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I AGRICULTURAL ECONOMICS

Crisis management aspects of agricultural enterprises under modern threats

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Abstract. Anti-crisis management of agricultural enterprises in the context of epidemics, environmental changes under the influence of anthropogenic factors, the threat of military action, natural disasters and climate change remains a pressing issue both in the EU countries and in Ukraine. There is an objective need to forecast the level of anti-crisis stability and competitiveness of agricultural enterprises. An integral element of the market economy is the creation and development of competitive advantages. External factors influencing the competitive interaction of enterprises in the relevant industry are also of no small importance. These external factors are always dynamic in terms of competitiveness, speed, depth and scale of changes in the market. The problem of increasing the efficiency of forming competitive advantages in situations of uncertainty and risk worries almost all aspects of society and attracts the attention of officials and business circles. Growing competition for product sales is constantly looking for new opportunities and reserves for product sales, improving technologies for creating high-quality products. Analysis of recent publications [1; 2; 3; 4] shows that such threats are constantly growing and require an adequate and timely response from the state and the management of agricultural enterprises. Research by Brownlie et al. [5] talk about the problems of soil pollution with mineral fertilizers, Kroebel et al. [6] focus on the anthropogenic impact of agriculture on the environment. These threats require the application of special state policy in a comprehensive relationship with the development of anti-crisis management in agricultural enterprises. Objective: to study the issue of anti-crisis management of enterprises in the agricultural sector and to supplement the tools of management influence on the sustainability of agribusiness in the face of various external and internal threats. Methods: forecasting risks for agricultural enterprises based on the analysis of climatic, military, epidemiological and environmental factors. Results: risk factors affecting the sustainability of agricultural enterprises in crisis situations have been studied and systematized. To work with these risks, it is advisable to use specialized information and analytical systems for strategic forecasting of enterprise activities. A fast and understandable user interface, integration of all enterprise data sources, a smooth and fast adaptation process at the enterprise, synchronization of order fulfillment dates, modeling of discrete events in the future are important here. Software for planning and forecasting demand should correspond to the business goals of the enterprise. Conclusions: it is necessary to implement advanced foreign experience in the field of anti-crisis management of agricultural enterprises. To make effective management decisions in a crisis, it is advisable to use specialized information and analytical systems. This will allow modeling situations in the future, applying modern methods of planning and forecasting demand for distribution, retail, e-commerce and brand.

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Key words: crisis management, military threat, climate change threats, epidemiological threats, natural disaster threats.

Exploring the economic viability and agronomic effects of green manure mixtures on winter wheat yields in organic farming in Latvia: a multi-location study

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Abstract. This study explores the adaptation of green manure practices to Latvia's climatic and soil conditions to enhance soil productivity and economic returns in organic farming systems. The study aims to identify the most suitable green manure mixture by evaluating economic factors, green biomass and dry matter yield, nutrient content, and its impact on winter wheat yields in organic fields across different locations in Latvia, considering variations in meteorological conditions. Field trials compared three mixtures: oats–mustard–oilseed rape–buckwheat (non-legume), oats–buckwheat–peas (legumes <50%), and oats–lupin–vetch (legumes >50%) against a control (black fallow). Data were collected on biomass, dry matter production, nutrient binding (N, P, K content), winter wheat yields, and economic performance. Meteorological analyses using the De Martonne Aridity Index identified distinct climatic patterns affecting green manure performance, with an associated correlation coefficient. The results revealed significant year- and location-specific variations in biomass and dry matter yield, mixture with legumes above 50% performing significant ($P < 0.05$) at the farms 'Gaikeni' and 'Geidas', as well as at Ltd. 'Mazbungas'. Despite lower biomass yield in certain years, mixture with legumes above 50%, through the follow-up effect, significantly increased winter wheat yields under optimal conditions at farms 'Mazbungas' and 'Gaikeni' being higher by 96.05% and 93.59%, respectively, compared to the control. Economic analysis revealed significant gross margin advantages for green manure cultivation, demonstrating its financial viability. This study underscores the potential of green manure practices in enhancing the sustainability of organic farming, improving yields, and increasing profitability, while highlighting the importance of selecting region-specific mixtures to account for climatic variability.
Key words: legume and non-legume mixtures, yield potential, nutrient content, gross margin

Acknowledgements. This study was conducted as part of the project 'Demonstration of Green Manure Effectiveness for Ensuring Soil Fertility in Organic Farming', funded by the European Agricultural Fund for Rural Development of the Ministry of Agriculture, project No. 22-00-A00102-000003.

