and also affects microbial activity and weed seed bank in the soil. Soil organic carbon is also a major attribute of soil health because it generally positively correlates with total organically bound aluminium, aggregates stability, soil bulk density and porosity, storage of nutrients and microbial activity. Soil microbial carbon has been used as a promising indicator of soil health due to its rapid responses to investigated agronomic practices and climatic conditions.

Keywords: soil health indicators, liming, tillage, manure.

THE INFLUENCE OF LONG-TERM TILLAGE AND RESIDUE MANAGEMENT ON TOPSOIL QUALITY IN SOILS WITH DIFFERENT TEXTURE

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It is known that all processes in different soils act in close interdependence and are site- and soil-specific, and climate and human activity dependent. Many studies have been done worldwide on soil structural composition, soil organic carbon (SOC) sequestration and soil greenhouse gasses efflux investigation, although most of published results were obtained in conditions different from the soil type, texture and climate conditions in the Nemoral-2 environmental / Boreal climatic zone. The effects of long-term tillage practices on soil properties are seldom reported in Boreal conditions.

The objective of this study was to estimate the subsequent long-term cumulative effects of 17 years of conventional (CT) and no-tillage (NT) in combination with straw removal or return, on SOC accumulation, soil pore-size distribution (PSD), water release characteristics (WRC) and CO_2 efflux on loam and sandy loam within a 0–10 cm layer of *Cambisol* during the main development stages of winter wheat.

A more pronounced superiority of NT over CT for SOC sequestration rate within the topsoil layer emerged on loam than on sandy loam. Furthermore, SOC sequestration rate under residue removal was 48% higher than under residue return conditions. In sandy loam, the SOC sequestration rate under NT over CT was similar in both residual backgrounds. The total volume of transition and storage pores, which is responsible for better soil water movement, was higher in sandy loam then in loam and under NT than under CT. However, a higher retention of topsoil moisture during the main growing stages of winter wheat was on loam than on sandy loam.

Straw on loam acted as a material for soil loosening by increasing the total volume of pores securing soil water exchange, i.e. fissures, transition and storage pores. Meanwhile, on sandy loam, the straw acted as a pore clogging material by decreasing the total volume of the same pores. Consequently, on loam, in spite of a high capability of NT with residue return to storage plant available water (PAW), the topsoil moisture during dry weather conditions at the growing of winter wheat was lower than under other soil management practices. On sandy loam, NT with residue returning governed the highest PAW content and maintained the highest topsoil moisture. Nevertheless, the highest potential to reduce CO_2 efflux on both loam and sandy loam has been demonstrated by CT with residue return.

Keywords: no-tillage, residues, top-soil, pore-size distribution, soil organic carbon, water content, soil texture.

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INTERNATIONALIZATION OF SOIL CLASSIFICATION – OBJECTIVES AND POSSIBILITIES

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International communication requires a common framework in different areas, and the soil is not an exception. Historically, every country has its own soil classification system developed and used for decades. These systems are good for national use and well fit to characterize local soil conditions. But unfortunately not for international use, e. g., for EU scale communication or even for Global Soil Partnership organized under the leadership of FAO. Actually, an alternative exists – the World Reference Base for Soil Resources (WRB) – the system designed to correlate the soil information among national classifications. But there is an open question – how to realize it? By intercalibration of national soil classification taxa with WRB ones or by classifying soils parallely according to one system and another? The first option might be more favourable, but – is it feasible?

Several attempts were made to find some correlation scheme for comparison of Latvia Soil classification with WRB. Both systems are constructed using an essentially different approach. Latvia soil classification is based on the principles of soil genesis and evolution, but WRB is strongly morphological oriented. This distinction makes direct comparison next to impossible. A similar problem is common in many countries. Therefore, the only realistic solution is to carry out training programs and to teach students (specialists) direct use of both soil classification systems – Latvia (national) and WRB. To facilitate the teaching and training process, the EU funded project "Freely Accessible Central European Soil" within the ERASMUS+ programme "STRATEGIC PARTNERSHIPS is run by the leadership of Nicolaus Copernicus University in Toruń (Poland). A team from nine universities representing Eastern and Central European countries (Poland, Czech Republic, Slovakia, Slovenia, Hungary, Lithuania, Estonia, and Latvia) is developing teaching tools (both printed and electronic), organizing soil tours and seminars for students, and collecting representative soil data across the countries of participation.

Besides students' training and development of teaching tools, some additional expertise should be obtained during numerous field expeditions in participating countries where soils were studied. The international team comprises soil specialists at different areas of expertise (geology, geomorphology, soil genesis and morphology, etc.) important for multidisciplinary research. These activities help better understand the advantages and shortcomings of both national classification and WRB.

The challenge of any soil classification is to characterize all soils in the region as well (informative, detailed, etc.) as possible. But none of the systems can cover everything, something is always left out. Are missing details important, and should they be incorporated into classification? Or is something too much for practical application of the classification scheme? How does WRB work in specific conditions? How to present the didactical tools for better understanding of the ideas of soil classification using both the national and international system? These are the main topics and outcomes of the realised project. The investigation was carried out within the framework of the project 2015-1-PL01-KA203-016480 "Freely Accessible Central European Soil".

Keywords: WRB, Latvia soil classification, students' training.

YIELD GAP IN NORWAY - AGRONOMIC KNOWLEDGE FOR INCREASED CEREAL PRODUCTION BASED ON NORWEGIAN RESSOURCES

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World food production faces some serious challenges, population is projected to increase by ca. 35% by 2050 and there is an increasing demand for plants for other uses like e.g. biofuels. This will require an up to 100% increase in food production by this date, given the current trends in diets, consumption and income continue. Increasing production is therefore a political aim in many countries today e.g. Norway. Possibilities to extend the crop production area are often limited and higher grain yields are an important measure to meet these challenges.

There is therefore a growing international interest in the potential for increasing crops on existing agricultural land. Stagnating crop yields are reported from many of the main cereal producing countries and new research methods have been established to analyze the yield gap, which is the difference between theoretically achievable crop yields (modelled and from variety trials) and those taken under practical conditions on a farm level (www.yieldgap.org).

Climate change will cause major challenges for many of today's grain producing countries, also in Europe. Norway is one of the few countries where climate change may give an opportunity to increase cereal production. Analyzes of the yield gap in Norway, made in cooperation with Wageningen University (Netherlands), show a gap in cereals around 40% which is higher than in some of the neighboring countries.

Research has shown that the size of the yield gap depends on a number of different factors that cause production potential to not be exploited. Such studies provide the basis for more accurate determination of the most important bottlenecks in production and how the potential can be utilized better in terms of both increased crops and improved resource utilization.

Sustainable intensification could strengthen the primary production in Norway and improve utilization of input factors. This will also help to reduce the negative environmental impact of agriculture and reduce the need for imports of food / feed.

Keywords: yield gap, Norway, cereals, sustainable intensification, reduced need for import.

THE EFFECT OF NON-CHEMICAL WEED CONTROL METHODS ON WINTER OILSEED RAPE CROP WEEDINESS AND PRODUCTIVITY

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The area of orgnanically grown oilseed rape in the world is about 93,000 ha, in Lithuania about 3,962 ha (in 2017). The yield of oilseed rape in organic farming is low and variable because of pests, weeds and diseases spreading. Weed control in winter rape crops is important especialy at early stages of development. The competitive ability of a rape crop for weed smothering is often used in organically grown oilseed rape, and usage of mechanical weed control is limited. Thermal weed control (steaming) is one of effective weed control methods in organic farming system.

This study aims to investigate the effect of non-chemical weed control methods on winter oilseed rape (*Brassica napus* L. ssp. *oleifera biennis* Metzg.) crop weediness and productivity.

A field experiment was performed in 2014–2017 at the Experimental Station of Aleksandras Stulginskis University (54°53' N, 23°50' E). The soil at the experimental site was classified as *Calc(ar)i-Endohypogleyic Luvisol* (*Drainic*) according to the WRB 2014. The main plot treatments involved plant bio-activators as follows: 1) without application and 2) with application. The subplot treatments included a combination of non-chemical weed control measures, including the following treatments: 1) thermal (water steam; row spacing of 48 cm) – TWC; 2) mechanical (inter-row loosening; row spacing of 48 cm) – MWC and 3) smothering (self-regulation; row spacing of 12 cm) – SMT.

Annual dicotyledonous weeds prevailed in winter oilseed rape crop: *Tripleurospermum perforatum*, *Stellaria media*, *Capsella bursa-pastoris* and of monocotyledonous *Poa annua*. Weed control methods and plant-bioactivators had no significant effect on weed density in winter oilseed crop before harvest. The lowest weed dry mass was in plots were MWC method was used. The stronger effect of TWC method was estimated in plots with plant bio-activators. TWC and MWC methods significantly decreased weed dry mass by 2.1 and 2.5 times in 2015 under dry wether conditions.

The highest density and the best over-wintering percent of winter oilseed crop was in 2015 and 2017 in plots with MWC. No significant influence of weed control methods on this indices was observed in 2016. The significantly highest seed yield was in plots with the use of MWC in 2015, and in plots with SMT and bio-activators in 2016. Bio-activators significantly increased seed yield of winter oilseed crop in plots with TWC and MWC (43.4 and 25.1%) in 2015, and in plots with SMT by 51.5% in 2016.

Keywords: winter oilseed rape, weed control methods, crop productivity, organic farming.

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CONTROL OF PERENNIAL WEEDS IN SPRING CEREALS THROUGH CROPPING SYSTEM

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It is hypothesised that on-farm practices of cropping system are related to weed pressure and species composition. In order to verify this a monitoring was carried out in Latvia during the five–year period. In a study was evaluated perennial weed community responces to cropping system on farms that work accordingly to conventional and organic farming methods. Weeds were monitored by occurrence method, in total in 82 fields. More than 10 perennial weed taxa, at species or genus level, were registered; the most common among them were *Elytriga repens, Equisetum arvense* L., *Cirsium arvense* and *Sonchus arvensis*. Based on weed monitoring data and data from field histories, it was concluded that cropping system affects the amount of perennial weed species, but control of them is less affected by the cropping system than agronomic method (f.e. undersown in spring cereals).

This study is a component of the CORE Organic Plus PRODIVA project and is part of the project 'Integrated pest management for weed control in arable crops for sustainable use of the environment and resources" supported by European Agricultural Fund for Rural Development (EAFRD) and the project "Recommendations for effective control of wild oat and other widespread weed species in Latvia" supported by Latvian Ministry of Agriculture.

Keywords: conventional agriculture, organic farming, weed management.

DEVELOPING DRONE IMAGING BASED METHODOLOGIES FOR APPLICATIONS IN GRASS SWARD MANAGEMENT

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Silage production of grass swards is a major branch of plant husbandry in the Nordic – Baltic region. The hectare yields obtained from grass swards are difficult to estimate as the swards are harvested from two to four times in a season and high moisture concentration in of the harvest makes estimation of the dry matter yield (DMY) challenging. In the Droneknowledge –project we studied first the possibility to estimate the fresh yield (FY) and DMY of a growing grass sward by images and vegetation indices captured by a drone. We generated variation into the timothy – meadow fescue sward by applying six different rates of nitrogen (0-150 kg N/ha) in Spring, and the primary growth was harvested at four different dates from 6.6. to 28.6.2017. The experiment was carried out at the Natural Resources Institute Finland at Jokioinen, Finland. The experimental design was a split plot with four replicates. Reference data for drone obtained images included the sward height measured by a height stick, and FY harvested by Haldrup forage plot harvester, and DMY calculated from FY and dry matter percentage in the harvested FY. The minimum and maximum treatment means in the studied sward ranged in height from 20 to 69 cm, in dry matter percentage from 19,3 to 36,9, in FY from 1320 to 24710 kg/ha, and in DMY from 490 to 5600 kg DM/ha.

A machine learning method based on a low-cost remote sensing system was developed by the research team at the Finnish Geospatial Research Institute. They first generated an ultra-high resolution photogrammetric canopy height model (CHM) with a point interval of 10 mm and red, green, blue and near-infrared orthophotos mosaics, and then extracted various 3D-features, intensity values and vegetation indices (VI) from the datasets. The best estimation results were obtained by combining the height, RGB and VI features. The Random Forest estimator provided better results than the Multiple Linear Regression. The correlations were at best 0.95-0.97 for the dry matter yield and 0.95-0.98 for the fresh yield estimations. The obtained results indicated that the low-cost multispectral photogrammetric approach could provide highly accurate estimates of fresh and dry matter yield for growing grass swards. This provides a sound basis to the Decision Support System (DSS) study component in the project to examine how using drone-based mapping can affect decision making in silage production. Ous DSS study covers field operations: overseeding, fertilizer application, weed control, and timing of harvests. We formalize the planning processes that take advantage of field maps created from the data. The focus is on the effect the drone-based data can have on the management and decision making processes. We will study how the drone-based data will supplement the tacit farmer knowledge used in traditional decision making. The work will demonstrate the effect of new technology on farm management processes, and contribute to research on knowledge management in agriculture.

Keywords: biomass, drone, DSS, photogrammetry, silage production, vegetation indices.

PROTEIN CONTENT VARIATION IN GRASS OF SPONTANEOUS VETCH AND SWEET PEA SPECIES

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Legumes, as a source of proteins and energy, are one of the major plants used for food and forage since olden times. Range of perennial *Lathyrus* (sweet peas) and *Vicia* (vetches) species grow in natural meadows of Lithuania. Due to their current economic value and potential for future utilization, *Vicia* and *Lathyrus* genus had a high priority for organic ruminant farm forage development.

The grass protein content, studies of spontaneous perennial *Vicia* and *Lathyrus* species were carried out. Fife *Vicia* genus (*V. cracca*, *V. sepium*, *V. pisiformis*, *V. sylvatica*, *V. cassubica*) and fife species of the *Lathyrus* genus species (*L. pratensis*, *L. sylvestris*, *L. tuberosus*, *L. palustris*, *L. maritimus*) were studied in collection of university Experimental station of Lithuanian University of Agriculture, Middle Lithuania, on soil – clay loam on sandy light loam *Calc(ar)i-Endohypogleyic Luvisol(LVg-n-w-cc)*.. The evaluation of grass protein content was based on testing of the individual plant grass mass ant parts like foliage, stems and flowers. The crude protein analysis was carried out using the Kjeldahl method.

The protein content in dry matter of grass varied between species and investigated plant parts. The lowest volume of protein was in stems of investigated species and the highest one – in blossoms. The protein content of the blossoms of the tested species ranged from 32.1 % up to 40.5 %, the protein content in foliage ranged from 21.4 % to 29.6 %. The largest portion in the tested species grass mass consisted of leaves (on average 50.8 %). The total foliage protein content of the tested vetch species was on average 25.62 %, and a little less in the sweet pea species – on average 23.13 %. *V. sepium* and *L. sylvestris* were characterized by the highest protein content in the grass. *L. tuberosus* and *V. cracca* were described by the lowest volume of protein. The relationship between the tested parameters and the location of geographical origin was not found during the experimental period.

Keywords: *Lathyrus*, *Vicia*, perennial, grass, protein content.

THE LANDSCAPE SPACE OF THE HISTORIC CENTER OF AIZPUTE

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Historically, Aizpute was first mentioned in the records in the middle of the 13th century. The Order of Livonia, the existence of the Duchy of Courland until the end of the 18th century, and the time of the Courland Governorate until 1918 have produced a very significant overlaying of the landscape space of the town. The river Tebra which enriches the landscape of the town has historically served as the border river between the Bishopric of Courland and the State of the Livonian Order. In turn, in the second half of the 19th century, a dike is constructed on the river and the historic centre acquires a vast waterfront - a mill lake. The left bank as the bluff with the ancient castle, manor brewery, the master's house, and roadside pub form a distinct silhouette of the cultural and historic landscape. Unfortunately, the expressiveness of the silhouette is reduced by a chaotic clumps of trees and a well-considered thinning is required for the existing trees. In summer, when trees sprout their leaves, the main sight lines are hidden. The most picturesque sight lines can be found on both banks of the river along the mill lake. The accessibility to this site remains an unresolved issue. This is one of the first tasks to be carried out in the development plan of the local authority. The scale of the historical building and the trees is particularly well comparable with the photographic material of archives. When researching each of the above sites of the old building in detail, the blue-green structures on both banks of the river Tebra.

The aim of the research is to explore the places of clumps of trees around the lake of the watermill on the Tebra river hiding the historic buildings of the town. The following objectives were set to achieve the aim: to evaluate the main sight line from the shore of the windmill lake; to analyze visual perception of roof landscape of the historic centre's buildings in sight lines from the river Tebra. Historic photos from Aizpute museum have been used for comparing the scenes in the photos with the present situation for the research purpose. A comparative method is used to make conclusions about the transformation processes and anthropegenic load in the historic part of the town that is related to the increased water level zone of the Tebra river. The research accurately explores the historic buildings of the shore line of the mills lake, which includes three dominants of landscape space – the Livonian castle, the church and the ansemble of manor buildings. As one of the most expressive objects of the north part of the Tebra mill lake is the Livonian castle which was originated in the middle of the 13th century as a fortress.

Keywords: historical landscape, aesthetic quality, heritage.

BIOECONOMY DEVELOPMENT IN LITHUANIA: TENDENCIES AND DRIVERS

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The questions investigated by the authors cover definition and coverage of bioeconomy, Lithuanian bioeconomy profile and development tendencies, drivers of Lithuanian bioeconomy strategy as well as the goals and objectives of Lithuanian bioeconomy development. The research is based on various research methods such as general scientific abstraction, analysis and synthesis, content analysis, statistical data analysis, questionnaires, interviews, case studies and others. The data for empirical research was collected from Eurostat, Lithuanian Official Statistics Portal and Joint Research Centre of European Commission.

Bioeconomy covers biomass production sectors, fully bio-based transformation and partly bio-based transformation sectors. In 2014, bioeconomy turnover of the EU-28 states totalled about EUR 2.2 trillion. Bioeconomy accounts about 9 percent of the entire EU economy. In terms of bioeconomy turnover per person, Ireland, Finland and Denmark were leaders in 2014. In Lithuania bioeconomy turnover per person was lower than the EU-28 average. In 2015, more than two thirds of turnover in Lithuanian bioeconomy was generated in the food sector, and slightly more than a fourth – in the forest biomass-based sector, where turnover of manufacture of bio-based textiles, apparel and leather as well as bio-based chemicals and pharmaceuticals was a bit more than a tenth. 17.6 percent of persons were employed in bioeconomy in Lithuania in 2015. Location quotient revealed that considering gross value added the concentration of Lithuania both in biomass production and fully bio-based transformation sector compared to the entire EU was 2.4 in 2014. Lithuania was among the leading EU countries in terms of bioeconomy growth in all subsectors of biomass production and fully bio-based manufacturing between 2010 and 2014. This country ranks first in terms of growth of the paper industry, fourth – in terms of growth of agriculture, food and beverage, and wood (except for the production of furniture) sectors and fifth – in terms of the growth of forestry and logging and fishery subsectors.

There are global, European and national drivers of Lithuanian bioeconomy strategy. Among the global drivers are depletion of natural resources, increasing population, increasing environmental pressures, and climate change. The main European drivers are common EU bioeconomy policy, strategy and action plan; assurance of biomass availability and sustainability and efficient biomass value chain; strengthening markets and competitiveness of the bioeconomy subsectors; necessity of close cooperation among all stakeholders – politicians, business people, scientists and the public; need of the development of new technologies and processes, especially industrial biotechnology. The bioeconomy development in Lithuania has been regulated and promoted through certain sectoral policies: agriculture, forestry, fisheries, energy, environment (including waste management), scientific research, innovation and biotechnology development, etc. In the future, the cross-sectoral links and interactions in the Lithuanian bioeconomy will increase for a number of reasons: increased demand for biomass not only in the traditional fields of manufacturing; need to increase the production of higher value added bio-products, i.e. to generate higher value applying cascading principle; transition towards circular economy; development and implementation of new innovations increasing multidisciplinary and cross-sectoral R&D. Goals and objectives of Lithuanian bioeconomy development should be directed to pursuing sustainable and strategically oriented development of bioeconomy, increasing the efficiency and sustainability of biomass production, processing and use of bio-waste; increasing the demand and consumption ofbio-products.

Keywords: bioeconomy, profile, strategy, drivers.

THE PATH TO BALANCED RURAL DEVELOPMENT IN THE VISEGRAD AND NORDIC-BALTIC COUNTRIES OF THE EUROPEAN UNION

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The paradigm of sustainable development as an economic and political concept has dominated research and policy agenda for more than two decades but still it poses challenges for assessment of development sustainability degree of countries or regions. In an effort to address the issue of sustainability measurement, our study proposes an original methodology to assess the distance between actual multidimensional development of rural areas and its sustainability equilibrium (state of equally balanced dimensions).

The aim of this study is: to assess the level of rural development based on the combined dimensions (economic, social and ecological) of its sustainability; to find the development level distance from sustainability equilibrium, and to identify this distance changes over time in EU states with focus on Visegrad countries, and Nordic and Baltic countries. The fundamental question is whether rural areas in these countries have been approaching or getting closer to their 'perfect' sustainability that incorporates economic, social and environmental performance.

The research uses the World Bank, OECD and Eurostat data for the 2000-2013 period. All four Visegrad group countries (Czech Republic, Hungary, Poland, Slovakia) represent Central European states and EU 2004 enlargement members while six of eight Nordic and Baltic states belonging to the EU include three old (Denmark, Finland, Sweden) and three new (Estonia, Latvia, Lithuania) members. The research methods comprise: factor analysis to build single indicators for each sustainability dimension (sub-indexes) and then to aggregate them into the composite indicator providing overall measure of sustainable development; the distance analysis based on 3D Cartesian coordinate system to find the distance of actual development point (described by the values of three sub-indexes) to sustainability equilibrium point (described by an average of these sub-indexes) – the shorter this distance, the more balanced (sustainable) is rural development in a particular country; time-series analysis of these distances to identify their changes over time.

The findings are as follows: Based on composite indicators, Swedish and Finnish rural areas were (2000-2013) on the highest level of development, opposite to Polish areas being the second least developed in the EU-28. Generally, rural development was higher in Nordic and Baltic countries but in 2013 much closer to its balanced state were Visegrad rural areas (with Hungary and Poland on top position) than these in Nordic-Baltic region (with the most unbalanced development in Latvia and Estonia). On average, during 2000-2013, the highest degree of rural development sustainability occurred in Hungary (EU-28 leader), Czech Republic and Poland while the lowest – in Latvia (last position in EU-28), Estonia and Sweden. Development patterns appear to be different – from high and sustainable development in Finland through high but unsustainable in Sweden to low but sustainable in Poland. From 2000 to 2013, the progress in rural sustainability took place only in Poland, Finland and Denmark whereas the reverse trend was evident for Czech Republic. Our results suggest that synergy between high level of development and its high sustainability degree may exist without making trade-offs between the three sustainability dimensions. How this balance can be achieved depends on various factors that need further research.

Keywords: sustainability, development, rural areas, Visegrad group, Nordic-Baltic countries.

RESILIENT FARMING SYSTEMS AND FARMERS MARKET DIFFERENTIATION.

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The presentation are based on the Lithuanian case study carried out as a part of the international research project "Rethinking the links between farm modernization, rural development and resilience in a world of increasing demands and finite resources" (RETHINK). This research project funded through RURAGRI is an ERA-NET supported by the European Commission under the 7th Framework Programme and national funding agencies in 14 countries.

The EU common agriculture policy (CAP) support is mostly focused on the technological modernization of farms, linked with production intensification, and weakly focused on the farms prosperity and resilience. As a result farmers are only a slightly motivated to produce added value and high quality food products, to use short food supply chains addressing constantly changing consumer needs, or to pay much attention on issues related to climate change. The farms modernization is not linked with innovations and sustainability, prosperity and resilience. The modernization consists largely of using improved seeds, modern farm machinery such as tractors, harvesters, threshers, etc., chemical fertilizers and pesticides in an optimal combination with water. The theoretical fundamentals formed up to this day are unusable for creation of CAP and national policy measures and agriculture farms management opportunities. For this reason the analysis of CAP and national policy impact on prosperity and resilience of Lithuanian farms and agriculture companies should be defined and justified.

The aim of research is to identify the impact of EU CAP and national policy on farmers farms resilience and rural prosperity. The research is based on the positive research paradigm, case study, content and descriptive analysis, empirical study methods, logical and systematical reasoning, graphic presentation other methods.

The Lithuanian case study was determining farmers' behaviour and causal factors in decision-making. The research based on the positive research paradigm, case study, content and descriptive analysis, empirical study methods, logical and systematical reasoning, graphic presentation, abstracts and other methods. The present is examining the impact of political factors on prosperity and resilience on farmers farms. The political factors have the highest impact for prosperity of the farms in Lithuania (as compared to the technical – entrepreneurial, ethical - social factors, and intangible values).

The support from the EU is not fully in line with the current concept of farms' modernization and agricultural innovation. The EU CAP and national policy on influence on the competitiveness of the agricultural sector is more strengthening than weakening. The research results show the main elements that farmers believe should be included in the new concept of rural prosperity, as well as the main strategies adopted to reach prosperity divided into the five sub dimensions: development of the rural social infrastructure and implementation of information technologies; strong self-governance, social awareness and partnership; high culture of life and communication; rural employment and job creation in rural areas, population welfare; economic and social viability, ecology and environmental security of the countryside.

Keywords: *Comman agriculture* policy, farms resilience, *farmers market,* rural prosperity.

MODERN LIVESTOCK POLICY IN NORWAY

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More than 90 percent of the agricultural area in Norway is used for animal feed and large forest and mountain areas are used for grazing. About 70 percent of market income in agriculture originates from livestock, and headage payments make up 30 percent of the direct payments. Livestock is important in Norwegian agricultural policy. In this paper we will present some elements of the agricultural policy related to livestock.

In an early phase the main objective of the livestock policy was to improve productivity and contribute to increased competitiveness. Increased production and lower relative food prices were important for securing enough food for the poor. Improved food safety was a goal as combating animal diseases and improving the hygienic standard in handling of animal products could prevent human diseases. Since the Second World War, a main objective was to become self-sufficient in products which Norway had natural conditions for producing. Income parity between farmers and other groups was a main goal, at least until the early 1990s. With a few exemptions, such as pelts from fur bearing animals, export has not been a goal for Norwegian agriculture, especially after the WTO agreement was implemented in 1994.

Much of the present livestock policy is related to food safety and animal welfare. The EU legislation in these fields, is implemented in Norwegian law. In some cases Norway has (or is about to) implemented stronger animal welfare regulations than the EU. For instance, it is likely that fur farming will be banned. Norway has been and still is free of several animal diseases and has an eradicating policy, stamping out specific diseases, such as virulent footrot in sheep and cronic wasting disease in wild reindeer, when detected. Antimicrobial resistance is a serious concern, and a reason for keeping the use of antibiotics at a low level in agriculture and fish farming.

In recent years there has been increased focus on public goods and bads from agriculture. On the positive side are landscape values, and effects of agriculture on rural activities and settlement. Livestock grazing is regarded as important for maintaining landscape values and supported. On the negative side are pollution of air and waterways and emission of greenhouse gasses (GHGs). The government is working on stronger regulation of manure management, which might have strong effects on agriculture in some areas if implemented. Emission of GHGs from agriculture has attracted attention recently with ongoing work to acquire more information on actual emission of GHGs from ruminants, effects of various measures to reduce emissions, and on developing effective policy measures. Another topic is possible negative effects of red meat consumption on human health. Clearly, there are conflicting goals regarding livestock and livestock policy.

Keywords: food safety, Norway, public goods and bads, food security, livestock policy.

THE LIVONIAN PUBLIC WELFARE AND ECONOMIC SOCIETY – ONE OF THE OLDEST OF ITS KIND IN EUROPE

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In the territory of Livonia, monasteries, but also the Jesuit College established in Tartu (1585) played the major role in the field of education during the early modern period. Gustav II Adolf, the King of Sweden, founded a university in Tartu in 1632. The University operated until 1710 when Swedish rule ended in Livonia. Under Russian rule, local progressively minded citizens in Estonia, Livonia and Courland recognised the need for non-Russian high schools and scientific organizations. One of the most important organisations was the Livonian Public Welfare and Economic Society (*Livländische Gemeinnützige und Ökonomische Sozietät*) founded in Riga in 1792 (moved to Tartu in 1813). The Society developed cooperative relationships between political and cultural powers, including research scientists in the area of agriculture, whereas the membership comprised enlightened estate owners, representatives of local power, prominent scientists, etc. On the initiative of G. F. Parrot, the Society's first secretary (who later became the first Rector of the Imperial University of Dorpat in 1802), the society was moved to Tartu in 1813 (after Napoleon's invasion of Russia), and operated here until liquidation in 1940. The major research activities supported by the Society dealt land improvement, animal husbandry and breeding, forestry, cartography, political and peasant reforms, etc. The society became a bridgehead in integrating economy, education and culture of this time, initiating projects beneficial to the public welfare in the area of agriculture, industry, trade, traffic and finance and promoting and generating cooperative networks between different societies across Livonia. The Society published a yearbook „*Oekonomisches Repertorium*…" (1808 – 1915, and issued a magazine „*Baltische Wochenschrift*" (1863 – 1915). It had 13 full members (*ordentliche Mitglieder*) at a time, including the president, vice president and treasurer. Between 1792 and 1918, the Society had a total of 115 full members and 13 presidents. Honorary members (*Ehrenmitglieder*) of the Society comprised the largest group, and there were some correspondent members.

Since 1918, after the Baltic States had entered independent statehood, was initiated development of agricultural scientific experimental stations at the universities, counselling services for farmers. The Nordic Association of Agricultural Scientists was founded in 1918 and respective national organisations were established as well. For example, the Estonian Agricultural Academic Society was founded in 1920. The Society was liquidated in 1940 along with its sister organisations in the Baltics. The Academic Agricultural Society was re-established in 1989, followed by similar organisations in the Baltic countries. Today, Estonia, Latvia and Lithuania are members of NJF that is celebrating its 100th anniversary this year.

Keywords: Livonia, Society, Nordic Association of Agricultural Scientists, Baltic countries

SENSOR TECHNOLOGY TO DETECT TICK-BORNE FEVER IN SHEEP ON RANGE PASTURE?

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More than two million sheep graze on unimproved, rough grazing lands during the summer months each year in Norway. Free ranging sheep are perceived to experience high level of animal welfare through their opportunity to perform natural behaviour. These benefits are however compromised when sheep experience predator attacks, disease and accidents. Ensuring animal health and welfare in farming systems gets increased attention, and new policies and legislations are implemented. Extensive farming systems provides particular challenges, as daily attention of animals is not feasible on range pastures. About 125 000 sheep (6-7%) are lost on such pastures every year. Being able to monitor farm animals on range pastures is increasingly important and implementing available technology for this purpose should be exploited.

Tick-borne fever (TBF) is a disease considered to be a major challenge in sheep farming during the grazing season along the coast of south-western Norway. It is caused by the bacterium *Anaplasma phagocytophilum (A.ph)* and transmitted by the tick *Ixodes ricinus*. TBF is characterised by high fever, inclusion of the *A. ph.* bacterium in neutrophils and severe neutropenia. Clinical signs of TBF is ofte observed within 14 days of infection, starting with an abrupt rise in rectal temperature (often above 41o C), a period of fever of one to two weeks and occasionally coughing, reduced appetite and dullness. TBF is seldom fatal but secondary infections may cause direct loss, but indirect losses like reduced weight gain.

Implementation of sensor technology in rangeland sheep farming can monitor physiological parameters, such as body temperature (T). Integrating such sensors in a GPS tracking system may contribute to detect, locate and treat sick animals, as well as improve our knowledge of animal health in time and space in rangeland farming systems. There are also possibilities of that such monitoring systems can alert abnormal behaviour i.e. predator attack.

The overall aim of this project is to develop a system for automatick real-time monitoring of physiological indicators of farm animals to ensure and improve individual health and welfare and productivity. The objective of the work presented here is to evaluate if a temperature sensor can be used for early detection of Tick-borne fever (TBF).

In 2016, temperature sensors (Star Oddi, Iceland) were implanted in the abdomen of 20 lambs in a one sheep flock in a TBF risk area and in 20 lambs from one flock in a non-TBF risk area in Norway. The sensors were programmed to log temperature every 10 minutes, and were implanted in lambs in early June and collected in early September to retrieve data. Temperature data were obtained from 13 temperature loggers from lambs in the TBF risk are and 14 loggers in the non-TBF risk area. The telemetry system (Telespor, Norway) was used on all lambs, and provided accelerometer information and real-time positioning data that was used for continuous surveillance on range pasture. All animals were monitored twice a day for approximately one month period after turned out on tick infested pastures. Number and magnitude of fever was calculated for each lamb. Preliminary results from this study will be presented at the conference.

Keywords: sheep, sensor technology, temperature, tick-borne fever, rangeland.

CAN THE ALERTNESS OF ICELANDIC LEADERSHEEP HELP TO PROTECT SHEEP FLOCKS AGAINST PREDATORS?

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Icelandic leadersheep, a unique sub-breed of the North European short-tailed Iceland breed, are known for their strongly inherited alertness and urge to lead their flock. They have been known through centuries for their outstanding behavioural abilities and intelligence and have not been selected for production traits like other Icelandic sheep. The behavioural traits of these sheep have attracted attention; particularly their alertness and the possibility that this could play a role in protecting sheep flocks against predator attacks. Norwegian scientists have shown breed differences in sheep mortality at summer pastures due to predators. A joint Icelandic/Norwegian project was initiated to test the hypothesis that the presence of Icelandic leadersheep affects flock behaviour when exposed to a predator model. An experiment was carried out on Hestur Sheep Experimental Farm in W- Iceland during two days in November 2016 using a total of 66 ewes divided into 11 groups. Six of the groups consisted of one Icelandic leadersheep and five Icelandic sheep (LSG), the remaining five groups consisted of six Icelandic sheep (ISG). The predator model tests took place within a fenced, rectangular pasture of 50m x 25m adjacent to a sheep house. All 11 groups were exposed to the same three treatments: human-, dog- and drone test, after a 10 minutes habituation period. The order of the treatments was randomized and there was a minimum 5 minutes interval between each test. All tests were video recorded. The behaviour observations recorded were; eat, stand walk, run and „other". Recordings were made every 5 seconds during a two-minute period before and after test period, as well as every 5 seconds in 5*30second periods during each of the human, dog and drone treatment. Statistical analyses were conducted using the GLIMMIX procedure in SAS. There was a significant difference in behaviour between the groups with LSG compared to ISG. The LSG spent significantly more time eating than the ISG groups for all tests, especially in the period after each test was finished, and it hence seems the LSG recover more quickly after a predator test. Including an Icelandic leadersheep into the flock affects behaviour. This should be further elaborated in commercial settings in order to understand the impact and relevance of including this genetic trait in sheep farming.

Keywords: sheep, behaviour, predators, Icelandic leadersheep, predator model.

COSTS AND BENEFITS OF PIG FEED SALMONELLA CONTROL PROGRAMME IN FINLAND

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Feeding stuffs and their quality play a significant role in the pork supply chain. Feed can be an important route for introduction of pathogens, such as Salmonella, into pigs. Hygienic management of feed is therefore important for animal health and food safety. Finland has adopted a stringent policy to control for Salmonella in animal feed. However, the economic rationale of the policy has not been analysed.

Our aim was to determine the cost and benefits of pig feed Salmonella control programme in Finland. Two options were compared: a) current pig feed salmonella control and b) an alternative where fewer preventive measures were taken and interventions upon detection of Salmonella in feed were more limited than in under the current control policy.

A Monte Carlo simulation model was developed to determine the costs incurred due to preventive measures and due to measures taken to eradicate Salmonella. The data were collected through surveys conducted among feed and livestock sector operators. The model was parametrised to represent current situation and an alternative scenario.

At present, the costs for prevention of Salmonella contaminations in pig feeds were estimated at €1.8-€3.0 million per year. The costs due to feed contamination and the resulting Salmonella infections in pigs and humans were estimated on average at three (0.7-8.7) million euros annually. Thus, the total costs of the current control programme were around to €5 million per year.

In an alternative situation where there was no control of feed-borne Salmonella, prevalence in pig feeding stuffs were higher. This would result in an increase in Salmonella infections in pigs to up to 12 per cent. According to a reduced control scenario, considerable increase in Salmonella prevalence in the Finnish pig feed could increase Salmonella contaminations in fattening pigs and human infections to 55-fold. When measures to eliminate Salmonella from feed were not carried out, the costs due to preventive actions against Salmonella were estimated at €1.1-€1.8 million per year. Additionally, the costs due to eradication of feed-borne Salmonella from pig farms, consequential measures at slaughterhouses and the health costs to humans could rose to approximately €32.5 million. The results suggest that the present Salmonella controls, including the preventive actions, are cost-effective and generate benefits to the society.

Keywords: Salmonella, feedstuff, risk management, cost-benefit analysis.

EFFECTS OF MONOCULTURES OF *E. CAUDATUM* AND *M. ELSDENII* INOCULATION ON *IN VITRO* FERMENTATION, METHANE PRODUCTION AND PREVENTION OF SUB-ACUTE RUMINAL ACIDOSIS

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The Intensive feeding with high concentrate levels, highly fermentable forages, and insufficient dietary coarse fiber can lead to the observation of various disorders related to digestion and metabolism by increasing ruminal acid production and lowering pH than optimum leading to sub-acute ruminal acidosis (SARA). The objective of present study was to find out the possibilities to reduce the chances of sub-acute ruminal acidosis (SARA) *in vitro* using separate and mixed monocultures of each of rumen protozoa (*Entodinium caudatum*) and bacteria (*Megasphaera elsdenii*, ATCC 17753).

The monocultures were included to two substrates i.e. wheat (30 g/L) and maize (30 g/L) as T1 (control: no addition), T2 (2 ml *E. Caudatum*, 5.5x104/ml), T3 (2 ml *M. Elsdenii*, 107 cfu/ml), and T4 (1 ml each of *E. Caudatum* and *M. Elsdenii*) and fermentation- and gas production parameters were recorded during 24 h of incubation. The rumen fluid was collected from two rumen cannulated holstein heifers (450 ± 20 kg live weight) offered alfalfa hay as the sole diet. The collected rumen fluid was subject to defaunation and isolated protozoa were frozen for future use. During incubations, buffered defaunated rumen fluid, and protozoa as well as bacteria monocultures were added to the substrate in the fermentation bottles. The generated data were analyzed according to General Linear Model with Repeated Measures statement using SPSS.

The maize significantly reduced ($P<0.001$) the concentrations of total volatile fatty acids (VFA) as well as individual VFA, lactate, NH3 and methane and total gas production. The concentrations of total VFA, lactate as well as general fermentation parameters did not alter ($P>0.05$) by the microorganism used. However, a combination of *M. elsdenii* monoculture and maize (grain × microorganism interaction) reduced ($P<0.040$) the methane concentration in the total gas and propionate production ($P<0.006$). It is concluded that a combination of maize and *M. elsdenii*, ATCC 17753 monoculture may be used to set off additional acid load in the rumen environment *in vitro*, thus controlling SARA. Additionally, it may reduce methane production, however, the *in vitro* results may be used with caution while generalizing for *in vivo* conditions.

Keywords: acidosis, monocultures, gas production technique, methane production, volatile fatty acids.

TRITICALE, BARLEY AND WHEAT AS A RAW MATERIAL OF WHOLE-CROP SILAGE

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Whole-crop silage from small-grain cereals is one option to decrease costs of the cattle farms. One harvest produces practically the same dry matter (DM) yield than 2 – 3 harvests in grass silage production. The low digestibility is often mentioned limiting the use of whole-crop silage for dairy cows feeding. However, cereal species and varieties can have wide variation in feed quality and by mixing grass silage and whole-crop silage suitable feed can be prepared for both dairy and beef cattle.

Spring triticale is fairly new crop in Finland and it is cultivated only for a raw material of whole-crop silage. The aim of this study was to compare yield and nutritional quality of some varieties of triticale, barley and wheat as a raw material of whole-crop silage. The results shown here are from 2017 experiment, but the aim is to repeat the experiment during 2018-19. Furthermore, we have conducted a feeding experiment to examine the performance of beef bulls offered diets based on different whole-crop silage alternatives, but those results are not introduced here.

Soil type in 2017 experiment at Luke Ruukki Research Station (64°44'N, 25°15'E) was sandy loam. Two varieties of triticale (Nagano, Nilex), two varieties of barley (Kaarle, Trekker) and one variety of wheat (Helmi) were used in a plot experiment. Artificial NPK fertiliser was applied so that N-level was 90 kg N/ha. We wanted also study establishing new ley during growing whole-crop silage, so there was option to decrease seed and fertilizer amount by 30% (normal/decreased). The experimental design was a split-plot with four replicates. The experiment was drilled at the end of May. Crops were harvested at the early dough stage using Haldrup-plot harvester. Feed quality analyses were done with NIR from dried crop samples.

At normal fertilizer/seed level DM yields were about 9500 kg DM/ha with the exception of Nagano, which yielded 10 200 kg DM/ha. Decreased fertilizer/seed level produced 10 – 15% lower DM yields. Trekker had the highest D-value (digestible organic matter in DM) (655 g/kg DM), Kaarle the second highest (625 g/kg DM) and D-value of other crops was below 600 g/kg DM. Crude protein varied between 80 – 90 g/kg DM. Water-soluble carbohydrate content was the lowest in barleys (about 100 g/kg DM) and the highest in triticales (about 200 g/kg DM).

Success of establishing new ley can be evaluated during coming grass yields. Probably, there will not be a big difference between normal and decreased fertilizer/seed level, because the crops were not lodged at all in the autumn of 2017. However, this method can be as an insurance against lodging and it cost here about 1500 kg DM/ha.

Results of one year and one soil type suggest that triticale varieties can produce a bit higher whole-crop silage yields than the other crops, but feed digestibility can be the best in well-chosen barley varieties.

Keywords: digestibility, crude protein, feed, ley, lodging.

DENITRIFICATION BIOREACTORS – A METHOD FOR REDUCING NITRATE FROM TILE DRAINAGE WATER

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Artificial drainage is a common agricultural practice in Lithuania. In this country, the total drained land area occupies 47% of the total land area and 87% of the agricultural land area. It is well known that tile drainage systems serve as transport pathways of contaminants directly from agricultural land to streams. When entering drains, water leaches nutrients (mostly inorganic forms of nitrogen), and the increased nutrient inflow into surface water bodies leads to their eutrophication. As a new technology, woodchip denitrification bioreactors for tile drainage are being investigated for practical edge-of-field nitrate (NO_3) removal. This technology is based on routing tile drainage water through the bioreactors, where nitrate is used by bacteria to oxidize carbon while reducing NO_3 to nitrogen gas. The rate of transformations of nitrates into gaseous forms depends on biological activity, inflow water temperature, pH, dissolved oxygen amount, flow velocity and hydraulic retention time.

Therefore, to test the technology three pilot-scale bioreactors (1 m^3 each) under field conditions were installed at Aleksandras Stulginskis University, Lithuania. The bioreactors were filled with mixed woodchips along with two types of additives (10% v/v) – activated carbon and flax-seed cake. The prevailing particle diameter of the woodchips varied from 1.5 to 3.0 cm. The bioreactors were fed nitrate during the study period at concentrations ranging from 4.0 to 29.1 mg N L^{-1}. Nitrate-nitrogen removal efficiency and rate along with the measurements of other water parameters at the inlet and outlet of each bioreactor were conducted with irregular time intervals.

The study has shown that the average nitrate removal efficiency in bioreactor with no additives was 44% and in bioreactor with activated carbon additive - 48%. In bioreactor with the flax-seed cake additive 45% of nitrogen load was removed. During the cold seasonal period, when water temperature at the inlet varied between +2.1^{0}C and +12.2^{0}C, the average removal efficiency of 32%, 36% and 34% was observed in bioreactor with no additives and in bioreactors with activated carbon and flax-seed cake additives, respectively. The tests also revealed that woodchip media are capable of achieving higher NO_3-N removal rates due to higher flow rates. Higher NO_3-N removal rates for shorter retention times are governed by NO_3-N removal reaction kinetics. This highlights the importance of better optimization and proper evaluation of the effects of hydraulic retention time when designing denitrifying woodchip bioreactors.

Keywords: denitrification bioreactors, agricultural drainage, nitrate removal.

MATHEMATICAL MODELLING OF THE ENERGY BALANCE FOR THE TREATMENT OF SOLID BIOMASS FUEL BY COMPRESSING

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The aim of the presented research is the implementation of a mathematical model for analyse and planning of the production of solid biomass fuel by compressing. The mathematical model reflects the current experimental state of the art of effectiveness for fuel compressing machines. The process of making briquettes is considered to be fairly energy-intensive. Nevertheless, if we compare the energy expenditures to the heating value of the fuel, then it is less than 10%, even when converted into primary energy. The experiments that were conducted by the authors illustrate that the actual energy expenditure is significantly smaller. The main expenditure comes from moving the working parts of the device. The energy that is needed for making of the briquette is insignificant. The residual bulk-material from agricultural and forest industry has low bulk density which consequently causes several management problems. However, it is beneficial to produce fuel with homogeneous properties using pressure processing. Unfortunately, the raw material does not correspond well to the pressure from the briquette machine, yet, the management can be substantially improved with adding wood to the mixtures.

Keywords: compressing, fuel, pressure, density, volume.

DYNAMIC MODELLING OF YEAR-ROUND BIOENERGY DELIVERY OF SHORT ROTATION COPPICE WILLOW

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Short rotation coppice willow is an energy crop grown on agricultural land with a typical 4 to 5 year replant rotation. The conventional system for harvesting is cut and chip followed by direct delivery to a heat or combined heat and power plant. The biomass can also potentially be used to produce liquid or gaseous biofuels. In order to optimise the bioenergy supply system, however, on demand delivery of raw bioenergy material on a year-round basis is required. Harvesting short rotation coppice willow is only done wintertime when the ground is frozen and the bioenergy crop is defoliated. In addition, direct-chipped biomaterial is not suitable for storage due to high water content. Stored material in piles or silos can potentially self-combust.

The objective of this study is to evaluate a system for year-round delivery of short rotation coppice willow where whole stems are cut and stored in piles. Unchipped stems stored outside will dry safely with time down to a storable water content. The biomass can then be chipped on site and transported on demand to a power or fuel conversion plant.

To evaluate the system discrete event modelling of the harvesting together with implementation of a natural drying dynamic model was used. Transport of machines and chipped biomass was simulated using network analysis in the road network, existing fields and a processing plant in Uppsala, Sweden. The model used 10-year historical hourly weather data to model natural drying of harvested stems and to calculate trafficability.

The system for year round delivery of short rotation coppice willow could deliver biomass an all months over the year except in April when the dry stems were out while the newly harvested stems had not reached safe storage water content. The harvest cost was about 40 € per tonne dry matter. Field trafficability, yield and harvest productivity were important factors.

Keywords: modelling, bioenergy, short rotation coppice willow.

PILOT SCALE CONTINUOUS THERMAL HYDROLYSIS OF ORGANIC WASTES FOR INCREASED BIOGAS PRODUCTION

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Thermal hydrolysis is an established method of pre-treating organic wastes prior to anaerobic digestion or as an intermediate step between two anaerobic digesters. The process can be likened to pressure cooking, where material is subjected to high temperatures (usually 100-200°C) and respective pressures for a certain period of time (usually <1 hour). For many full-scale and, to the best of our knowledge, all pilot and laboratory-scale applications, the equipment used usually operates in batch mode due to technical difficulties of adding and removing material to a pressurised continuous process. The advantages of a continuous (or semi-continuous) process at full-scale over a batch process include a smaller footprint and lower operational costs. At pilot or laboratory-scale, batch thermal hydrolysis reactors suffer from problems of slow heating and cooling times which leads to poor definition of true treatment times. This work describes the development and operation of a pilot scale (treatment volume of 1.02 litres) thermal hydrolysis system that operates semi continuously. By using a high electrical heating power of 7.2 kW and a high heating surface to volume ratio, the system can treat materials for periods of just a few minutes. The system has been tested using the liquid fraction of cattle manure and biogas batch tests have shown that methane yields were increased by up to 40.5% at four days digestion, but the improvement was less pronounced at longer digestion times, with 12% increased methane yield after thirty two days.

Keywords: biogas, pre-treatment, thermal hydrolysis.

TRANSPORT FUELS VIA BLACK LIQUOR GASIFICATION - AN ANALYSIS OF CLIMATE IMPACT WITH LIFE-CYCLE ASSESSMENT METHODOLOGY

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Fuel crops are considered, according to several studies, to reduce greenhouse gas (GHG) emissions by 50-80% compared with fossil fuels. But what happens if the raw material comes from forest raw materials instead? The opinions here differ greatly, which led to a political discussion of forest fuel as a raw material: can you bind large amounts of carbon? or do they lead to a disaster with greatly increased GHG emissions compared to fossil fuels?

The aim of the project was to develop an approximate method that provides sufficiently accurate values for GHG emissions in the production of the transport fuels from black liquor, also when the biogenic carbon flows in the incoming forest raw material are included, using life-cycle assessment (LCA) methodology.

In order to achieve this, the carbon balance with carbon binding in growing forests and land has been studied for a Norway spruce forest in southern Sweden, which is felled after a 100-year rotation cycle. To get a landscape perspective, 100 such rotation cycles have been superposed in 100 different stages of development.

The wood is used for production of pulp and paper. In this production, there is a lignin residue, black liquor. This black liquor can be used as a raw material in a fuel synthesis where DME (dimethyl ether) and FTD (Fischer-Tropsch diesel) is produced, which can be used as transport fuels.

The carbon climate impact has been studied with two types of LCA methodology, so-called attributional life-cycle assessment (ALCA) and consequential life-cycle assessment (CLCA). The ALCA calculates a future integrated paper, pulp and transport fuel production system, while the CLCA evaluates the environmental consequences of changing an existing paper pulp mill to also produce transport fuel.

Further, the analysis has been carried out for different starting points of calculation: a) start with a grown forest; b) start with a forest in the middle of several rotation periods in a landscape; and c) start with land without vegetation.

The results for the ALCA show that the reduction of GHG compared to fossil fuels are: a) 23% for DME, 37% for FTD; b) 107% for DME, 104% for FTD (a small net binding of carbon for the case which usually applies in practice); and c) 190% for DME and 170% for FTD (a significant net binding of carbon). If you ignore biogenic carbon and possible binding of soil carbon, the corresponding values will be 93% for both DME and FTD.

Conclusions are that the produced fuels comply with the EU-directive of 60% reduction of GHG for bio-fuels, forests have a significant potential for binding of carbon, and the results are highly dependent on the assumptions assumed in the forest raw material production system.

Keywords: life-cycle assessment, fuels, black liquor gasification, fuel synthesis, forest.

MECHATRONICS APPLICATIONS IN THE AGRICULTURAL WORLD

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Nowadays, food security is one of the most compelling challenges worldwide. For this, more precise consideration, understanding, and planning of the future of agricultural engineering and Biosystems are needed not only nationally, but also internationally. This involves new strategies, methods of food production and the supply chain. One of the ways to increase production, quality and to reduce waste and losses and perform different operations, timely and correctly is the use of new technologies and updated machines. In addition to these, Mechatronics is one of the most key and updated domain, which is a kind of interdisciplinary knowledge with many job opportunities. Applications of this science in agricultural engineering and Biosystems could modernize both mechanized and non-mechanized systems, which can lead to improve the production systems and accelerate the processes. Furthermore, implementation of Mechatronics makes agriculture more attractive to the younger generations than just funds. Before this, an advanced knowledge and critical understanding of the essential requirements such as the linked sciences, applications, and challenges, are needed. Thus, this presentation aims to introduce modern technologies and understanding of the domain, the importance, applications and challenges associated with Mechatronics in the agricultural world and the related chains. This makes the future of agriculture more attractive, specific and interesting than before.

Keywords: development, mechanization, mechatronics, new technologies, precision farming.

THE DEVELOPMENT OF ERGONOMIC LIVESTOCK TECHNOLOGY IN OPTIMAL CONDITIONS FOR LIGHT INDUSTRIAL COMPANIES

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Livestock farming has, over the years, developed from the source of livelihood of agrarian society into a modern science. Feeding livestock and ways of keeping it has attracted a lot of attention from various stakeholders. Today, we have reached a level that allows for the production of animal products with rather little effort and low cost, however, it is still a long way to go to perfection. Continuously advanced technology and newly introduced materials require further research and integration into efficient livestock production. In today's society, it is no longer enough to provide the animals with just a simple shelter and sufficient quantity of food- we need to go deeper into small things, every detail needs attention. Modern livestock buildings technology using even the fast and accurate technology to evaluate it uses a computer technology or intelligent system to make a comprehensive assessment, work processes, environmental impact assessment, optimal temperature, humidity, air flow, atmosphere air gas condensation, fodder containing correct nutrients, etc., ensure rapid growth of the animal's well-being environment. When creating the ideal conditions, it should be kept in mind that all costs will be repaid in the long run, the application of high-end technologies may not be sustainable. The key might be in cheap and easy solutions, such as the design of lightweight buildings, which allows a person to easily control all indoor climate parameters, assessment of work processes and work technologies designates.

Keywords: livestock breeding, work process, microclimate, workflow, precision farming.

DAIRY COW LONGEVITY IN VOLUNTARY MILKING SYSTEM

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In modern dairy farming the main emphasis is put on the modernization of different processes, such as feeding, milking, herd monitoring and microclimate control. In last decade European dairy farmers recognized the positive aspects of voluntary (automated) milking systems (VMS). One of main benefits of VMS in dairy farms in the long run is standardized milking procedure that improves the milk quality and, after adaptation period, milk productivity. The cows that are included in VMS milking groups' needs to meet certain standards. The most important trait for VMS cows is the quality of udder – teats need to be straight and optimally placed in the middle of each quarter. As cows are getting older, the quality of teats and udder decreases and the milking in VMS is getting impossible and cows are removed from group or from herd that leads to significantly reduced longevity. The decrease of lifespan in each farm is connected with significant financial losses that could be avoided by the stronger selection process for VMS. The aim our study was to find out the effect of different factors on the longevity of cows milked in VMS.

The study was carried out in Latvia University of Life Sciences and Technologies (LLU) research and study farm "Vecauce". In farm there are 2 different milking systems – VMS (DeLaval) and milking parlour (herringbone DeLaval). Cows in VMS are fed with the partially mixed ration and they have unlimited access to fodder stations where they can receive preprogramed amount of fodder. In the VMS group in each given time are included 100 Holstein Black and White (HBW) dairy cows. For study purposes we used Data about 114 HBW dairy cows that were included in VMS group from year 2013 to 2018. From Latvian "Agriculture Data Centre" we collected data about cow lifespan traits, milk productivity and body conformation trait linear evaluation results.

The average analysed cow lifespan was 1824.2±52.05 (approximately 5 years) days in which was obtained 30017.9±1280.25 kg milk, and in one life day – 16.1±0.35 kg milk. The conformation trait linear evaluation scores for teat length, front and rear teat placement, central ligament and udder depth traits significantly worse ($p<0.05$) were in the third lactation. The udder depth linear evaluation score in the first lactation showed significant impact on the lifetime milk productivity traits – cows with the optimal evaluation score (5 points) of udder depth characterized with significantly lower lifespan and lifetime milk productivity (accordingly 1795.4±55.62 days and 29995.6±1411.13 kg milk), but with the highest life day milk productivity (16.09±0.38 kg). As the VMS group in "Vecauce" farm were completed with the consideration of the rear teat position, the results obtained in first lactation did not show any impact on longevity traits on the other hand, the cows that characterized with optimal rear teat position evaluation scores (5 points) in third lactation had significantly longer lifespan (2145.6±83.16 days) and higher lifetime and life day productivity (accordingly 38336.3±2110.46 kg and 17.6±0.47 kg milk).

Keywords: udder conformation, lifespan, live weight.

AUTOMATIC TECHNOLOGY TRENDS IN ESTONIA DAIRY FARMS

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The first ideas about fully automated milking process were generated in the mid-seventies and focused on technical improvement of milking system. Topics included in the program of specialist conferences, like Automatic milking – a better understanding confirm that current problems concerning automatic milking system (AMS) cover socio-economic aspects, farm and milking system hygiene, animal health, milk quality and abnormal milk, welfare, grazing, farm and herd management. All of the mentioned problems and the other ones are the field of detailed research works and assessments to develop knowledge about automatic milking as an integrated system in the dairy farm

The present work places focus on cow motivation to visit the milking unit. AMS in Estonian dairy farms were tested and 3 cow traffic situations were analyzed for effects in cow behavior, effective use of the barn, and milking capacity.

The ideology of the automatic milking system allows each animal to operate around the clock according to its needs. From the point of view of production, however, complete freedom is not feasible, because the goal is still the production of milk, not the keeping of animals today and in the near future. Experience shows that some animals, however, should be milked driven. However, it does not suit the purpose of automatic milk production, the work of a man on a board should be minimized. The motivation to feeds is the main drive of the cows to visit milking station. Therefore, a computer controlled cattle control system, which also includes traffic control, is in use. Along with the technical differences in AMS, the organization of animal movement is important on board.

Keywords: automatic milking, cow motivation, behavior, capacity.

DEVELOPMENT TREND OF APPLES SORTING MACHINES IN THE WORLD

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Apple is one of the most popular fruits worldwide with an annual production of over 80 million metric tons. According to the FAO, China, the US, and the European Union are the top three producers of apple in the world, respectively. "An apple a day keeps the doctor away" is a common saying, which describes the impressive health benefits of apple in human life. However, there are good enough reasons to sustain apple trade and production. For this, the appropriate chain supply of this fruit is essential. Nowadays, apples sorting machines are important as same as the chain supply in international trade market. In this regards, the development trend of apples sorting machines in the world, including past, present and future will be presented. The presentation talks about the key issues covering the global apple production, the top ten producers of apple, the importance of sorting machines in the supply chain, history and the previous sorting systems, and recent technology. Finally, technical specifications, types of sorting machines, important parameters, famous and infamous manufacturers of sorting machines worldwide, the future aspects and other relevant practical matters will be presented.

Keywords: apple production, chain supply, new technologies, sorting machines, manufacturers.

SAFE RECYCLING OF HORSE MANURE FOR AGRICULTURAL PURPOSES

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Huge amounts of horse manure is either burnt or illegally deposited. Treated correctly it is a good source for plant nutrition and valuable as a soil improvement or for other horticultural uses. To ensure a safe return to agriculture, aspects such as residues of unwanted compounds should be considered. For instance, there is not much knowledge about the fate of pharmaceutical residues in horse manure.

The main aim of the project was to develop a method for analysing several pharmaceutical compounds in a single sample and to study how selected pharmaceuticals decompose in manure using different biological methods. Another objective was to map customer interest in possible peat substitutes made of local resources, e.g horse manure.

Commonly used equine medicines were selected for the study. In total, 70 samples of horse manure and horse manure compost were analysed.

The Ultra Performance Liquid Chromatography - tandem mass spektrometer (UPLC MS/MS) was used to develop the analysing method.

Manure from treated horses and horse manure with additions of controlled amounts of medicines were composted outdoors in a windrow consisting of horse manure and freshly cut grass. In a pot trail, earthworms were added to some of the manure from the treated horses to study the effect of worm action on the biodegradation of pharmaceutical residues.

A survey on use and preferences of soil and fertilizer products was conducted among 100 garden centre customers.

The analysing method was found capable of analysing all four active ingredients at the same time.

Contents of pharmaceutical residues in horse manure were highest 1-2 days after treatment, with some variation between substances. After this peak, residue contents in manure decreased rapidly.

Degradation of the added medicines was slow in the composting trials. In the compost windrow, the contents of medicines decreased gradually throughout a 60-day period, with slightly different degradation curves for the various substances. Three of the tested active ingredients were still detectable in the compost after 60 days. The earthworm trials need be improved and repeated, as many worms also died in the untreated horse manure pots.

The customer survey showed that there is a certain interest for peat-free, locally produced soil and fertiliser products. Approximately half of the respondents replied that they are willing to pay as much as 20 % more for such products.

The project provided a basis for the further development of horse manure as a pharmaceutical residue-free product. Manure from treated horses should be kept apart from other manure for the first 1-3 days after medical treatment. Strategies for the management of such manure should be developed so that this resource can be used safely in plant production.

Keywords: horse manure, vetenary medicines, decomposition.

CHARACTERIZATION OF MARGINAL AGRICULTURAL FIELDS IN SWEDEN - AREAS, SHAPES, LOCATIONS, TRANSPORT DISTANCES AND TIME DEMAND FOR MACHINE OPERATIONS

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In Sweden, thousands of hectares of agricultural land are not being actively used for agricultural production. Of the total agricultural land area of 2.57 million hectares in 2017, 0.16 million hectares were fallow land. Hundreds of thousands of hectares of ley are also underutilized or cultivated at low intensity. In 2008, the excess cultivation area of this crop was estimated to be 0.2-0.3 million hectares. Bearing in mind the ongoing rationalization and closure of small farms, the current total acreage of such 'marginal' land may be as high as half a million hectares.

The demand for renewable biomass fuels for the production of heat, electricity and vehicle fuels is expected to increase. Therefore, instead of fallow or fields being abandoned and overgrown with brushwood, an alternative for 'marginal' land is the cultivation of dedicated energy crops such as poplar, short-rotation coppice willow and perennial energy grasses. The overall aim of this project is to compile a decision basis for farmers on how to improve the profitability of such fields.

In the project, marginal fields were characterized in four municipalities (Svalöv, Ronneby, Vingåker, Skellefteå) in Sweden with regard to field size, field shape, distance to farm, location (in flat land or non-flat land areas and in areas with respect to level of standard yields). Furthermore, field work was simulated for different field sizes and field shapes in order to compare the time demand for machine operations in 'marginal' fields and in 'normal' fields. For this, a dynamic simulation model was developed to simulate the driving pattern of machines on a minute/second time scale level, taking in-field preparation and finishing up times into account, as well as operational speed in rows/passes and delays due to turnings, acceleration, stochastic stoppages, etc.

Preliminary results showed that there are large differences within Sweden. For example, what is considered as a 'less fertile' and 'small' field in one part of the country may be considered as a 'fertile' and 'large' field in another part. Nevertheless, the average field area for fallow and extensive ley culture usually is in the range 1-2 ha, which is smaller than for e.g. cereal crops. Marginal fields often have a more irregular shape, and they are often more distant, but this is also dependent on region and type of landscape. The simulations of field operations showed that field area and field shape have significant impacts on time demand, and hence machinery costs. For example, it was shown that the time demand rises steeply for fields smaller than about 1.5 ha as a result of more time, relatively seen, spent on e.g. turnings. Later in the project, the economic profitability of cultivating various conventional as well as bioenergy and industrial crops on marginal agricultural land will be calculated and compared.

Keywords: marginal field, characterization, simulation, machinery.

REMOVAL OF AMMONIUM IONS BY USING ZEOLITIC WASTES

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In this research the sorption capacity of ammonium ions was investigated by using zeolitic waste FCC catalyst. By using XRD analysis it was determined that maine mineral is zeolite Y which consist of this zeolitic waste. It was used as an adsorbent for petroleum refining during catalytic cracking, and after a certain time it contaminates and becomes a waste. This waste in Lithuania can make up to 200 tons per year. For ammonium removal two types of zeolitic materials were investigated. The first type was used untreated and the second one was activated by integrating in 15 % H_2O_2 aqueous solution. In our previous works it was determined that the zeolite sorption capability increased (about 1.75 times after 48h) after treatment with a hydrogen peroxide solution, but it wasn‘t investigated the amonium ion removal. The initial solution for ammonium ion removal were made by using NH_4Cl solution. Initials concentrations were 1mg/l. The experiment werte carry out under dynamic conditions. Sorption durations were from 12 untill 72 hours. The iniatial results show that this type of zeolitics waste are suitable for amonium sorption from water solutions.

Keywords: zeolites, zeolitic waste, ammonium uptake.

INSECTS – A POTENTIAL PROTEIN SOURCE FOR FEED OR FOOD

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The insects are considered to be an opportunity to create new business in rural areas and in the food sector and to improve protein self-sufficiency. Close to 2000 insect species have been identified edible. Although globally 2 billion persons consume insects as food, in Europe they are used in small quantities. In Finland, the use of insects as food was allowed in 2017. Because insects are a novel line of production, there is little experience on how to organize insect rearing.

The aim of this paper is to analyse the potential of insect rearing in Finland. Our analysis is based on literature analysis, data collected from a farm rearing house crickets in Finland and calculations prepared based on the data during a development project Entolab.

According to the literature, insects have the potential to produce protein efficiently. They consume less water and feed per kilogram of biomass they gain, than traditional farmed animals. However, insects have often been readred with chicken feed for instance. In order to foster the environmental argument, it would be important to find novel sources of feed for insects. These would preferably sources which are currently not used as food or feed, such as biomass or sidestreams which are currently of low value. However, little is known which feedstuffs are best-suited for insect rearing.

Another factor that is critical for the success of insect rearing is the ability to increase the use of automation. Because insect rearing is still fairly labour-intensive, novel solutions are needed to to automatize especially daily manageemntroutines such as feed supply.

Foods placed on the market in Europe must be safe, and food safety is a priority. Insect food manufacturers must meet the hygiene standards (HACCP, safety, hygiene, traceability). To ensure both product safety and insects requires good hygiene practices. For example, the sanitation of breeding grounds and platforms is an essential part of biosecurity. Ensuring safe feed is an integral part of food safety.

Economically, majority of production costs in insect rearing are either fixed costs, or due to feeding or labour use. The results, as well as currently limited scale of production and high costs of production suggest that currently insects are better suited for food use than for feed use. Food use allows innovative approaches to develop business and to supply high-premium insect products to the markets. However, as the production efficiency is improved and production volumes increased in the coming years, also feed use can become economically viable option.

Keywords: edible insects, feed, profitability, production system.

THE HORTICULTURE HERITAGE OF THE SWEDISH STATE RAILWAY - A BASIS FOR A GREENER ENVIRONMENT IN PUBLIC TRANSPORTATION

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The garden organization of the Swedish State Railways (SJ) started in 1862 about six years after the foundation of the State Railways. A "director of the railway gardens" was employed in order to organize parks and plantations at the railway stations and restore the wounds the new transportation method gave to nature in Sweden. The plantings were aesthetic and for utility. Most plants were delivered from the main nurseries of SJ. Tests of suitable plant species were conducted in order to find suitable, hardy plants. In the mid 1900s about 500 000 plants were delivered annually. Hedges were planted along the railway lines to protect from snow drift, wind and keeping away livestock from the tracks. 1862-1960 five garden directors influenced the plantations in an ambitious vision of spreading horticulture to remote places and thus enlighten the Swedish population. In 1961 the last employed director had left his employment and an external consultant was brought in until the closing of the garden organization in 1973. The reduction of the gardening organization during the 1950s and onwards reflected an increasing focus on rational handling of people and goods. The railway stations were no longer the places for meetings and gathering but the travelers were stimulated to rapidly pass by on their journey. This époque reflect the transition from enlightment and supplying harmonious travelling experiences to becoming a supplier of time efficient transportation. Our research is the yet most thorough archive inventory. Unfortunately, the archives of SJ were weeded thoroughly before they were turned over to the National Archives. Most of the material has been lost, among which hundreds of detailed drawings of flower beds, parks and ornaments. The fragments are few and give only glimpses of the gardening activities performed by SJ during more than a hundred years. However, the archives gives us a good basis for using the horticultural heritage to make the modern railway stations greener and more attractive for the travelers of today. We look for Nordic-Baltic partners for an international project on design of railway environments for improved attractiveness and in the long run increased railway transport.

Keywords: landscape planning, horticulture, public transportation.

CREDIT SUPPORT FOR AGRICULTURAL LAND PURCHASE IN POLAND - EVOLUTION AND PERFORMANCE

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The aim of the presentation is to examine the characteristics and evolution of the credit support for agricultural land purchase in Poland and to assess its outcomes after 23 years of operating with special focus on changes in farm structure. The examined period covers years 1994-2016. Descriptive statistics was applied for analyses of empirical data.

In Poland, the preferential credits for agricultural land purchase were introduced at the beginning of the nineties of XX century. They were part of the credit support system for restructuring and modernisation of the Polish agriculture that started in 1994. The state agency was established for running the system. Credits are granted by commercial banks at their own risk. Credits are allowed under credit lines that differ with respect to aims, scopes, terms. In 1994-2016 preferential credits for land purchase were granted under six credit lines. Three of them were in operations during the entire period. Credit terms were advantageous for borrowers. Till 2015 the interest rate on credits under four credit lines was calculated as one-fourth of the central bank rediscount rate, next as 67 per cent of WIBOR 3M. In the case of one credit line, the borrowers paid 50 per cent of interest rate charged by bank.

Preferential credits for agricultural land purchase got farmers' attention. Under two credit lines designed for land purchase only, banks provided about 141,000 credits of total nominal value estimated at PLN 10 billion (ca $3 bn). Assuming the same number of credits for land purchase granted under other lines, the total number and value of such credits increased twofold. The numbers indicate that 14% of the Polish farms were beneficiaries. Author estimates that 1.8 million ha of agricultural land (ca 10% of agricultural land area in Poland in 1994) changed the owner during the examined period. These numbers do not reflect the full demand for preferential credits as the value of subsidies was limited. Subsidised agricultural land purchase influenced the farm structure by area. The average per farm area of agricultural land increased from 6.7 ha in 1994 to 10.3 ha in 2016. The share of agricultural land bought with the credit support in market agricultural land turnover in examined period, estimated by Author at 45%, illustrates the role of this support for improvement of farm structure. But negative outcomes appeared too. As credits encouraged the demand for agricultural land, they contributed to sharp increase in agricultural land price. The nominal price of arable land in 2016 was 16 times higher than in 1994.

To sum up, the credit support for purchase of agricultural land is well organised. The credit terms stability deserves appreciation. Data analysis indicates the important role of preferential credits in encouraging the agricultural land turnover. The support contributed to the improvement of farm structure. In the examined period, average farm area increased by 50%.

Keywords: land purchase, farm structure, credit support.

ENTREPRENEURIAL INTENTION AMONG STUDENTS OF BALTIC REGION

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Many countries are dealing the problem of weak participation of young people in labour market. Many researchers propose development of entrepreneurship as one of measures for solving this problem. The growth of entrepreneurial activities will help in reducing the unemployment rate. But it is not enough to have the ideas and wishes to start new business. There are needed also knowledge; financial, legal and mental opportunities. Attitude towards entrepreneurship can be based on personality traits and demographic characteristics, economical and social environment etc. Investigation on students' intention in this research was made using data received during implementation the GUESSS project in year 2016. There were involved students from Higher Education Institutions in 50 countries around the world who provided answers to wide range questionnaire. The objective of this research study is to explore the entrepreneurial intention among students from higher learning institution. Authors of this research concentrated only on few of these questions concerning intentions of respondents to run their own business (self-perception towards entrepreneurship, the entrepreneurial background of parents). There were used data collected in following countries of the Baltic region: Denmark, Norway, Poland, Sweden, Estonia, Finland, Lithuania, and Latvia.

Descriptive statistics, Kruskal-Wallis test (K-W) and Tukey Contrasts were used to compare independent groups. Data were analyzed using R software.

It would seem that students from Latvia and Poland have a stronger desire for a transition towards entrepreneurship than students from oher countries. The weakest ambition indicated Swedish students. The Danish and Finnish students scored the influence of the entrepreneurial background of parents the highest, and Swedish students the lowest. The research found out that there were statistical significant differences between countries and gender ($p<0,01$).

Keywords: students, entrepreneurship, own business, Baltic region, cross-national comparison.

SUMMARIES OF POSTERS

RELATIONS BETWEEN SOIL PROPERTIES AND CO_2 GAS EMISSIONS FROM DIFFERENTLY TILLED MAIZE CULTIVATION

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Soil-degrading factors, such as tillage, can increase the CO_2 emissions from the soil. For this reason a long-term (since 1988) stationary field experiment was carried out at the Experimental Station of the Aleksandras Stulginskis University (ASU), Lithuania in 2009-2012 and 2014. The purpose of investigations was to establish the correlation of soil physico-mechanical, chemical and biological properties with CO_2 emissions from differently tilled soil. Five primary tillage treatments were tested: deep conventional ploughing (23-25 cm depth), shallow ploughing (12-15 cm depth), deep cultivation (27-30 cm depth), shallow cultivation (disking, 12-15 cm depth) and no-till. The soil of experiment was Endohypogleyic-Eutric Planosol (PLe-gln-w). Crop rotation – winter weat, maize, spring barley and spring oil-seed rape. In experiment, the physical-mechanical properties of the soil were tested: penetration resistance, soil bulk density, moisture content, temperature, agregation and agregate‘s stability, total and aeration porosity; chemical properties: pH, available phosphorus and potassium; biological properties: sacharase and urease activity, number and biomass of earthworms. Soil testing was performed after primary tillage in autumn and after wintering before presowing soil tillage in spring. * - probability at $P < 0.05$, ** - at $P < 0.01$.

Correlation-regression analysis of research data showed, that at the end of vegetation, a strong negative correlation ($r = -0.977^{**}$) was found between soil temperature and CO_2 gas emissions. In each year of investigations, at the end of vegetation, due to different soil temperature and humidity regimes, a negative strong correlation between CO_2 gas emissions and total or aeration porosity ($r = -0.816^{**}$and $r = -0.830^{**}$) in the upper (0-15 cm) layer was found. In the deeper layer (15-25 cm), correlations were similar - $r = -0.836$ ** and $r = -0.878$ **.

After tillage in outumn, strog negative correlations were found between the soil penetration resistance in the upper soil layer ($r = -0.745^{**}$) or in the deeper layer ($r = -0.713^{**}$) and CO_2 gas emissions. In that period, in the upper soil layer, a strong correlation ($r = 0.727^{*}$) was obtained between soil aeration porosity and CO_2 gas emissions.

During all years of investigations, after autumn tillage, an average negative rorrelation was found between CO_2 gas emission intensity and urease activity ($r = -0.617$ *). In spring, in the upper soil layer (0-15 cm depth), a positive correlation was found between soil bulk density and CO_2 gas emissions. The weight of earthworms correlated with CO_2 gas emissions from the soil negatively ($r = -0.745$ **).

Keywords: CO_2 emission, correlation, maize, soil properties.

AGROECONOMIC EVALUATION OF AROMATIC AND MEDICINAL PLANTS USED FOR THE ENRICHMENT OF GRASSLANDS

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For livestock, medicinal plants improve the lack of appetite and facilitate the digestive process of animals, boost their immune system, reduce inflammation, grow up milk secretion, etc. The aim of this research was to clarify the successfulness of seeding medicinal plants in pasture. The trial was carried out in sod gleyic soil, pHKCl 5.7, organic matter content 2.1 g kg^{-1}, Latvia, May 2016. The trial was implemented including two mixtures of seeds. The mixture "Country Horse 2122" contained nine species of medicinal plants: 7% yarrow (*Achillea millefolium* L.), 18% caraway (*Carum carvi* L.), 20% chicory (*Cichorium intybus* L.), 2% wild carrot (*Daucus carota* L.), 15% fennel (*Foeniculum vulgare* Mill.), 1% hedge bedstraw (*Gallium mollugo* L.), 10% parsley (*Petroselinum sativum* Hoffm.), 10% ribwort plantain (*Plantago lanceolata* L.), and 17% salad burnet (*Sanguisorba minor* Scop.). The second mixture contained oregano (*Origanum vulgare* L.) and St. John's wort (*Hypericum perforatum* L.) in equal parts. The seeds were sown in squares that were free from sward: "Country Horse 2122" in eight repetitions, and the mixture of oregano and St. John's wort in seven repetitions. The squares were established in a zigzag pattern. In the trial, the influence of the mixture on the growth and development of plants was studied, the changes in botanical composition were established, and the installation costs were calculated. For "Country Horse 2122", the first sprouts were observed on the 8th day after sowing; for oregano and St. John's wort – on the 21st day after sowing, and also in the further vegetation the plants developed much more slowly. In 2017, the botanical composition of the mixture "Country Horse 2122" changed to 13% and that of the oregano and St. John's wort 'mixture – to 52%. Overall, in the squares with the oregano and St. John's wort mixture, more than 50% of all plants were weeds. The costs of seeds and manual work for the "Country Horse 2122" trial made 139 EUR per 100 m^2, and for the mixture of oregano and St. John's wort – 208 EUR per 100 m^2. When freshly cut plants were fed to dairy cows, the animals consumed the eagerly. It was also observed that the plants' mixture did not change the quality (taste, odour, and colour) of milk negatively. The mixture "Country Horse 2122" can be recommended to farmers – it can be sown mechanically n lines. Though, in this case, the costs are about 250 EUR per ha, the yield can be cut in the year of sowing.

Due to the needs of specific growing conditions, the use of oregano and St. John's wort in grassland may cause problems (the development of plants is weak in the first year). Also, the price of these seeds is more expensive than for the "Country Horse 2122" mixture.

Keywords: medicinal plants, botanical composition, mixture.

ANALYSIS OF MOISTURE CONTENT AND GROSS CALORIFIC VALUE IN THE MIXTURES OF GRASS AND TIMBER BIOMASS FOR PRODUCTION OF SOLID FUEL

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Grass biomass is one of the types of solid fuel (pellets), which is considered to be the most promising renewable resource, possessing appropriate energetic qualities and a sufficiently high calorific value. In the production of biomass fuels, moisture content is an essential physical parameter that reduces the amount of combustible substances and influences the process of combustion: makes fuel burning difficult, prolongs drying time, and reduces combustion heat and boiler capacity and efficiency.

In order to make fuel energy efficient, the moisture content of biomass material should not exceed certain limits; therefore, it is important to clarify the indicators of moisture and gross calorific values for the grass and timber biomass and their mixtures to find the optimal biomass application (in pure form or in mixtures) for the production of solid fuels.

Field trials were conducted at the Study and Research farm "Peterlauki" (56°53' N, 23°71' E) of the Latvia University of Life Sciences and Technologies in 2011 – 2015.

The research was carried out on five species of grasses: reed canary grass (*Phalaris arundinacea* (L.) Raush.) cultivar 'Marathon', festulolium (× *Festulolium* Asch. & Graebn.) cultivar 'Vetra', timothy (*Phleum pratense* L.) cultivar 'Teicis', meadow fescue (*Festuca pratensis* Huds.) cultivar 'Vaira', and tall fescue (*Festuca arundinacea* Schreb.) cultivar 'Fawn'.

For the formation of pellets, the following biomass components were used: grasses – reed canary grass, festulolium, tall fescue, timothy, and meadow fescue; and timber – birch (*Betula pendula* Roth.), osier (*Salix* spp.), grey alder (*Alnus incana* (L.) Moench), aspen (*Populus tremula* L.), and hybrid aspen (*Populus tremuloides* × *Populus tremula*). From the obtained timber and grass powder (ø<1 mm), pressed pellets were formed using the manual press "IKA WERKE". The two-component pellets were composed in the following ratios: 3/1 (75% timber + 25% grass), 1/1 (50% timber + 50% grass), and 1/3 (25% timber + 75% grass). Single-component (100%) pellets of timber or grass powder were used for control.

Grass biomass was obtained from the first harvest of grasses in the 1st and 2nd year of use.

The moisture content and gross calorific value were determined at the Laboratory of Testing and Research of Waste Products and Fuels "Virsma" according to the standards ISO 589 and LVS EN 14774 and ISO 1928 an pelletizing d LVS EN 14918, respectively.

The average moisture content of grass biomass samples before pelletizing was 9.0% (from 8.1% for meadow fescue to 10.4% for festulolium); for timber – 7.8% (from 7.0% for osier to 8.5% for hybrid aspen and birch). In timber and grass biomass mixtures, the moisture content decreased with the increase in timber percentage. Adding 1/3 of timber, the moisture content in biomass mixtures decreased by 5% on average, but adding half and 2/3 of timber, the moisture content decreased by 15% and 20%, respectively.

In this study, the highest gross calorific value of grass biomass was determined for timothy (16.9 MJ kg^{-1}) and reed canary grass (16.4 MJ kg^{-1}).

The highest gross calorific value (≥18.0 MJ kg^{-1}) of biomass mixtures was detected for the ratio of 3/1 (75% timber + 25% grass) – in the mixture of birch or osier with reed canary grass, festulolium, and timothy. The gross calorific value of timber and grass biomass mixtures increased when the percentage of timber increased. This suggests that up to 25% of grass biomass can be add in the mixtures of timber and grass biomass in order to obtain a qualitative solid fuel material (pellets).

Keywords: timber and grass biomass, moisture, gross calorific value.

INFLUENCE OF LEAD ACCUMULATION ON PHYSIOLOGICAL PARAMETERS AND MINERAL ELEMENT (Mg, Fe, Mn) UPTAKE IN CROP PLANTS

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Soil pollution with hazardous elements including heavy metals has become a problem all around the world. There are two ways for soil pollution with heavy metals - as a natural process or as an anthropogenic activity. Heavy metals can cause health problems for people through access to the food chain. So, it is important to pay attention to soil, especially agricultural soil, contamination with hazardous elements. Mechanisms of physiological processes in plants are affected under heavy metal pollution. The aim of this study was to find out the impact of different lead (Pb) concentrations in the substrate on Pb accumulation in barley and lettuce leaves and roots, uptake of mineral elements, as well as effect on photosynthesis and chlorophyll *a* fluorescence, thus revealing differences between monocotyledons and dicotyledons. Barley (*Hordeum vulgare* L.) and lettuce (*Lactuca sativa* L.) were selected for the vegetation experiment as representatives of the monocotyledons and dicotyledons, respectively. Plants were grown in quartz sand under controlled growth conditions. The experiment lasted 28 days for barley and 43 days for lettuce. Plant growth and physiological parameters were investigated under increasing level of Pb in substrate: 0, 400, 600, 800, 1000 mg L^{-1} for barley and 0, 200, 250, 300, 350 mg L^{-1} for lettuce. Pb was added as $Pb(NO_3)_2$ in substrate. The following methods were used to analyze the plant material: the concentrations of Pb, Mg, Fe and Mn in air-dry plant material were estimated by atomic absorption spectrophotometry (Perkin Elmer AAnalyst 700); the content of photosynthetic pigments were determined by spectrophotometry method; chlorophyll *a* fluorescence parameters were determined with continuous excitation chlorophyll fluorimeter Handy PEA system. It was observed that the fresh weight of the experimental plants decreased with increasing concentration of lead in the substrate. Pb concentrations in roots were higher than in leaves for both barley and lettuce. There were differencies in the ability of Pb accumulation between model object leaves during the experiment. The results showed that in the conditions of the highest Pb concentrations in the substrate respectively 1000 mg L^{-1} for barley, the concentration of Pb in barley leaves was 414.20 mg kg^{-1}, while three timed lower pollution level for lettuce (Pb 350 mg L^{-1}), caused almost similar Pb in lettuce leaves - 329.74 mg kg^{-1}. In general, the uptake of several mineral elements (Mg, Fe, Mn) in lettuce and barley increased under Pb pollution. An increase of Pb concentrations in substrate resulted in the decreased content of chlorophyll *a+b* in leaves of model objects. At the end of the experiment in the conditions of maximum investigated Pb concentrations the content of chlorophyll *a+b* in barley leaves was 2.1 times lower and in lettuce leaves 1.3 times lover than that in the control plant leaves. The results showed that increasing Pb concentrations in substrate has a different effect on photosynthesis describing parameters in monocotyledons and dicotyledons. Both exclusion and tolerance strategies operate as plant resistance mechanisms to Pb as a stress factor in the model ojects – barley and lettuce.

Keywords: heavy metals, monocotyledon, dicotyledon, photosynthesis parameters.

ALLELOPATHIC INFLUENCE OF WINTER OILSEED RAPE RESIDUES WITH BIO-PREPARATIONS ON GERMINATION OF *SINAPIS ARVENSIS* L.

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The aim of the research was to identify the allelopatic influence of winter oilseed rape residues taken after harvest and after differentt period of decomposition in the soil (2, 7 and 14 months) treated with bio-preparations and slurry on the germination of *Sinapis arvensis* L. seeds. Investigation carried out in a model field experiment at the Experimental Station of Aleksandras Stulginskis University, Lithuania. Samples of different morphological parts of winter oilseed rape were collected after harvesting. They were cut into 2–3 cm size chaffs and samples of 20 g were placed into the 9 × 12 cm size plastic mesh bags. 28 bags with winter oilseed rape threshing remains were treated with bio-preparation Bio1, 27 bags – with slurry, and 28 bags – with slurry and bio-preparation Bio2. Stubble and roots were treated (separately) with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2 (14 bags with each bio-preparation). Bio-preparation Bio1 is used for the soil activation and composting. In the composition three carrier materials included: dolomite, molasses and magnesium sulphate. Bio-preparation Bio2 is used for aerobic conversion of slurry. In the composition two carrier materials included: calcium carbonate and molasses. Sample bags were placed in ploughed up furrow on the experimental site (bare fallow) at the 20 cm in depth and ploughed up. The effect of the residues on germination of *S. arvensis* seeds was studied using Petri dishes with two compartments. Weed seeds were germinated in one compartment, and in the second – placed oilseed rape residues (30 mg cm^{-3} fresh weigh). Treatments of *S. arvensis* germination bioassays: 1) without oilseed rape residues (Control 1); 2) oilseed rape residues without treatment (Control 2); 3) oilseed rape residues with bio-preparation Bio1; 4) oilseed rape residues with slurry; 5) oilseed rape residues with slurry and bio-preparation Bio2.

Treatment of oilseed rape residues (threshing remains, stubble and roots) with bio-preparations and slurry after harvesting increased the allelopathic inhibitory effect of residues on the germination of *S. arvensis* seeds. After two months of the decomposition in the soil of winter oilseed rape threshing remains treated with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2, also roots treated with bio-preparation Bio1 and with slurry statistically significantly reduced ($P<0.01$) germination of *S. arvensis* seeds. Winter oilseed rape stubble, treated with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2 taken after two months of the decomposition in the soil, had no influence on germination of this weed seeds, but after seven months of the decomposition in the soil, had statistically significant ($P<0.05$) influence on seeds germination. Winter oilseed rape threshing remains and roots, treated with all treatments, after seven months of the decomposition in the soil, had no influence on weed seeds germination. After 14 months of the decomposition in the soil, rape threshing remains and stubble, treated with slurry and slurry with bio-preparation Bio2 reduced allelopatic stimulatory effect of threshing remains and stubble on *S. arvensis* seeds germination. Ivestigation showed, that use of bio-preparations and slurry for winter oilseed rape residues, changes the allelopathic properties of winter oilseed rape residues.

Keywords: winter oilseed rape, threshing remains, stubble, roots, slurry, bio-preparations, germination, *Sinapis arvensis*.

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CHALLENGES AND PROSPECTS OF ORGANIC AGRICULTURE IN ICELAND

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Icelandic agriculture was mainly based on organic practices until the middle of the 20th century. However, only a few pioneers adopted fully organic principles until 25 years ago when VOR, the society of organic producers was founded. Soon followed the foundation of the certifier TÚN, advisory services in the Farmers Association of Iceland, teaching and research at Hvanneyri Agricultural University and the first legislation on organic farming, now fully replaced by EU regulations through EFTA membership. The development has been slower than anticipated but there are clearly great challenges ahead due to a fast growing market for organics, a demand which should be met by increased domestic supply rather than by imports. Looking at the prospects, and in spite of the fact that Iceland is lagging behind most of the Nordic and Baltic countries in developing organic farming, the numbers of certified farmers have grown from 6 to 31 and certified processors from 2 to 29 during the last 25 years. It is estimated that only 1% of the total national agricultural production is organically certified while 2% of the food sales constitute imported organics, mainly cereals, vegtables and fruit products. Exports are mainly seaweed products. In spite of the short growing season, cool climate and difficulties in growing legumes and cereals, such obstacles should be viewed in the context that in Iceland there are relatively few diseases in plants and animals and the use of pesticides and antibiotics is minimal compared to other countries. Moreover, the heritage breeds of dairy cattle, sheep, goats and horses are grassland-based, normally kept under extensive conditions and agricultural soils are virtually free from pollutants. Consequently, the difference between conventional and organic foods is less than in most countries in terms of safety and image. The author believes that in the future sustainable sheep production and geothermal greenhouse cultivation will be amongst the most promising organic enterprises in Iceland. Looking at such prospects in view of the present biological challenges, however, it is important to consider also both institutional and political obstacles. These include the need to increase the acquisition and transfer of knowledge through research, education and extension and the drafting and ratification of a clear governmental policy for the organic sector. Still the potential contribution of organic farming to the reduction of greenhouse gas emissions has not been realized by official bodies in Iceland. Of further concern is the lack of flexibility in EU regulations so as to allow for regional variation within the organic framework.

Keywords: greenhouses, organics, policy, production, sheep.

PERENNIAL LEGUMES FOR PLANT NUTRITION IN ORGANIC AGRICULTURE

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On farm nitrogen fixation of legumes is driving force in organic agriculture. Including lucerne, red clover (or grass-clover) in arable cropping systems will enhance soil quality in general. Taproot systems especially those of perennial legumes can make soil nutrients plant available from the solid phase and increase the density of vertical biopores in the subsoil thus making subsoil layers more accessible for succeeding crops (Köpke et al., 2015). Research was carried out at the Lithuanian Research Centre for Agriculture and Forestry's Joniškėlis Experimental Station on a clay loam *Endocalcari Endohypogleyic Cambisol.* The study was aimed to explore the belowground and aboveground mass of forage legumes red clover (*Trifolium pratense L.),* lucerne *(Medicago sativa L.)* and festulolium (x *Festulolium*) used as green manure in terms of their quality composition (nitrogen, phosphorus, potassium) and decomposition rate (carbon:N) and to estimate cereal productivity under organic cropping conditions.

Results showed that aboveground and belowground of swards depended by plant species. Forage legumes, with deep roots to produce high dry matter yields. Lucerne and red clover has the greatest dry matter yield – two times more then festulolium. Nitrogen concentration in the aboveground mass of lucerne was higher than that in red clover. Red clover and lucerne accumulated 7849.5-8458.7 kg ha^{-1} of their aboveground biomass and 4868.8-5606.9 kg ha^{-1} of belowground. Nitrogen concentration in the aboveground mass of lucerne was higher than that in red clover. Red clover and lucerne accumulated 253.3 and 284.2 kg ha^{-1} of symbiotic N in their biomass (aboveground and belowground). There seems to be no difference in growing lucerne and red clover. But on the other side, lucerne has intensive and deeper root system and improves properties of top- and subsoil. The festulolium accumulated more less of aboveground – 4952.5 kg ha^{-1}, and less of belowground mass – 4434.6 kg ha^{-1}. Phosphorus and potassium content was greater in the aboveground than that in belowground swards mass. The phosphorus content in the aboveground mass of forage legumes was on average 1.7 times higher than in sole festulolium. The aboveground mass of legumes was rich in potassium.

Nutrients (N, P) become available to plants only after roots and residues decomposition. The mineralization indicators (C:N, C:P) of the belowground and aboveground mass depended on the plant species. The highest C:N ratio of the aboveground mass was identified for festulolium (45-54). The most favourable for decomposition biomass ratio (C:N = 13-20) was of red clover and lucerne mass.

In the crop rotation sequence after red clover, having used part of the aboveground mass as green manure, and when growing winter cereals for two years, a significant increase in the total productivity of plants of crop rotation sequence was established, compared with the crop rotation sequence without forage legumes. Forage legumes, as pre-crops for cereals, significantly reduced nitrogen input.

Keywords: lucerne, red clover, nitrogen, phosphorus and potassium.

PRODUCTIVE SOIL FERTILITY UNDER SPRING WHEAT DIRECT SEEDING IN THE ENVIRONMENT OF EUROPEAN PART OF RUSSIA

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In the developed natural and economic conditions of the region, the main direction of maintaining crop production is resource-saving. However the results of researches on studying the influence of soil processing and technological systems on its nutritious conditions and in general on fertility are very contradictory. Therefore, the experimental work on studying the prolonged affect (2011-2016) of direct sowing technologies and intensification levels on elements of efficient fertility of the ordinary chernozem and efficiency of spring solid wheat in the Middle Povolzhye, which is the most demanded crop in Russia, was carried out. Five agrotechnologies with direct sowing of crops and various intensity levels of using arable lands were investigated: Five agricultural technologies with direct crop sowing and different levels of intensity of arable land use were studied: 1. direct sowing + seed treatment + herbicides for vegetation (Background); 2. Background + biologics in the phase of tillering (Bioneks Kemi); 3. Background + mineral fertilizers (including spring wheat – pre - sowing application of ammonium nitrate (N30) - Background 1; 4. Background 1 + insecticides on spring wheat (decis Pro twice) - Background 2; 5. Background 2 + biologics (Kemi Bionex). In the case of control the traditional technology with annual plowing under all crops rotation were used. Nitrates, movable forms phosphorus and potassium, were defined according to state standard specifications 26951-86; 26204-91. The received results were processed by method of a dispersion analysis and according to D.A. Dospekhov. In the years of carrying out the researches of hydrothermal coefficient (HTC) during May-August did not exceed middle annual values and it was 0.45-0.74. At the same time in 2011, 2013 there were good conditions for growing and crop development. In 2015 at the HTC in June was 0.21, the efficiency of spring wheat was lower than middle annual values. It was considered that complex using of technology of direct sowing applying straw as a fertilizer stabilizes soil supply with nitrogen, increases phosphate content by 1.5-16.5%, an exchangeable potassium by 14.6-23.1%. During the research years, the high efficiency of nitrogenous fertilizers applying was set and it provided the increasing of NO_3 quantity by 1.4-1.8 times. The improvement of the nitric soil conditions by direct sowing in which starting doses of nitrogenous fertilizers were combined with integrated plant protection against weeds of diseases and wreckers gave a chance to obtain the greatest productivity of grain – 1.76-1.79 t/hectare that is 0.41-0.44 t/hectare (30.4-32.6%) above monitoring. The harvest increase from application of biological products was 0.15 t/hectare (11.9%), starting doses of N30 nitrogenous fertilizers – 0.17 t/hectare (13.4%), combined with the use of fertilizers and insecticides of 0.50-0.53 t/hectare (39.7-42.0%). On the basis of the obtained data by direct sowing of spring solid wheat, it is recommended to apply calculated doses of mineral fertilizers on productivity of 2.0 t/hectare, using low-cost, high efficient methods and ways of their applying (during sowing, local and band sowing). It is necessary to apply means of plant protection of new generation to fight with two-part weeds, infection diseases in the soil and in the seeds, corn bug thripses and cereal flies.

Keywords: direct sowing, spring wheat, nitrogen fertilizers.

EVALUATION OF FERTILIZATION EFFECT AT PRODUCTION OF STUMP SHOOTS IN POPLAR STANDS

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Landowners with harvested poplar plantations are currently facing the choice of planting with or without stump removal or establishing a new plantation based on stump shoot production. To stimulate stump shoot production by fertilizing around the stumps is an unproven method. A previous project (funded by STEM) established fertilization experiments in three harvested poplar plantations with one-year-old stump shoot 2012 in order to evaluate the short-term fertilization effects (two growth seasons) with two different fertilizer dozes 75 and 150 kg N ha^{-1} respectively. Half of the trial's sample plots were repeatedly treated the following year. Then a significant effect was found with repeated treatment with the higher fertilizer yield 150 kg N ha^{-1} for all three plantations. The present study has been revised in spring and autumn 2016 and autumn 2017 to evaluate the long-term fertilization effects. The results show that there is a long-term effect of fertilizing stump shots.

The results show that there is a long-term effect of fertilizing stump shoots. However, for the lower single dose (75 kg N ha^{-1}), no fertilization effect was noted on the biomass production. For the higher dose (150 kg N ha^{-1}) with repeated treatment, a clear fertilization effect was noted. The effect was noted for the stands and overall higher compared to the other treatments. On the other treatments, (repeated treatment with 75 kg N ha^{-1} and single dose with 150 kg N ha^{-1}), the results were not clear. The effect between them varied between the stands and in some case no effect was noted for either treatment.

In order to calculate the economic outcome of nitrogen fertilization, the results of the three test sites were combined. The overall result was that fertilization can be economically defensible even at today's low chip prices and current nitrogen fertilizer prices for the higher doses 150 and 300 kg N. The calculation is a draw at about 10 öre or lower per kWh. The single dose of 75 kg N spreading can not be economically motivated in any test site.

Keywords: poplar, stump shoot, fertilizer, fertilizer effect, bioenergy, biomass.

A RELAXED EDDY ACCUMULATION SYSTEM TO MEASURE GREENHOUSE GAS FLUXES FROM AGRICULTURAL ECOSYSTEMS

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Eddy covariance (EC) systems are currently state-of-the-art in measuring greenhouse gas fluxes from terrestrial ecosystems. Yet, they are limited to a few trace gases due to the lack of fast response analysers. High financial costs and high power consumption may further restrict their suitability. An alternative to EC is the relaxed eddy accumulation (REA) technique. REA avoids the need for a fast response analyser by collecting air from upwards and downwards moving air parcels into separate reservoirs at a constant flow rate (Businger and Oncley, 1990). After collecting the air over a predefined time period the air in the reservoirs is analysed by a slow response analyser and the average flux can be calculated. Currently, we are developing and testing a REA system that is capable of measuring CO2, CH4, N2O, NH3 and H2O fluxes simultaneously with only one gas analyser (Picarro G2805). This system is compatible with virtually any gas analyser and thus supports the flux analysis of a wide range of other tracers like volatile organic compounds, isotopes and aerosols. Furthermore, the modular design and rugged casing makes the sampling system very robust and portable, and DC operation makes it suitable for a wide range of field campaigns. The performance of the system is tested in spring 2018 on an agricultural managed organic soil in central Sweden. The results will be compared to established EC systems for CO2, CH4, H2O and N2O.

Keywords: eddy covariance, greenhouse gas, nitrous oxide, flux measurements.

CO_2 EFFLUX FROM THE SOIL AS INFLUENCED BY THE CONTRASTING VEGETATION COVER AND MANAGEMENT CONDITIONS IN *RETISOL*

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Soil CO_2 efflux is a physical process driven primarily by the CO_2 concentration diffusion gradient between the upper soil layers and the atmosphere near the soil surface. Soil CO_2 production is heavily influenced by environmental factors (soil temperature, soil moisture, organic content, etc.). In this research the temporal dynamic changes of CO_2 efflux from the soil surface using a closed chamber method (LI-COR LI-8100A Automated Soil CO_2 Flux System) were investigated. The measurements were done on *Retisol* in grassland and in arable land under conventional tillage (CT) on hilly landscape, Western Lithuania. Soil CO_2 efflux was measured every 3-4 weeks during the vegetation season from May to August, 2017. Each measurement was performed in triplicate.

The soil vegetation cover and the amount of humus significantly influenced the soil respiration rate. The greatest efflux values ranging from 1.59 to 2.25 μmol CO_2 m^{-2} s^{-1} were recorded in the grassland site and from 0.85 to 2.16 μmol CO_2 m^{-2} s^{-1} were observed in the arable land under CT. These efflux values were lower than in the grassland. Agro chemical data revealed that the content of humus amounted from 0.45 to 2.3 %, total N from 0.05 to 0.1 %, organic C from 0.26 to 1.33 % in the soil depth of 0-60 cm of the grassland site, while the content of humus (0.25-1.67 %), total N (0.02-0.71 %), organic C (0.15-0.97 %) at the same soil depth were recorded in arable land under the CT. These values were lower than in the grassland. Soil temperature and moisture are the main factors exerting influence on soil gas origination rate. The relationship between soil CO_2 efflux and temperature at a 5 cm depth can be described by a simple multiple regression model ($y = 0.1908x^2 – 7.1208x + 67.621$, $R^2=0.78$, n=5, p=0.549, valid for temperature from 14.93 to 21.47 °C). Soil CO_2 efflux displayed a typical polynomial relationship with soil volumetric water content (VWC) at a 5 cm depth ($y = -0.0361x^2 + 1.463x – 12.737$, $R^2=0.48$, n=5, p=0.937, valid for VWC from 15.43 to 31.80 vol.%).

According to the results of topsoil respiration under contrasting vegetation cover and management conditions in *Retisol*, the CO_2 efflux differed in quantity and was directly related to humus, nitrogen and carbon content. The content of humus, total N and organic C in the arable land site under CT was lower than in grassland. The same trend of efflux originating from the soil during vegetation period was observed in all experimental sites. The soil experiments indicate that the amount of soil humus contributed significantly to the soil-atmosphere exchange of trace gases.

Keywords: Soil CO_2, soil temperature, soil volumetric water content, humus.

SEED COMPOSITION OF DIFFERENT *CAMELINA SATIVA* AND *CRAMBE ABYSSINICA* CULTIVARS

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Biodiesel is produced mainly from rapeseed oil in European Union. With an increase in demand for oilseeds, two alternative oilseed crops for Europe, camelina (*Camelina sativa* (L.) Crantz) and crambe (*Crambe abyssinica* Hochst. ex R.E. Fries), identified as major candidates for the future European bio-based economy.

The aim of study was to evaluate seed oil composition of five camelina and four crambe cultvars as an interaction of genotype and meteorological conditions in Lithuania.

Seed were sown and grown at the Experimental Station of Lithuanian University of Agriculture, Middle Lithuania, on soil – clay loam on sandy light loam *Calc(ar)i-Endohypogleyic Luvisol(LVg-n-w-cc*). To determine fatty acids, the oils were extracted by the Folch method (Folch & Less, 1957) and NIRS method was used to determine the glucosinolate content.

The oil content in dry matter of seeds varied between species, years of cultivation and cultivars. This characteristic varied from 22.07 to 42.47% in camelina seeds and was 34.89% on average in years of investigation. The oil content in seeds of crambe varied in slightly narrower range (23.35–36.60%) with average of 29.33%, and was significantly lower than oil content in camelina seeds ($p = 0.035$). The glucosinolates content varied from 61.82 to 68.63 μmol g^{-1} in oil of crambe, and from 14.70 to 30.51 μmol g^{-1} in oil of camelina and differed significantly between species ($p < 0.001$). The result of factorial Anova revealed that plant species had the highest effect on variation of glucosinolates content in oil. By analogy to oil content, the increase of precipitation had significant negative effect on glucosinolates content. Camelina oil was characterized by predominating of linolenic acid which amount varied from 34.8 to 41.6% and was 36.6% on average, while crambe oil was predominated by erucic acid, which varied from 53.2 to 60.9% with average of 57.74%. The second the most abundant fatty acid in oil of both species was oleic acid, which amount did not differ between species. While the content of all other studied fatty acids differed significantly between both species (Mann-Whitney U test, $p < 0.001$).

The PCA distinctly separated both species, while intraspecific cultivars are was grouped according years of cultivation. It is obvious, that variation of fatty acid composition in camelina and crambe seed oil was much less affected by inheritable features of cultivars than by meteorological conditions of different years.

Keywords: *Camelina sativa*, *Crambe abyssinica*, cultivar, oil composition, glucosinolate.

EFFECT OF 50-YEAR CROP ROTATIONS ON SOIL ORGANIC CARBON CONTENT

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Identification and implementation of land use and soil management practices which create a positive agricultural soil/ecosystem carbon budget and restore soil quality is specific challenge worldwide. Moreover, soil carbon sequestration is almost only negative emission technologies which are readily available at a low cost and crop rotation is one of those. The objective of our investigation was to compare effect of 50-year term application of different crop rotations on soil organic carbon.

Long-term field experiment was established in 1966 at the Experimental Station of Aleksandras Stulginskis University at 54°52'50 N latitude and 23°49'41 E longitude. 9 different crop rotations were arranged in time and space. In addition *Rye monoculture* as well as *Continuous bare fallow* were included as control treatment. Soil – *Calc(ar)i-Endohypogleyic Luvisol*. All cereal straw was incorporated as organic residues. Soil organic carbon content was evaluated in 2015 and 2016, after 50 years from the beginning of this long-term field experiment.

Winter wheat grown in *Cereal, Field with raw crops* and *Norfolk* crop rotations. In this crop the highest (15.2 g kg^{-1}) organic carbon content was found in *Norfolk* crop rotation. *Cereal* crop rotation has an organic carbon content of less than 1.1 to 1.2 times, compared to other crop rotations.

Winter rye were grown in *Intensive, Field with raw crops, For green manure* and *Three course* crop rotations, as well as in *Winter Rye Monoculture*. In this case the highest amount of organic carbon was observed in *Intensive* (15.6 g kg^{-1}) and *Field with raw crops* (14.9 g kg^{-1}) crop rotations. The lowest – in crop rotations *For green manure* (11.3 g kg^{-1}) and *Three course* (12.0 g kg^{-1}).

Barley also were grown in 6 different crop rotations: *Intensive, Cereal*, *For green manure, Norfolk, Fooder*. The highest organic carbon content (from 6.5 to 20.7 %) was found in *Norfolk* (15.5 g kg^{-1}) and *Fooder* (14.5 g kg^{-1}) crop rotations compared to other crop rotations. The lowest organic carbon content was found in *Intensive* crop rotation. Similar amount of organic carbon also found in crop rotations *Cereal* and *For green manure*.

Soil organic carbon in *Continuous bare fallow* obtained 2 times less. Bare fallow without farmyard manure application decreasing soil productivity mostly. Crop rotation design in modern agriculture persist as one of major instruments for soil organic carbon management and sustainable intensification.

Keywords: soil organic carbon content, crop rotation.

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INFLUENCE OF LONG-TERM CROP ROTATION ON WINTER AND SPRING CEREAL PRODUCTIVITY

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Long-term field experiment was established in 1966 in the Experimental station of Aleksandras Stulginskis University. This paper presents productivity data of winter and spring cereals in 2015 – 2017 from this long-term field experiment. Winter wheat, winter rye and spring barley was grown in 9 different crop rotations arranged in tame and space as well as rye monocrop were included. Soil – Calc(ar)i-Endohypogleyic Luvisol.

The highest winter rye productivity results were obtained while rye growing after manuring in grassland and fallow crop rotation sequences. Notwithstanding winter rye is not sensitive to preceding crop, majority of cases showed lower productivity of rye yield in a fifty years term rye monocrop to compare with crop rotation. In our experiment the biggest effect on rye productivity elements obtained from preceding crop and from total rainfall and temperature on grain formation time. The correlation between these indices was significantly strong.

Winter wheat is more sensitive to preceding crop, the influence of crop rotation was significant in all years of these experiment. The best preceding crop for wheat was vetch-oat mixture fertilized with animal manure in cereal crop rotation.

Spring barley were not so demanding to preceding crop, they can be grown after winter cereals. However their productivity was higher in row sequence or in case of animal manure application during crop rotation.

Keywords: winter rye, winter wheat, spring barley, crop rotation, proceeding crop.

Acknowledgements. This work was supported by the National Science Program "The effect of long-term, different-intensity management of resources on the soils of different genesis and on other components of the agro-ecosystems" (grant No. SIT-9/2015) funded by the Research Council of Lithuania.

THE EFFECT OF SOWING DATE ON COVER CROP BIOMASS PRODUCTION

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The primary objective for using cover crops is to reduce fallow periods and losses of nutrients remaining in the soil after harvest of the main crop. For effective soil protection and nutrient binding it is essential to produce adequate biomass in the fall. The biomass production depends on the length of the growing season and the sum of effective temperatures. In northern climate, there is a limited time between cash crop harvest and first winter frosts.

Species of the *Brassicaceae* family are commonly used as cover crops because of their rapid growth in the fall and effectiveness of taking up residual nutrients from the soil. White mustard (*Sinapis alba* L.) has been one of the most used autumn cover crops in Estonia. Tillage radish (*Raphanus sativus* L.) is widely used in many parts of the world and in recent years it has also been introduced to Estonia. Both crops have been the biggest biomass producers in recent years when sown at the beginning of August. White mustard is incorporated in the soil in autumn, because it does not overwinter in Estonia. Tillage radish is more cold tolerant and its large taproot decomposes during winter leaving relatively residue-free and weed-free seedbed by spring. Therefore it is also suitable for no-till systems. A field experiment at Estonian Crop Research Institute was conducted in 2017 with white mustard and tillage radish to compare cover crop biomass production at different planting dates.

Cover crops were sown on August 3, 8, 14 and 18, the previous crop was winter wheat. The above and below ground biomass samples were collected before frosts. Dry matter (DM) yield was determined after drying the material to a constant weight.

At the earliest sowing time, the biomass of white mustard was 4900 kg DM ha^{-1} of which 18% consisted of roots. The biomass of tillage radish was 3800 kg DM ha^{-1}, root percentage was 48%.

With delayed sowing at 8.08, 14.08, and 18.08 the above ground biomass of white mustard decreased 27.9, 70.3 and 72.6%, respectively. At the same time the root percentage remained nearly the same (14–18%).

The biomass of tillage radish biomass decreased 44.1, 63.5 and 69.7%. Tillage radish's root percentage decreased more than white mustard's, but radish had significantly greater root system.

Studies in Estonia have shown that the biomass of cover crops is significantly reduced when sown after mid-August.

Keywords: white mustard, tillage radish, biomass, sowing time.

PHOTOSYNTHETIC ACTIVITY INDICATORS AND YIELD POTENTIAL OF CORN HYBRIDS WITH MINERAL NUTRITION AND GROWTH STIMULATORS TREATMENT

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To evaluate the parameters of corn photosynthetic activity and determine the productivity of different hybrids with early maturity while applying mineral fertilizers and growth stimulators.

This research was conducted in 2015-2017 years. The soil of location was a typical heavy loam chernozem with residual-carbonate and medium-humid content. Before plowing on 25-27 cm, mineral fertilizers were applied: diammophos and ammonium nitrate. Rates were calculated with balanced method. Planting depth: 5-6 cm. Method of planting: broad-band. Planting density – 65 th. seeds /ha. Growth stimulators Aminocat and Megamix N_{10} were applied in 5-6 leaves stages with 0.5 l/ha dosage. Standard moisture to calculate grain yield was 14%. Assimilation leaf area was counted with own Samara SAA methodology. Photosynthesis potential (PP) and pure photosynthesis productivity was calculated with methodology of A.I. Begishev and A.A. Nichiporovich.

The design of experiment #1 to study the influence of mineral nutrition on different maturity hybrid was following: Application NPP on planned yield 7 t/ha – background 1; 8 t/ha – background 2, 9 t/ha – background 3 (Factor A);Corn hybrids (Factor B): Falcone, Delphin, Krasnodarsky (FAO 180); Gitago, TK 202, Eurostar (FAO 200).

The design of experiment #2 to study the influence of growth stimulators on early hybrids was following: Aminocat, Megamix N_{10} (Factor A); Hybrids Falkone, Delphin, Krasnodarsky 194 (Factor B).

Yield level of corn hybrids with mineral nutrition in 2015-2017 years was 4,70…7,17 t/ha. While applying the growth stimulators the yield level was 4,86… 5,86 t/ha with maximum observed yield on Delphin with Megamix N_{10} treatment. Based on the results from 2015-2017 years, corn hybrids formed 21,27…35,84 th. м^2/ha of leaf area while applying fertilizers and the maximum amount was observed on TK 202 hybrid on background 3. The largest leaf area on the variants with growth stimulator application was noticed on Delphin and Krasnodarsky 194 – 35,78 and 37,06 th. m^2/ha., accordingly, where Aminocat was applied. Maximum photosynthesis potential was observed on TK 202 and Delphin hybrids – 1,95 and 1,92 million m^2/ha. days, on background 3. Maximum photosynthetic potential with growth stimulators application was 2,50 million m^2/ha. days. The biggest pure photosynthesis productivity was observed with mineral nutrition application on Falcone hybrid (FAO 180) – 10/06 gr/m^2 per day.

Closer to milky-wax ripeness stage – leaf area was 35,84 th. m^2/ha., with mineral fertilizers application. Growth stimulators are facilitating the enlargement of leaves on corn. Application of mineral nutrition increasing the photosynthesis potential to 1,95 million m^2/ha. days. When applying the growths stimulators the parameter of photosynthesis potential is increasing up to 2,36…2,50 million m^2/ha. days. Pure photosynthesis productivity increasing in variants with both big doses of mineral fertilizers, and with growth stimulator treatments. Growth stimulator treatment increasing the grain yield up to 10,8 – 14,2%.

Keywords: corn, fertilizer, growth stimulator, leaf area, photosynthesis potential.

THE FIELD PEA YIELD AND NITROGEN BALANCE DEPENDING DIFFERENT FERTILIZER RATES

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The aim of this study was to compare and analyse the impact of organic and conventional growing system treatments to the dry matter yield (DM) of field pea (Pisum sativum), nitrogen use efficiency (NUE) and nitrogen leaching.

The data was collected during the period of 2012- 2016 and carried out on the experimental fields of the Estonian University of Life Sciences (58° 22´ N, 26°40´E). Soil type was Stagnic Luvisol (sandy loam surface texture, C 1,38% and N 0,13%, pH_{KCL} 6,0).

The experiment was set up in systematic block design with four replicates of each treatment and plot size was 60 m2. The field was divided by nitrogen treatments: three different treatment in organic plots (M 0, M I- cover crops, and M II- cover crops and manure) and four different treatment in conventional plots (N0, Nlow, Naverage, and Nhigh). The five-field crop rotation based on following order of the crops: barley undersown with red clover – red clover – winter wheat – field pea – potato. Field pea mineral fertilizer treatments were N0P0K0 and N20P25K95.

The average yield of field pea was higher in conventional plots where mineral nitrogen fertilizer was used. The highest yield was 2,60 t/ha, obtained from conventional N1 treatment. Lower yield in N2 and N3 plots can be explained by the after effect of high mineral fertilizer rate given to winter wheat the year before. Organic farming with cover crops gave the average yield 2,06 t/ha that is 21% lower compared to conventional farming. However, the difference of yield in different farming systems varies from year to year: in 2015 it was 25%, but in 2016 it was 35%.

The nitrogen use efficiency was calculated as 1 kg total DM yield per 1 kg of N applied, fixed symbiotically and collected by cover crops. Higher NUE revealed in treatments with lower amounts of N but relationship was not linear. The nitrogen uptake efficiency is obviously higher where pre crop got up to 50 kg N per hectar. Furthermore the yields of field pea stay lower in higher N rate of pre crop. It´s reasonable to grow such pre crops before field pea which have lower N demand. Otherwise the N losses will be happen.

Obviously the pea as leguminous fixing N2 from atmosphere and riching soil for next crop. Soil samples to measure N% in this were taken in spring before pea sowing and next spring before next crop. These measurements shows significally N leaching which depends on active temperatures in springtime. For detail view please see the poster.

Keywords: field pea, nitrogen balance.

PRODUCTIVITY OF GRASS AND LEGUMES MIXTURES WITH *POTERIUM POLYGAMUM* TREATED WITH GROWTH STIMULATORS

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Objective of research was to evaluate parameters of photosynthetic activity of perennial grasses. The productivity determined of grass and legumes mixtures with *Poterium polygamum* treated with growth stimulators "Matritsarosta" and "Gumi 20M".

The research was conducted in year 2015-2017. The soil of the experimental plot is typical black soilaresidual-carbonate medium-humus medium-heavy heavy loam. Growth stimulators "Matritsarosta" and "Gumi 20M" were applied during the tillering phase on grasses and third leaves phase on legumes. The yield of green mass was determined by decade. The assimilation surface of the leaves was determined by the method of the Samara State Agricultural Academy (contour method). The photosynthetic potential and the pure productivity of photosynthesis were calculated by the method of A.I. Begisheva and A.A. Nichiporovich.

The planting scheme for evaluating the influence of stimulators: stimulators "Matritsarosta", "Gumi 20M" (factor A); Plants mixtures *Bromus inermis* + *Poterium polygamum*, *Bromus inermis* + *Bromus erecta* + *Poterium polygamum, Bromus inermis* + *Bromus erecta* + *Onobrychis arenaria* + *Poterium polygamum, Bromus inermis* + *Bromus erecta* + *Medicago* x varia Martyn + *Poterium polygamum*, *Bromus inermis* + *Bromus erecta* + *Lotus corniculatus* + *Poterium polygamum*; *Agropyron pectinatum* + *Poterium polygamum, Agropyron pectinatum* + *Elytrigia* + *Poterium polygamum, Agropyron pectinatum* + *Elytrigia* +*Onobrychis arenaria* + *Poterium polygamum*, *Agropyron pectinatum* + *Elytrigia* +*Medicago* x varia Martyn + *Poterium polygamum*, *Agropyron pectinatum* + *Elytrigia* + *Lotus corniculatus*+ *Poterium polygamum* (factor B).

It was concluded that he yield of green mass while applying growth stimulators on the whole variants is increasing before flowering phase. Mixes with *Bromus inermis* the field level in average in years 2016-2017 was: tillering phase – 5.94…14.27t/ha, budding phase – 9.27…22.34t/ha, blooming phase –12.76…28.07 t/ha, fruit formation phase – 17.52…32.77t/ha; with *Agropyron pectinatum* in branching stage – 4.76…19.18 t/ha, budding phase – 7.05…23.04 t/ha,blooming phase – 11.52… 29.52 t/ha, fruit formation phase – 14.58…31.29 t/ha, where four-component mixtures with *Onobrychis arenaria* are leading with the application of "Gumi 20M". The largest area of the assimilation apparatus was formed by grasses *Bromus inermis* +*Bromus erecta* + *Onobrychis arenaria* + *Poterium Polygamum* – 83,96 th.m^2/ha and *Agropyron pectinatum* + *Elytrigia* + *Onobrychis arenaria* + *Poterium polygamum* - 89,64 th.m^2/ha while applying "Gumi 20M". The dry matter amount was highest on mixture of *Bromus inermis* +*Bromus erecta* +*Onobrychis arenaria* + *Poterium polygamum* – 14.45t/ha and *Agropyron pectinatum* + *Elytrigia* + *Onobrychis arenaria* + *Poterium polygamum* – 10.26 t/ha with growth stimulator "Gumi 20M".

Application of growth stimulants "Matritsarosta" and "Gumi 20M" increased the intensity of leaf formation, the formation of photosynthetic potential, which largely forms a crop yield. The maximum productivity, the collection of dry matter and the digestible protein are distinguished by crops with traditional leguminous crops of the region: *Onobrychis arenaria*, *Medicago* x varia Martyn, provide a green yield of up to 32.77 t/ha, dry matter 14.45 t/ha and 1.25 t/ha.

Keywords: *Agropyron pectinatum*, *Bromus erecta*, *Poterium polygamum,* growth stimulators, green mass, dry matter.

BIOMASS OF SOFTWOOD AND HARDWOOD TREES GROWING ON AFORESTATED FARM OR DEGRADED LANDS FOR BLENDED FUEL PELLETS PRODUCTION

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Production of biomass fuel pellets has significantly increased over the last decade and involves international trade of ten million tones annually. To cover the needs in biomass feedstock, fuel pellet producer appear to draw in competition with other biomass consumers.

The main aim of this investigation is comparison of the fuel characteristics of wood, including stem wood and non-debarked wood, widely used for industrial production of fuel granles from the following species: pine (*Pinus sylvestris*), aspen *(Populus Tremula L.*), with the ones of wood species considered today as a alternative raw material for granulation: lodgepole pine (*Pinus contorta*) and plantation poplar species (*Populus spp.*) and willow (*Salix spp.*) growing on aforestated farm lands or degraded lands. Fuel characteristics including elemental composition, ash content and calorific values of stem wood and bark of above mentioned trees species, were evaluated. The ash content in non-debarked wood biomass in dependence of bark portion in mixture was evaluated using regression equations.

The behaviour of the investigated biomass at thermal oxidation conditions, modelling combustion process, was evaluated using TG, DTG, DTA methods in air atmosphere. The effect of softwood/hardwood ratio in the composition of sawdust mix on the energy consumption for granulation, standard mechanical characteristics of the pellets obtained were investigated. Laboratory scale pilot flat die pellet mill KAHL-1475 was used for granulation. The one batch (300 g) gasifier of original construction (1.2 kW) equipped with gas analyser Testo and water cooled jacket was used for measuring of heat released rate and emissions at different stages of pellets combustion.

All investigated fuel characteritics of the stem wood and bark of *Populus Tremula L.*, *Populus spp.* and *Salix spp.* are significantly worse than corresponding characteristics of *Pinus contorta* and *Pinus sylvestris*. The main disadvantage of the investigated hardwood species is high ash content as for stem wood, as especially for bark, that significantly lowers the calorific value of the biomass.

For all types of wood biomass the optimal portion of hardwood and softwood was find to produce the pellets which meet the requirements of EU standards for fuel pellets.

Keywords: pine, willow, lodgepole pine, poplar, stem wood, bark, mixed fuel pellets.

IS SLAUGHTER AT A MOBILE ABATTOIR BENEFICIAL FOR MEAT QUALITY?

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The objective of this project was to compare animal welfare and meat quality at mobile vs. large scale stationary slaughter. Handling at slaughter exposes the animals to welfare risks and can be very stressful. In addition to reducing animal welfare, stress associated with slaughter may impair meat quality. The effects of mobile slaughter on animal welfare and meat quality have so far not been studied to a large extent.

One small-scale mobile and one conventional stationary abattoir were studied. At the mobile plant, the animals were taken from the farm facilities to an inspection pen, from which the animals were driven along a short driveway to the stun box. The plant was housed in two trucks, parked on farm. Animals slaughtered at the stationary abattoir were transported up to 250 km on road, and about one third of them were kept in overnight lairage before slaughter. A total of 283 and 281 animals were included at the mobile and the stationery plant, respectively. At the stationary plant, the carcasses were electrically stimulated. The mobile plant used pelvic suspension and the stationary plant Achilles suspension. The observations included animal handling and animal behaviour in the driveway to the stun box and in the stun box, blood chemistry at bleeding (cortisol, glucose, lactate), carcass conformation and fat grading (EUROP scale), marbling and meat quality attributes (pH, weight loss at thawing and cooking, colour, Warner-Bratzler shear force, compressive load and modulus) after seven days of hanging.

There was no clear association between final pH of the meat and the animals' emotional expression at the start of driving or with the way to drive the animals. Ultimate meat pH differed between the slaughter plants; carcasses slaughtered at the mobile plant had a higher pH, which could be due to the fact that electrical stimulation was not used. The percentage of animals with a final pH above 5.8 at cutting was 14.8% at the mobile plant and 7.7% at the stationary one. At both plants, cooking loss decreased with increasing fat class and with increasing marbling. Shear force and compressive load were higher at the stationary plant, where compressive load was highest in cows and bulls; otherwise the differences between different animal categories were small. At the mobile plant, animals regarded as hesitant prior to being driven had higher, and animals considered as nervous even higher, compressive loads. Both compressive load and shear force were slightly higher in animals staying overnight at the stationary plant.

This project shows that calm animals when driving to the stun box begins, an appropriate layout of the slaughterhouse premises, driveways and equipment and correct handling of the animals during driving, stunning and bleeding are essential to achieve low stress levels and a high meat quality. There are conditions for good animal welfare and meat quality in both mobile and stationary slaughter of cattle. Based on the project, it cannot be concluded that animal welfare or meat quality is generally better with one or the other way of slaughtering.

Keywords: mobile slaughter, stationary slaughter, animal welfare, meat quality.

EFFECTS OF FOUNDRY SAND ADDITION ON TRAFFICABILITY, YIELD AND CO_2 EMISSION FROM A CULTIVATED PEAT SOIL

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Peatlands store a large share of the world's soil organic carbon and are widespread in Northern and Central European countries. Drainage is a precondition for traditional agricultural production on organic soils. Drainage increase peat mineralization and changes the physical and chemical soil quality. Only a few decades after initial drainage, agricultural systems on drained organic soils start experiencing a high risk of crop failure. Decreased hydraulic conductivities lead to decreased infiltration, ponding, and finally to abandonment as drainage will not be effective anymore. Another problem is the low trafficability.

The aim of this experiment is to investigate if the addition of foundry sand to the top soil will improve the trafficability and how it will affect the yield and CO_2 emission. In the Swedish part of the EU-funded PEATWISE project, a field experiment (randomized block design, 3x3) was set up at a former cultivated, but now abandoned, fen peat located at Bälinge Mossar (60.03N, 17.43E). We compare trafficability, yield, oxygen concentration in the soil and CO_2 emission from plots sown with Timothy (*Phleum pratense*) treated with 0 cm, 2.5 cm or 5 cm foundry sand. The sand was applied in the autumn of 2015 and mixed in the top 10 cm of the soil. CO_2 emissions were measured with automatic chambers (ADC BioScientific, UK) taking 12 measurements per day in frames where we removed the vegetation.

The trafficability was slightly higher for the plots with sand addition 2016 but the opposite was found 2017 despite that you can feel that the stability has increased just by walking on the plots. The yield 2017 was highest from the plots with 5 cm sand (11.6 t d.m. / ha), lowest from plots with 2.5 cm sand (8.8 t d.m./ha) and the control yielded 10.3 t d.m./ha.

The CO_2 emission during the autumn of 2015 (15/9-1/11) was highest from the plots without sand addition (3.4 μmol $m^{-2}s^{-1}$) and lowest from the plots where 5 cm sand was added (1.4 μmol $m^{-2}s^{-1}$). The emission from plots with the 2.5 cm treatment was 1.8 μmol $m^{-2}s^{-1}$. During 2016 (4/5 – 27/9), the emissions were lowest from the plots treated with 5 cm foundry sand (4.26 μmol $m^{-2}s^{-1}$), and highest from the plots with 2.5 cm sand (6.10 μmol $m^{-2}s^{-1}$). The untreated plot had an average CO_2 emission of 5.09 μmol $m^{-2}s^{-1}$. The 5 cm plots had lowest emission 2017 as well, emitting an average of 4.53 μmol CO_2 $m^{-2}s^{-1}$ whereas the 2.5 cm treatment emitted 4.87 μmol CO_2 $m^{-2}s^{-1}$and the 0 cm treatment 5.92 μmol CO_2 $m^{-2}s^{-1}$.

The addition of foundry sand changes the properties (physical and chemical) of the soil which reduce the CO_2 emission and increase the yield.

Keywords: CO_2 emission, peat soil, foundry sand.

ESSENCE AND PECULIARITIES OF MONITORING OF SOCIO-ECONOMIC AND SPATIAL DEVELOPMENT OF THE REGION

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The article has revealed the essence of monitoring the socio-economic and spatial development of the region. The study has concluded that it is necessary to methodically differentiate spatial monitoring and "classical" monitoring of social and economic development. Besides, indicators of monitoring of spatial development of the region have been given and the order of their estimation has been described on the example of regions of the South of Russia. An assessment of the model of spatial organization of territories has shown that the most even distribution of economic power and impulses of economic development are noted in the Stavropol Territory. The economy of this region develops on a network principle, unlike other regions of the South of Russia, although it has a similar specialization and comparable conditions for the resource potential. The paper con-cludes that the implementation of monitoring of socio-economic and spatial development of the regions should be indivisible elements of the tools of the regional management system, aimed at timely identification of the existing differentiation of the territories in order to further smooth it. The application of methods of spatial analysis makes it possible to identify such important parameters of the development of the region as the level of centralization, narrowing, fragmentation of economic space. The analysis of spatial development allows reduc-ing the asymmetry in the development of the regions of Russia through the application of complex targeted regional development programs, the activities of which are built individually for each typological group of regions, depending on the level of spatial development.

Keywords: region, monitoring, spatial development, socio-economic development, narrowing, economic space.

WHEAT YIELD AND ENERGY PRODUCED BY IT

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Wheat is an important crop in the world. The main direction of using wheat is grain for food production due to flour baking properties and high calorific value of grain. New solutions are being sought for obtaining higher yields by limiting harmful organisms and using chemical compounds, however, it can be obtained by carrying out elementary agrotechnical measures, like appropriate soil tillage method and crop rotation.

The aim of the research is to confirm that, by choosing soil tillage method and forecrop, it is possible not only to get higher winter wheat grain and straw yield, but the total energetic gain from harvest also increases. The paper was based on one season data (2016/2017) from two factorial trial with two soil tillage treatments and three crop rotations, which was started in 2009. In this study, the first factor was soil tillage method (minimum and traditional) and the second – three winter wheat forecrops (winter wheat, oilseed rape, faba bean). Totally six variants in four replications were investigated. Winter wheat variety 'Zentos' was sown in Cambic Calcisol (Bathyruptic, Episiltic, Protostagnic). Yield was harvested at GS 92 using direct combaining, and recalculated at 100% purity and 14% moisture. Straw yield was calculated from grain: straw ratio after sample-sheets' analysis. Gross calorific value (MJ kg^{-1}) was obtained using bomb calorimeter according to the method LVS EN ISO 18125:2017, for an average sample of each variant of grain and straw, in total 12 samples. Calorific value of dry matter yield was calculated to obtain energetic gain per hectare. Research is financed by National Research Programme AgroBioRes, Project Soil.

The results showed that soil tillage method ($p<0.01$) and forecrop ($p<0.001$) had a significant impact on winter wheat grain and straw yield, and on energy yield gained from grain and straw. The highest grain yield was obtained when wheat was grown after faba bean (8.06 t ha^{-1}) and oilseed rape (7.08 t ha^{-1}), but the lowest – in repeated wheat sowings (6.38 t ha^{-1}). The highest straw yield also was obtained when faba bean was forecrop (10.36 t ha^{-1}). Calculated grain: straw ratio was on average 1: 1.29. When investigating the gross calorific values of each grain sample, the difference between established values had been noticed. Wheat gross calorific value was 18.2 MJ kg^{-1} when it was grown after faba bean, but value was lower by 0.7 MJ kg^{-1} when it was grown in repeated wheat sowings. The gross calorific value of straw had an opposite result – the lower value was noted growing wheat after bean (17.8 MJ kg^{-1}), but that in repeated wheat sowings was 18.3 MJ kg^{-1}. The energy gained from grain (on average 110.5 GJ ha^{-1}) and straw (on average 144.4 GJ ha^{-1}) was the highest when forecrop was faba bean, but the lowest in repeated winter wheat sowings. In this study, higher grain and straw yields and energy yields were obtained in variants with minimum soil tillage ($p<0.01$).

It is possible to increase the productivity of winter wheat by choosing the forecrop and soil tillage method.

Keywords: winter wheat, forecrop, soil tillage, yield, energy gain.

RESULTS OF TESTS OF LABORATORY INSTALLATION OF MICROHPP

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The article considers quantitative and qualitative assessments of water and energy resources, which uses a certain system of indicators, including the topographic, hydrological and energy features of the river or basin.

The technical potential was estimated by the gross hydroelectric resources of the river flow to be accounted for, reduced by the amount of losses of hydraulic energy. Preliminary design and a prototype of microHPP was developed with the propeller and hydroturbine and a laboratory facility Thefor carrying out research tests. Laboratory installation for conducting research tests of microHPP consisted of a 1-reservoir, 2-a pump, 3-a valve, 4- the micro HPP itself, 5 and 6-pressure gauges and, 7 and 8-hoses, 9-a control panel and control. A capacity of reservoir 1.5 m^3. The installation uses a KM 100-80-160-C9HL4 pump with a capacity of 100 m^3 and a pressure of 32 m. The pressure gauges serve to determine the head. Experimental investigations were carried out under pressures 2, 3, 4 m. The frequency of rotation of turbines in the experiments varied from 250 to 2500 min^{-1}.

The rated power of 1 kW, laid down in the technical design assignment, is achieved with water flow (0,03 ... 0,035) m^3/s and a water pressure of 4 m. At the same time, the turbine rotation speed was (1520 ... 1580) min^{-1}. During the test period, the nodes and units of microHPP worked stably in accordance with their functional purpose. In general, bench tests of microHPP showed a sufficiently high performance.

Keywords: microHPP, water and energy resource, hydropower resources.

CHALLENGE OF THE PROBIOTICS ON GROWTH PERFORMANCE AND INTESTINAL HEALTH IN PIGLETS

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Due to the World concerns of antibiotic abuse, there is an increased interest to improve health and reduce antibiotics usage in pig farming by alternatives. Probiotics induce alterations to the intestinal microbiota, improve mucosal immunity and enhance gut tissue integrity, therefore stabilization of the intestinal microbiota is an essential precondition key for intestinal health and growth in pigs. The aim of our study was to find out the effects of the mixture of probiotics on growth performance and intestinal health in piglets.

Two weeks old piglets (n=22, Duroc × Landrace) were allocated in two groups: basal diet (C group) and basal diet + mixture of probiotics added to the drinking water (P group). During the experiment (6 weeks) offered and refused feed, as well as piglets were weighed to calculate average daily gain, daily feed intake and feed conversion ratio. At the end of experiment, piglets (four from each group) were slaughtered. Fecal samples and samples of digestive content (n=36) were used for enumeration of *E.coli*, *Enterobacteriaceae* and *Lactobacillus* spp. Tissue samples of *jejunum* were dehydrated and embedded in paraffin wax, sectioned and stained with haematoxylin and eosin for histomorphological measurements and immunohistochemistry.

In this study, oral administration of mixture of probiotics had no significant difference ($p>0.05$) on weight gain, average daily gain (353 ± 15 g d^{-1} vs. 369 ± 27 g d^{-1}) average daily feed intake (620 ± 88 g d^{-1} vs. 580 ± 82 g d^{-1}) and feed conversion ratio (1.80 ± 0.09 vs. 1.68 ± 0.15) compared group P to group C. After three weeks of experiment, the challenge of probiotics decreased the count of *Enterobacteriaceae* ($p<0.05$, 1.73 ± 0.38 lg cfu g^{-1} vs. 3.37 ± 0.47 lg cfu g^{-1}) and the count of E.*coli* ($p>0.05$, 1.66 ± 0.38 lg cfu g^{-1} vs. 2.91 ± 0.29 lg cfu g^{-1}) in the feaces. After six weeks of experiment, probiotics increased the count of *Lactobacillus* spp. ($p<0.05$, 7.75 ± 0.24 lg cfu g^{-1} vs. 6.27 ± 0.82 lg cfu g^{-1}) and decreased the count of *E.coli, Enterobacteriaceae* ($p>0.05$) in *jejunum*. Compared group P to group C, probiotics had no significant difference ($p>0.05$) on villus height (358.71 ± 7.47 μm vs. 360.70 ± 13.77 μm), crypt depth (244.16 ± 6.79 μm vs. 231.42 ± 11.24 μm) and the ratio of villus height to crypt depth (1.61 ± 0.06 vs. 1.71 ± 0.08) in *jejunum*.

Treatments had the opposite effect on mucosal Treg (Foxp3 positive cells) in jejunum – significantly inceased was in probiotic group compared to control.

This study demonstrates that mixture of probiotics supplied via drinking water had no affect on growth performance, but significantly improved gut microbial balance - increased count of *Lactobacillus* spp. and decreased count of *Enterobacteriaceae* in piglets. Probiotics had no significant influence on the alterations in morphology of small intestine in piglets.

Keywords: histomorphology, gut microbiota, Foxp3.

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CONTROL OF TRANSIENT PROCESSES IN MILKING MACHINES

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Currently, there are a wide variety of technologies of machine milking. But all the milking machines have a strong mechanical effect on the udder of cows. Because of this, there are a number of negative factors that reduce the quantity and quality of milk. Analysis of the construction of teatcups and vacuum pumps shows that when the milking machine is operated, sudden transients occur in the interstitial chamber of the teatcup. The rapid transition processes greatly inhibit the reflex milk output. This leads to a decrease in productivity of cows and increases the incidence of mastitis. The best way to manage the transition in a teatcup is the use of control devices. This method is implemented through the use of various types of valves. Developers of milking equipment are the task of creating an electric pulsator with the regulatory regime. This mode should provide a more continuous transition from quantum of sucking up on the compression stroke. Also, this mode must be able to be used in installations of individual milking or milking robots. Most of the development created to regulate the duration of transient processes, solve the existing problem only partially. Therefore, they are not issued by the industry. The article describes a review of the methods of improving the design of teatcup to manage the transition process in misenai camera teatcup. The management of the transition will enable us to live in milking machines from existing deficiencies in the milking.

Keywords: milking machine, teatcup, pulsator, liner, pulsation chamber.

WOOL QUALITY OF NORWEGIAN WHITE SPÆL SHEEP BREED

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The Norwegian White Speal Sheep are characterised by their fluke-shaped and tapered short tail, dual-coated wool and the ability to thrive under harsh environmental conditions. The income in Norwegian sheep farming comes from lamb meat, wool and pelts. Today, wool is of minor economic importance, commonly accounting for less than 10% of the income. However, the interest of wool as a sustainable and local fibre is increasing. Wool quality traits of the Norwegian White spæl breed has been reported to be declining; i.e. an increase in medulated fibres and in kemp. To address this challenge, there has been developed and incorporated 1) wool quality assessment tutorials for farmers and breeders, 2) included heritability estimates of wool fleece weight and quality class in index calculations, and 3) conducted OFDA analysis of wool from breeding rams for three consecutive years. The work was initiated by the research-project *KRUS - Enhancing local wool value chains in Norway* (NFR 244618/E50) and has been carried out by NIBIO, the Norwegian Sheep Breeders Association (NSG), Animalia and Norilia.

Wool quality assessment tutorials for farmers and breeders are available as a.pdf and video for free download from NSG webpage (nsg.no). A 'wool evaluation kit' with a magnifier is available for purchase, also from NSG. Implementing index estimates was made possible when including fleece weigh and fleece classification from all sheared lambs at slaughter into the Norwegain National Sheep Recording system. Further, OFDA analysis were conducted on wool from breeding rams collected autumn 2015, 2016 and 2017. The wool samples were analysed using the optical FD analyser (OFDA100; BSC Electronics Pty Ltd, Western Australia, Australia). OFDA analysis is conducted to describe wool quality traits, development of quality traits over time and also development of quality traits at different age of breeding rams. Preliminary results from this study will be presented at the conference.

Keywords: sheep, wool quality, Norwegian white spæl, dual felt, double-coat.

IVERMECTIN RESISTANCE OF HORSE DIGESTIVE STRONGYLES

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Lately, much has been said about ivermectin resistance to digestive horse strongilide infections. Often, the owners of the horses choose the animal to do deworming, without sending first the coprogram to the laboratory for the test. Misidentifying antihelmetic and inappropriate doses result in the strongilide ivermectin resistance.

Our goal was to investigate whether the ivermectin resistance was observed in horses in Latvia. The tasks were as follows: collecting faecal samples, examining them, calculating the quantity of an invasion, identifying resistance. The study was launched in March 2018.

In the study, we used 23 horses from the age of five, different sexes and types of use (sport, hobby etc). Horses were from different districts of Latvia (Jelgava, Riga, Jekabpils, Aizkraukle region). All animals were clinically healthy - rectal temperature, respiration rate, heart rate, condition of the animal were determined. 23 horses were examined for coprology specimens. Samples were obtained from each horse rectal, faeces put into sterile plastic bags, each individually identified (animal identification number, age, gender), and transported in a cold box at plus 4° C to the laboratory for investigation. Samples were examined at the Laboratory of Veterinary Medicine at the Parasitology Laboratory using the flotation method. The egg number is set per gram of faeces after McMaster. (D. Keidane, 2006).

Depending on the results obtained and the volume of the invasion, all positive horses were given an ivermectin-containing paste. The dose is adapted to the individual weight of each horse. Repeated faecal samples were taken after 14 days. Samples were examined by flotation method, and the number of eggs re-diagnosed per gram of faeces after McMaster.

We can conclude that in the samples, before deworming with ivermectin-containing paste, the number of strongilidae eggs varied from 100 to 800 eggs per gram of faeces. Collection and investigation of faecal samples are still going on.

Keywords: horses, ivermectin, resistance, strongyles.

TECHNOLOGY DEVELOPMENT OF PROTEIN-FAT EMULSION AND ITS USE IN FOOD PRODUCTION

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In today's market, the production of high-quality, cost-effective, competitive products is impossible without the use of advanced technologies and innovative solutions. The objective of this research work is scientific testing of methods related to the development of innovative technology of protein-fat emulsion with a higher stability than its analogs. The use of the developed protein-fat emulsion in the production of food stuff enables to create a finished product with optimal functional and technological properties. Scientific researchers are presented on the example of emulsified sausage goods. When developing the technology of protein-fat emulsion, the following raw materials were used: high-oleic sunflower oil, an aqueous solution of animal protein product "Kat-gel 95". The emulsion was obtained using a device for cavitation disintegration of liquid food media and water "Hielscher Ultrasound Technology UP" according to the developed modes. During the series of scientific experiments the following research methods were used: analytical, organoleptic, measuring, calculation. The conducted researches allowed to recommend the replacement from 15 to 20% of meat raw materials on the received emulsion in a formulation of sausage goods. The absence of pork fat in the sausage goods, as well as the replacement of meat raw materials in the composition of the product with the developed protein-fat emulsion, contributed to the improvement of the quality characteristics of the finished product, increasing the stability of sausages during storage, improving organoleptic properties, reducing the caloric content of meat products; reducing the risk of defects associated with the emergence of bouillon - fat drips. Further increase in the level of protein-fat emulsion leads to a slight increase in the structural and mechanical properties of sample minced meat systems and economically impractical. All the samples of boiled meat products are characterized by a lack of bouillon - fat drips and are resistant in storage.

Keywords: emulsion, emulsion stability, technology, composition, raw meat.

THE CHANGES OF MILK PRODUCTIVITY AND QUALITY OF LATVIAN LOCAL BREED DAIRY COWS

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With the farm modernization and increasing cow milk productivity farmers are usually preferring specialized dairy breeds (usually Holstein Black and White (HBW) breed). Although HBW cows are highly productive, but they have not built the resistance to different local environmental conditions. On the other hand the native breed cows are bred in the region for hundreds of years and are more resistant to negative environmental effects, they characterizes with stronger health, better longevity and higher milk composition indicators. Despite the positive aspects of local breed cows, because of their lower milk yield there is small number of animals in the population of native breeds in the dairy herds in European Union states. With that in consideration there is a need to emphasize the positive traits of local breed cows and therefore maintain the dairy breed biodiversity. In Latvia there are 2 dairy cow native breed – Latvian Blue (LZ) and Latvian Brown (LBGR). Cows are located mainly in small farms (1 – 5 cows per farm), with the exception of Latvia University of Life Sciences and Technologies (LLU) research and study farm "Vecauce" where are located 30 LBGR cows.

For analysis of genetic resources cow milk productivity and quality, we collected data from 25 LZ cows and 25 LBGR cows that were included in VPP AgroBioRes 3 LIVESTOCK project and concluded at least one productive lactation. Analysed cows were located in different farms and had different environmental conditions. For study purposes were collected data about cow daily milk productivity (from monthly recordings), milk productivity, reproduction traits and live weight in 1st and 3rd lactation. Data were collected from Latvian "Agricultural Data Centre" data base.

Analysed group cows in the first milk recording control (from day 7 to 38 after calving) characterized with in average 19.09±0.64 kg daily milk yield and milk fat 4.48±0.13% and 3.25±0.06% protein content. If studied closer, milk fat content significantly ($p<0.05$) higher was in LBGR breed group (accordingly 4.70±0.19% and 4.26±0.18%), but the protein content in milk was similar in both analysed groups – 3.24±0.09 for LBGR and 3.27±0.07 for LZ breed cows. At the end of lactation the difference of milk fat and protein content in milk increases. At the 10th time of recording (day 278 to 318 after first calving) the difference between milk composition traits increased. In LBGR cow milk there was 5.06±0.17% fat and 3.97±0.13% protein, but for LZ breed cows that was significantly lower ($p<0.05$), accordingly 4.43±0.20% of fat and 3.68±0.07% of protein. In the context of milk quality we analysed the amount of somatic cells in milk. As cows were kept in different housing systems with different health and hygiene protocols, the somatic cell count (SCC) differed not only between both analysed breeds, but also between different milk samples. At the beginning of first lactation significantly higher SCC was for LBGR breed cows (176.1±57.53 thousands in 1 mL^{-1} milk), but in LZ cow milk there was 105.6±20.53 thousands SCC in 1 mL^{-1} milk.

Keywords: milk composition, somatic cell count, milk yield.

IMPACT OF THE FLOUR OF JERUSALEM ARTICHOKE ON PRODUCTION OF METHANE AND CARBON DIOXIDE AND WEIGHT GAIN IN CALVES'

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The aim of this research was to measure the amount of methane (CH_4) and carbon dioxide (CO_2) in calves' rumen and compare the obtained results between the control group and the experimental group which received the additional supplement of the prebiotic inulin in a dosage which showed the best results in our previous experiment and also compare the live weight gain between the groups.

The research was conducted in the dairy cow farm in Latvia. Ten clinically healthy randomly selected Holstein Friesian (*Bos Taurus L.*) crossbreed calves of average age 33±6 days were used in the research. Calves were split into 2 groups: 5 calves in the control group (CoG), 5 were supplemented with 12 g of flour of Jerusalem artichoke (*Helianthus tuberosus* L.) per calf, containing 6 g of prebiotic inulin (Pre12). The prebiotic was added to barley flour once a day in the morning. The length of the experiment was 56 days. CH_4 and CO_2 were measured by using cavity ring down spectroscopy device Picarro G2508. The weight measurements and samples form calves' rumens were evaluated three times during the research – on the 1st, 28th and 56th day of the research. Samples were obtained by puncturing the calf rumen with 16G needle and were collected into 20ml syringes. The site of puncturing was the upper left flank where visually was noticed the accumulation of gases. After collection of gases 10 ml of this gas was injected into gas analyzer and measured 180 seconds.

The data of initial and daily live weight gain were normally distributed ($p>0.05$), and there was homogeneity of variances ($p>0.05$). Independent-samples T test showed that the weight gain during the whole research was more to the Pre12 calves (65.8 ± 6.57) than CoG calves (36.8 ± 7.98), a statistically significant difference of 29.00 (95% CI, 18.33 to 39.66), $t(8) = -6.272$, $p <0.001$. Also the daily weight gain was more to the Pre12 calves (1.2 ± 0.12) than CoG calves (0.7 ± 0.14), a statistically significant difference of 0.518 (95% CI, 0.325 to 0.710), $t(8) = -6.209$, $p <0.001$. The data of CO_2 and CH_4 were not normally distributed ($p>0.05$), and Mann-Whithey U test showed that there was no difference of mean amount of CH_4 in calves' rumen between CoG and Pre12 as well as there was no difference of mean amount of CO_2 in calves' rumen between CoG and Pre12 ($p>0.05$). Also, Kruskal–Wallis H test showed that there was no difference of mean amount of CH_4 and CO_2 in calves' rumen between different days of the experiment ($p>0.05$). The main results showed that the prebiotic inulin at dosage 6g per calf added to barley flour once a day can promote the more rapid weight gain in calves and it does not influence the mean amount of CH_4 and CO_2 in calves' rumen.

Keywords: inulin, calves, CH_4, CO_2, weight gain.

CORRELATION BETWEEN DAIRY COWS' RUMINATION ACTIVITY, PRODUCTIVITY INDICES AND HEALTH

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In recent years, the precision farming technologies are increasingly used in livestock feeding and health management. The aim of the study was to investigate correlation between "HeaTime Pro System" registered daily rumination times and cows' average milk yield, number of lactations, milk fat, somatic cell count and health status. The experiment was conducted within the State Research Project (AgroBioRes) VP29 in one dairy herd with 362 milking cows where rumination sensor is installed. In the fresh cows' group the individual rumination times of cows were gathered daily at 24:00 seven days before and after milk sampling (M) day and were calculated the average rumination activity (R15), then it was compared with the rumination activity on M day (RM). The rumination data of 92 cows during the first 120 days of lactation were divided into groups and were compared: productivity - above 40 litres/day and below 20 litres/day; milk fat below 3.1% and above 5% in the first 40 days of lactation; somatic cell count (SCC) above 1 million and mycoplasmosis infected animals. The statistical data analyses were performed on Excel and SPSS17 platform.

Results. The average R15 and RM did not differ significantly. In the high yield group, productivity was significantly ($p<0.05$) higher than in low yield group, but RM in these groups did not differed significantly ($p>0.05$). Cows infected by mycoplasmosis had insignificantly lower R15 than the high productive cows. In cows with milk fat below 3.1%, R15 was the highest - 632±37 min/day, and it was significantly higher than cows with milk fat above 5% - 568±22 min/day; these cows have a risk of subacute rumen acidosis (SARA) and ketosis, respectively. In cows of the third and fourth lactation, R15 was significantly ($p<0.05$) higher than in the first and second lactation. The lowest R15 was found in cows with low productivity, high SCC and with milk fat above 5%. There was found a moderate correlation between all 92 cows' R15 and milk yield ($r=0.43$), R15 and milk fat % ($r=-0.46$), but in cows with milk fat above 5% there was a strong correlation ($r=-0.75$).

Conclusions. Changes in average 15 days' rumination time in context with milk yield and milk fat % can be used for recognition of cows with metabolic disorders - ketosis and SARA. In this investigation, cows with different milk fat %, lactation number and SCC had a significant difference ($p<0.05$) rumination activity in 15 days period.

Keywords: cow, rumination, milk fat, productivity.

THE RESULTS OF STUDIES OF THE CLEANING DEGREE OF AN ELECTROSTATIC AIR CLEANER

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An electrostatic air cleaner is a highly efficient means for air clearing which allows blocking the dust, tiny particles and bacteria. However, the cost of such devices is quite high; for example, the increase of degree of cleaning by 6 percent raises relative value of almost in 3 times. As a result, it restrains their distribution in agriculture. The solution to this problem is possible to upgrade the design of the electrostatic air cleaner, which consists in science-based choosing the area of a collecting electrode.

The standard research methods were used for the experiment: the method of multifactorial experiment, statistical analysis, determination of the adequacy of the experimental data. The measuring equipment, which completed certification in the Russian Federation, was used such instruments as ammeter, kilovoltmeter and precision balance. The have been studied several collecting electrodes in the form of tubes with different inner surface such that its area corresponds to the analytical values: a smooth surface, a corrugated surface, an undulated surface, a complex surface with interleaving niches and crowns (like cuts in firearms).

As a result of experimental studies, it is found the dependence of the degree of cleaning of the electrostatic air cleaner η on the speed of the particles movement to the collecting electrode ν and supply air w at a constant square area of the collecting electrode. The maximum degree of air cleaning from bacterial pathogens varies from 60 to 99 percent with a collecting electrode surface area 5 m2.

Firstly, electrostatic air cleaners must be used in the microclimate systems of maternity buildings, preventative clinics, areas for young-stock breeding and poultry, on the stations of artificial insemination and in buildings for the collection of milk. The use of air cleaning installations in conjunction with recirculation allows reducing gas content in the room, where animals are kept, in 6 times; the number of pathogenic bacteria (coliform bacillus, staphylococcus) is reduced in 10 times; amount of consumed electric power is reduced to maintain the microclimate in 2 times; a young stock loss is decreased from 40 percent to 5 percent.

Keywords: collecting electrode, electrostatic precipitator, ecology.

ELECTROPHYSICAL WAYS TO REDUCE POTATO LOSSES

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Modern techniques of potato tubers storage have a number of economic, technical, and technological disadvantages and they don't ensure high product safety - potato losses run up to 70 percent per storage season. It is expected that losses can be cut by applying electrophysical methods of potato tubers treatment before storing. Thus the effects of electrophysical treatment methods on the potato safety during its storage are considered in this article.

During the experimental studies potato tubers were exposed to electromagnetic direct-current field, electromagnetic alternating current field, ionization, microwave field. In the design of the experiment standard research methods such as a multifactorial experiment method, a statistical analysis, and an adequacy test were used. The equipment used in the research: equipment for magnetic potato treatment, a microwave field generator, a generator of air ions, DC and AC voltage sources, and auxiliary instruments certificated and licensed in the Russian Federation.

The experimental machine for electromagnetic treatment of potato tubers was designed according to standard parameters of electric network: 220 V and frequency 50 Hz. When the machine is connected to AC, magnetic induction in the treatment area is 0.35 mT. When using AC-to-DC conversion, voltage value remained constant and was equal to 220 V.

As a result of the experimental studies it has been found that untreated potatoes had mass loss of 39 percent. Mass loss of potatoes treated with microwave field was over 50 percent. Potatoes exposed to aeroionization lost 23 percent of their mass. At a magnetic treatment dose of 6-8 mT•s mass loss of potatoes does not exceed 20 percent, but when a dose of magnetic treatment is greater or less than the specified ranges, mass loss of potatoes exceeds 40 percent reaching 75 percent. Hence it has been demonstrated that the method of electromagnetic treatment within specific ranges is the most economical one.

It is anticipated that magnetic fields influence the potato cells, as the result of the effects, potato tubers either lock in moisture, starch and other substances, or lose them quickly due to inner-structure destruction. According to the results of the experiments, electromagnetic potato tubers treatment at a dose of 6-8 mT•s has been recognized as the most effective option.

Keywords: potato, aero-ions, microwave field, magnetic field.

CHEMICAL AND MICROBIOLOGICAL QUALITY OF *TENEBRIO MOLITOR* AND THEIR POTENTIAL FEED

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The use of insects in feed and food is becoming more and more desirable, in order to improve the sustainability of food production. The future economic importance of insects may also be significant. Microbiological and chemical risks have been mapped for insect rearing and processing and the most significant risks have already been identified. However, more research is needed. Insect production must also take into account ethical and animal welfare aspects.

The microbiological and chemical contaminants in insect feeds and foods are influenced by the insect species, production method, feeds for insects, growth phase, and insect processing methods. The most significant of these factors is feed.

Insects and their feeds have been studied in Finland e.g. in "Insects in food chain"- and "ScenoProt"-projects. In this poster presentation, results of microbiological and chemical analyses of *Tenebrio molitor* larvae are shown. In present project, "Safe and sustainable feed for insects from domestic side streams of bio-economy" (HyväRehu), the comparison of feeds containing vegetable sidestreams as part of insect feed were designed and the microbiological quality was assessed before and after the four week growth period of larvae. Feeds studied in the HyväRehu-project were designed in the light of previous research and knowledge and they will be introduced in this poster. Usually the main component of the feed for *T. molitor* larvae is grain together with protein rich feedstuff. Added yeast has previously been discovered to speed up the growth of *T. molitor*. Investigated feeds were designed on the basis of substituting soya bean, that is commonly used as an ingredient of feed, and some of the grain with domestic side streams of bio-economy to increase the sustainability and productivity and ensuring the safety of *T. molitor* breeding. Best suitable side streams for this purpose are year-round well available, profitable, dried and microbiologically safe materials. Potato protein, barley feed, mash feed, fishmeal, pressed turnip rape, pea meal, faba bean and carrot were chosen to be used as feed ingredients aiming to test feeds that would meet the nutrition requirements of the *T. molitor* larvae and produce good growth with low mortality. As a conclusion, more research is needed for the control of microbiological quality of *T. molitor*.

Keywords: *Tenebrio molitor*, insect production, safety, nutrients.

CONFLICTS IN BALTIC FISHERIES

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The Baltic Sea is the youngest and one of the smallest seas on Earth. It is characterized by a lack of tides and the epicontinental character. Marine environment of the Baltic Sea is significantly influenced by various anthropogenic factors such as overfishing and anthropogenic eutrophication. These factors are known to interact between each other as well.

The large research studies on the Baltic Sea fisheries realized by the authors at the Faculty of Economics and the Faculty of Food Sciences and Fisheries at the West Pomeranian University of Technology in Szczecin. There were used methods of induction in order to draw general conclusions from individual observations and synthesis with deduction for achievement of output of the known and already proven general theorems. The elaboration is mainly based on the European legislation, regulating the fishery in the Baltic Sea, Eurostat materials and data gained from STECF– Scientific, Technical and Economic Committee for Fisheries as well as the report of the Commission for the EP and the Council.

The deteriorating biological conditions in the Baltic Sea, a small epicontinental sea, due to overexploitation of fish stocks has led to a decline in the condition of fish stocks, both quantitatively (reduction of shoals) and qualitatively (size of the specimens and their condition). Overexploitation of fish stocks particularly concerns the most valuable species (e.g., cod and salmon) as well as the species that they feed on (e.g., herring and sprat). The growing competition in the exploitation of Baltic fish stocks has resulted in conflicts between different types of fisheries: small scale, marine, and recreational fisheries. Coastal zones experience intense conflicts, in which case, the most disadvantaged is the small-scale fisheries operating in a short distance from the harbors. However, catches for the industrial purposes are a probable cause of deterioration of the Baltic cod stocks. According to our review, the present condition of Baltic fisheries is far from the desired state described as sustainable fishery.

Keywords: Baltic Sea, responsible fishery, sustainable fisheries, small-scale fisheries, marine fisheries, recreational fisheries.

HOW FOUR TYPICAL SWEDISH PRODUCTION SYSTEMS FOR LAMBS AFFECT SENSORY ATTRIBUTES OF THE MEAT

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The aim of this study was to evaluate the effect of the four most typical production systems for Swedish lamb on sensory attributes of meat including appearance, texture, taste and flavour using an analytical panel.

In total, 32 crossbred intact ram lambs (Dorset x Fine Wool; 75:25) were included in the study. Groups of 8 animals each were assigned to one of four production models for weaned intact male lambs. Group 1 on indoor feeding was fed a total mixed ration consisting of grass and clover silage *ad libitum* and a constant amount of 0.8 kg concentrate per lamb and day, Group 2 and 3 on cultivated pasture with or without 0.3 kg concentrate per lamb and day, respectively, and Group 4 grazed a semi-natural pasture. Further, all lambs were weighed each week. At slaughter, carcass weight, conformation and fatness as well as pH and temperature after 24 hours were recorded. After six days ageing *M. longissimus dorsi* were sampled and immediately frozen and stored at -20°C until analyses. The samples were thawed and cooked using the *sous vide* method to an internal temperature of 65.5±1.2°C. The samples were chilled overnight and then cut in 5 mm slices. Samples were held at 70°C for 10 minutes before served. Sensory analysis was performed by a trained panel with six assessors. The sensory data was analysed by two-way ANOVA, with production system as fixed and assessors as random factors. Differences were considered significant when $P<0.05$.

Regarding the sensory attribute 'resistance to cutting', Group 3 was scored lower compared to Groups 2 and 4. There were also a strong tendency ($p=0.051$) for Group 4 being scored higher than the other groups for the attribute 'hay odour'. The indication that the meat from lambs grazing semi natural pasture may be related to the lower growth rate and higher age at slaughter for this group and would be of interest to investigate further. Regardless of the differences in growth rate and final pH after 24 hours there were no differences for the sensory attributes. According to these results it could be valid to speculate about individual differences between animals rather than differences due to the different production systems. Normally, growth rate and pH value of the meat are considered as tools to predict sensory attributes, such as tenderness, in this study there were no clear relationships.

The results from this study indicate that the four different production models, covering the Swedish lamb production, did not affect ultimate pH or colour of lamb carcasses. Sensory meat attributes affected were 'hay odour' and 'resistance to cutting'. With this in mind, it seems that the different production systems, besides having an effect on production and carcass descriptors, did not influence eating quality including tenderness and flavour which are of the most important once from a consumer perspective. Furthermore, this study found that the variation between animals was higher than between the different rearing systems.

Keywords: live weight gain, pH-value, temperature, sensory attributes, texture, colour.

SELECTED METHODS OF FORMATION DESIRABLE PHENOTYPE OF DIFFERENT SHEEP BREEDS

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Modern trends in the development of sheep breeding suggest an increase in the importance of meat characteristics of animals with the fullest possible preservation of wool productivity indicators, which is particularly in demand when organizing lamb production, combined with the application of remote aerospace methods for assessing pasture fertility.

The study of the relationship between morpho-biochemical blood indices and resistance to the live weight of young animals obtained from intra- and inter-linear selection of parents and the correlation analysis of the economically useful signs of mothers with their daughters made it possible to establish the degree of the prepotent influence of one mothers' sign on the manifestation of a similar trait in offspring.

The Caucasian breed ewes of the desirable line have the greatest heritability of wool fineness (21.1-22.3 μm), so as the Jalghin merino ewes of the fine line - (18.1-20.5 μm). The shearing of the washed wool was better inherited by the Caucasian breed animals of the desired line and its interlinear selection with the thick-wool line, as well as the Jalghin merino ewes of the strong line. The latter were characterized by the greatest degree of heritability of the live mass, as well as interlinear ewes when combined with long-wool and thick-wool lines.

At the age of 4 months, young ewes had the highest repeatability rates and did not have significant differences between linear and interlinear variants of breeding. With increasing age, the level of repeatability factors in all groups was reduced to values of 0.41 to 0.61. At the same time, it should be noted that the young ewes of the Caucasian variety with interlinear breeding had the living mass feature characterized by greater stability than the linear one.

The experimental groups of sheep Caucasian and Jalghin merino were grown in pasture areas with an index NDVI (Normalized Difference Vegetation Index) of at least 0.55 ± 0.03, established by the results of remote assessment of pastures using unmanned aerial vehicles (UAVs).

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Keywords: sheep, animal line, correlation, heritability, repeatability.

GENETIC CAUSES OF BIRTH OF IMPAIRED CALVES AND REPRODUCTION DYSFUNCTION OF A DAIRY HERD

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Modern genotypes of dairy cattle created using the Holstein breed are characterized by improved performance of the ex-terrier relative to the milk-type expression in the animal and increased by 25-50% compared to the initial mother breeds by the milk production parameters, annual yield of the best cows in commodity farms can often reach 7,5-9,0 thousand kg of milk. However, the uncontrolled use of improved bulls can often lead to disruption of the process of reproduction of the herd and the birth of weakened and unviable calves.

Analysis of the causes of the disruption of the normal reproduction process in the dairy herd of black-and-white cattle, which got by crossing with bulls of the Holstein breed, showed that the cause of the birth of a weakened youngster with signs of deformity (internal organ dystopia, aplasia and limb hypoplasia, absence of lumbar vertebrae, eye pathology, anal atresia) and clinical signs of a disorder of the function of the gastrointestinal tract (diarrhea, rejection of feed, lethargy, oppression), dehydration (dryness and loss of skin elasticity, apadenie eyeball), thickening of the joints was the use of the selection of parental pairs of bull-producer with a genetic anomaly HH1C. In this case, the genetic analysis of the broodstock for 12 types of haplotypes associated with impaired fertility and 31 types of monogenic diseases showed that only 6.9% of the breeding stock caused the appearance of genetic anomalies of CVM and BLAD.

In the system of growing young cattle, the animals were grazed in the farm cultural pastures with the index NDVI (Normalized Difference Vegetation Index) in the range of 0.55 ... 0.65, on the average, 0.60 ± 0.02, established according to the results of remote assessment of pasture areas with the use of unmanned aerial vehicles (UAVs).

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Keywords: genetic anomalies, pasture stock raising, dairy cattle.

MAINTAINING THE STABILITY OF MILK-YIELD PARAMETERS AND MILK QUALITY IN HIGH PRODUCTION MILK CATTLE

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In the conditions of industrial milk production the stability of production processes and the steady supply of raw milk to processing enterprises are of particular importance. In the climatic conditions of the North Caucasus in summer the air temperature often rises to +35 ... + 45 ° C and causes the development of heat stress in animals, violation of physiological metabolic processes, decrease in feed intake, increased water consumption, changes in milk productivity and milk quality.

Monitoring of the chemical composition of milk conducted in the six top dairy herds of the Stavropol Territory with a total livestock 4586 cows with an average daily milk production about 25-35 kg showed that, along with a drop in milk yields, decrease in the amount of fat and protein in milk 3.61-8.68% and 1.88-7.65% respectively took place during the abnormally high summer air temperature. The feed analysis demonstrated that the content of exchange energy in dry basis was 9.4 MG / kg, fibre - 19.7%, and the protein was a bit reduced - 14.8%. It has been established that the addition of concentrated feeds to the daily allowance providing 680 g of crude protein promoted an increase in the protein content in dry basis to 16.6%, resulting in increased fat content in milk to 3.60-3.72%, and the protein to 3.21-3.42%. At the same time, the maximum air temperature was still quite high within +34-37 ° C.

A linear affiliation analysis of highly productive cows that are more resistant to the abnormally high temperature factors has shown that the daughters of the bulls of the leading lines in the Holstein breed (Wis Back Eidial 1013415, Reflection Sovering 198998 and Montvich Chifshtein 95679) with a milk productivity more than 11,500 kg and fat and protein 3.87% and 3.23%, respectively, and the age of the first calving about 720 days, are characterized by positive breeding progress in the herd.

Keywords: milk quality, protein, dairy herds.

MEAT AND INTERIOR FEATURES OF EWES OBTAINED FROM PARENTS OF DIFFERENT AGE

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In this article the meat productivity of offspring received from reciprocal selection of parental pairs of 1.5 and 3.5 years age of the Soviet merino breed sheep. It was found that, on average, the ewes obtained from the uneven-aged selection on the slaughter mass exceeded the ewes received from the even- age selection by 6.2% (P <0.05), on the slaughter yield this superiority was 1.5 abs. percent. It was also found that the ewes obtained from the lambed ewes of 3,5 years age and the rams of 1,5 years age exceeded the herdmates of other variants of selection for slaughter mass from 4.3% (P> 0.05) to 14.9 (P <0.05) and slaughter output - from 0.6 to 2.3 abs. percent. The coefficient of meat in the ewes from the uneven-aged selection was on the average higher by 0.27 units. The first class of cuts was the most in Group II animals (94.2%), which exceeded the herdmates of Groups I, III and IV by this indicator - by 1.8, 0.2 and 0.7%. The first sort of cuts was greatest in animals obtained from lambed ewes of 3.5 years age and rams of 1.5 years age (94.2%), which exceeded the herdmates from 0.2 to 1.8%. The ewes from the uneven-age selection exceeded herdmates from the even-age selection in the length of the small intestine and the average index was 27.8 m, which is higher by 0.5 m, or by 1.8%. The results of the research showed that in terms of meat and interior characteristics, the offspring received from the parents of uneven-age selection are superior to those obtained from the even-age selection parents.

The experimental groups of fine-wool merino sheep were kept in pasture areas with index NDVI (Normalized Difference Vegetation Index) in the range 0.50 ... 0.65, on the average 0.58 ± 0.03, established by the results of remote assessment of pasture areas using unmanned aerial vehicles (UAVs).

Keywords: sheep, reciprocal selection, Jalghinsky merino ewes, unmanned aerial vehicles.

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THE USE OF UNMANNED AERIAL VEHICLES IN THE MONITORING OF AGRICULTURAL LAND IN THE STAVROPOL TERRITORY

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Modern technologies allow remote monitoring of the quality of agricultural land using unmanned aerial photography. This process is less expensive, more mobile and more efficient and provides accurate and detailed information on the required object. The use of high-resolution cameras from 5 cm / pixel allows you to quickly examine large arrays of fields. The organization of monitoring is most effective when there is a service of geoanalytical data (space images) and in this case, monitoring is carried out from the problem areas.

Monitoring of agricultural lands in the Stavropol Territory with the help of UAV showed that the processes of land degradation tend to increase and solving this problem is one of the top priorities in land management. Negative processes develop both on arable land and on natural forage lands due to an increase in anthropogenic load. Since a large plowing of the territory and uncontrolled grazing of agricultural animals contribute to the development of various types of land degradation.

The timely identification of new foci of erosion processes and their development helps to solve the problem of agricultural land degradation, which is achieved through the use of remote technologies. Inventory of land using UAV is much more accurate and productive than current methods of bypassing the field on the contour or drawing on satellite data. Therefore, this work and the scheme for identifying degraded lands with the help of UAV can be the main document for working out the methodology and developing working projects to eliminate local causes of agricultural land degradation.

Keywords: land monitoring, unmanned aerial vehicles.

Acknowledgement. The research was carried out with the financial support of the Ministry of Education and Science of Russia under the Agreement No. 14.613.21.0081 with the Ministry of Education and Science of Russia from November 22, 2017, the unique identifier: RFMEFI61317X0081

INCREASE OF PASTORALISM EFFICIENCY WITH APPLICATION OF AEROSPACE MONITORING

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Pastoralism makes it possible to provide at least 70% of the animals' need for digestible protein, while the efficiency of production processes increases proportionally with the extension of the pasture period from 7-8 to 9-10 months, which is typical for the North Caucasus, Transcaucasia and Central Asia. At the same time, due to the unstable dynamics of climatic conditions in recent years, the methods of distance assessment of pasture fertility, based on the use of aerospace monitoring acquire special significance.

The development of the effectiveness of the use of various unmanned aerial vehicles (UAVs) for the remote evaluation of production processes in pastoralism has shown that the most optimal is the use of the complex, including unmanned aircraft of multi rotor type of small and medium range with takeoff weight from 5 to 50 kg, range of action from 5 to 75 km with a wireless channel for controlling and transmitting video and thermal information. The optimum flight height of a UAV is 40-100 m, with a wind speed of up to 7 m/s. Behavioural responses of pasture animals (fattening cattle, sheep) did not statistically significantly change during monitoring using UAV, so the difference in the time spent on feeding behaviour in the animals of the experimental groups was observed in the range of 0.06%. Decoding of NDVI-snapshots allows to identify areas with insufficient vegetation of pasture plants and to evaluate their nutritional properties (dry matter content, nitrogen concentration), which allows rationally planning the use of pasture areas.

Keywords: pasture, pasture animals, unmanned aerial vehicles.

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THE ASSESSMENT OF THE FUNCTIONING OF PHOTOVOLTAIC INSTALLATION UNDER SMALL HOUSEHOLD CONDITIONS

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The aim of the study was to present the mechanism of operation and to assess technically and economically a typical household photovoltaic installation. The study included the data on the construction of the PV installation panels and the aspects connected with the profitability of the investment. The energy consumption and production from the existing photovoltaic installations was analysed and the project was assessed as well. The polycrystalline panels, the monocrystalline panels and the CdTe panel were selected for the analysis. The value of the savings was calculated on the basis of the energy production from the photovoltaic installation multiplied by the average energy cost and the coefficient for the prosumers in the settlement with the distribution system operator. The discussed photovoltaic installation used the photovoltaic polycrystalline panels which allowed for the achievement of the most beneficial yield-price relationship under Polish conditions. The economic analysis determined a degree of the covered energy demands in the discussed case. It amounted to 29.44% per year and allowed for the obtainment of the savings at the level of over PLN 1200 per year.

Keywords: photovoltaic installation, energy production, energy consumption, renewable energy sources.

THE DEVELOPMENT OF THE INTERFACE SOLUTION FOR THE ACQUISITION OF INFORMATION FROM THE OBD SYSTEM OF THE VEHICLE

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The intensive development of the automotive industry has been observed over the past decades. The prices of cars have become more affordable for the average consumer, resulting in the increase in the number of the vehicles. This is connected with the increased exhaust emission which has an adverse impact on the environment. The proper standards whose role was to minimise the harmful effects of the vehicle on the environment were placed on the car manufactures. The on-board diagnosis systems have been developed for the permanent monitoring of the vehicles. The OBD system is one of them. The aim of the study was to develop the interface with the use of simulation tools for the acquisition of information from the OBD system for the engine simulation of the vehicle in-service within the currently applicable WLTP test. The diagrams of the performed simulation of the operation of the vehicle within the WLTP test with the use of the Scilab Xcos environment and the results achieved from the applied interface were presented in the design part. The mathematical relations were used to build a simulation model of the operation of the vehicle within the WLTP test which faithfully reproduces the real operating processes. The development of the simulation for the acquisition of the data on the current operating parameters of the engine allows for the creation of the programming solutions at the initial stages without the necessity for the operation of the programme with the real OBD system integrated in the vehicle.

Keywords: OBD, WLTP, diagnosis.

THE METHODOLOGY OF PREDICTIVE CALCULATIONS OF BREAKTHROUGH WAVE IN HYDRODYNAMIC ACCIDENTS OF STORAGE DAMS

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Currently, more than 280 reservoirs of various types and purposes are operated on the territory of Kazakhstan. Safety problems at the facilities of the hydraulic engineering complex have particular importance, not only associated with the flooding of the territory, but also with water and energy supply.

The purpose of this work is to calculate the storage dams in the case of hydraulic accidents.

Based on the results of full-scale leveling surveys, predicted calculations of the breakthrough of the storage dams of Bartogai, Kapchagai and Kurtinsky hydrounits have been made.

Methodical recommendations developed in the laboratory of bridge hydraulics and hydrology of the department for the exploration and design of railways of the scientific research institute of transport construction include the determination of costs in the dam section during its destruction, as well as in the passages located in the up and down streams of the storage dam, taking into account the transformation of the breakthrough wave or release in transit.

The work uses recommendations and GOSTs, the rules of operation of storage dams of hydroelectric complexes and other methodological documents devoted to the safety of dams and hydraulic structures.

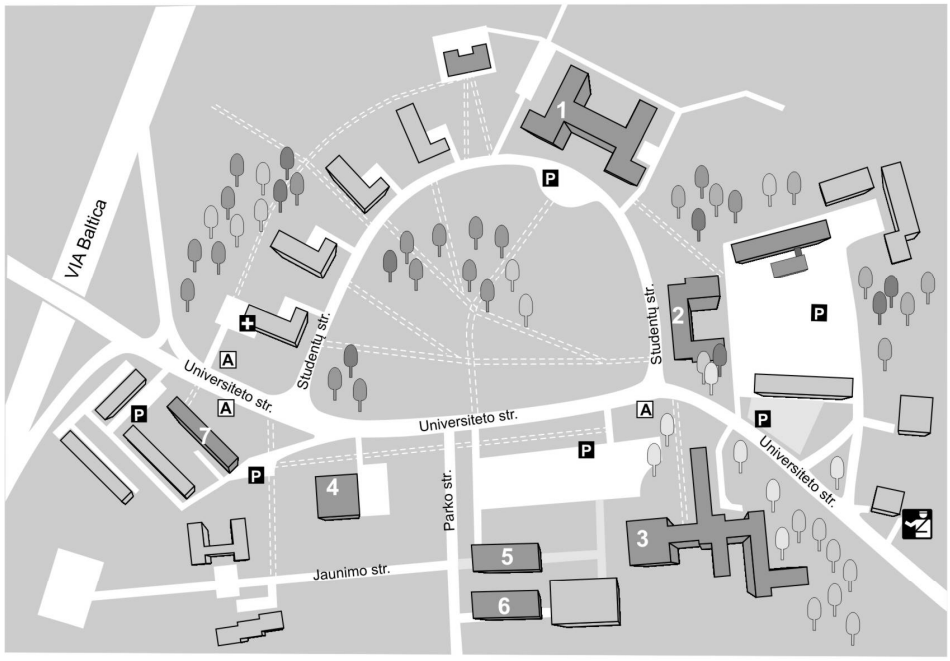
To perform predictive calculations of the breakthrough of water dams in the downstream of the hydrounit, a level-theodolite survey was performed at a distance of 7-8 km from the dam site.

The remaining transversals were taken from space images using GIS technologies.

Hydraulic calculations determined the parameters of the breakthrough wave when the dam of the Kapshagaysky, Bartogai and Kurtinsk reservoirs was destroyed: the height of the crest of the breakthrough wave; the speed of breakthrough wave, as well as the water level mark, the speed of breakthrough wave and the time of the wave passage through the planned sections with the establishment of possible flooding zones in the hydrodynamic accident.

Keywords: storage dams, earth dam, hydrodynamic accident, breakthrough of dam, consumption of breakthrough wave.

Campus scheme of Aleksandras Stulginskis University (ASU)



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2. II building (Faculty of Agricultural Engineering)
3. III building (Faculty of Economics and Management, Faculty of Water and Land Management)
4. IV building (Park of Agricultural Science and Technologies)
5. Exhibition Center 2
6. Exhibition Center 3
7. Hostel No. 5 (guestrooms)

REGISTRATION OF PARTICIPANTS

Central Building, 2nd floor (Lobby)

OPENING CEREMONY AND PLENARY SESSION

Central Building, 2nd floor (Ceremony Hall)

PARALLEL SESSIONS:

Section A: Sustainability of Agroecosystems

Central Building, 5th floor (Auditorium No. 505)

Section B: Bioeconomics and Innovations

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