II AGRICULTURAL ENGINEERING

Study of the working unit for replenishing the stock of technological material at the field robot service station

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Abstract. This study introduces an improved design of a hinged-sectional working body for a flexible screw conveyor, tailored for transporting granular agricultural materials. The research focuses on analyzing how the structural features of the hinge mechanism affect its performance, particularly regarding angular axis displacement, prevention of jamming, and reduction of energy loss. Analytical models have been developed to calculate the arc path of the ball across friction surfaces, its velocity, and the hinge's efficiency coefficient. Findings indicate that the highest efficiency (between 0.88 and 0.91) is achieved when the ratio of the ball radius to the rotation radius of its center falls within the range of 0.3–0.45. An increase in the inclination angle of the conical socket reduces overall efficiency, as it raises the radial component of friction force. Therefore, the most effective design involves minimizing this inclination angle within the constraints of the hinge geometry. Additionally, to improve the conveyor's overall performance, reducing the deviation angle of the hinge axes — effectively increasing the screw's bending radius — is recommended. This approach minimizes jamming risks and efficiency losses. The critical limit for this angle is defined as 20–25°, with the efficiency coefficient maintained at 0.9 or above. To refine the structural design of the screw sections, computer simulations were used to evaluate how applied torque affects deformation. The simulations revealed that higher torque values result in increased twisting angles, especially when the number of axial rods is minimal. Overall, the proposed configuration enhances loading and unloading efficiency and broadens the functional scope of bulk material handling, particularly for grain transport.

Key words: flexible screw conveyor, hinged-section mechanism, transmission efficiency, torque deformation, structural optimization, bulk agricultural materials.

Development of an artificial intelligence-specialist based on a language model adapted for agri- and horticultural counseling

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Abstract: A study conducted by European Parliamentary Research Service in 2023 states that there is a growing interest in artificial intelligence systems that can be used for better decision making in agri-food sector. Using these intelligent systems gives the producers better control over the processes that affect their income. In this study a language model was developed with the aim of creating an artificial specialist on plant and berry cultivation. It takes numerical and text-based data such as leaf color, height, NDVI as input and outputs instructions to improve plant's health and yield. The base model was chosen based on initial fine-tuning and evaluation processes that involved 20 general questions about cultivation of different cultures. Based on the results a language model was chosen for further fine-tuning using the Quantized Low-Rank Adaptation (QLORA) method. The fine-tuning dataset consisted of data gather from "Agronomy Research" and "Agraarteadus" science journals. The journals were chosen because they describe the local terms the best. The final model was optimized to run on affordable and field deployable hardware. As a result, a model was developed which can be deployed on a field robot to perform on-site decision making using the data collected by the sensors of the robot. In future research, the resulting language model can be used as input for further fine-tuning using data from different scientific papers and journals. The documented fine-tuning process can be used as a reference to develop several artificial experts across the field of agriculture.

Key words: agrorobotics, language models, QLORA, precision agriculture, smart farming.

Designing Collaborative Autonomy: Challenges and Opportunities Across Agricultural and Forestry Systems

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Abstract. The rapid advancement of autonomous systems is transforming land management practices across agricultural and forestry sectors. This keynote explores the frontier of human-machine collaboration in these domains, examining how autonomous robots and intelligent machinery are reshaping operations from crop cultivation to timber harvesting and land excavation. We'll investigate the technical challenges in developing truly autonomous field systems capable of navigating complex, unstructured environments, and discuss emerging solutions that balance automation with meaningful human oversight. Drawing on recent innovations and field deployments, the presentation will highlight key considerations for designing effective human-machine partnerships that enhance productivity, sustainability, and safety.

Differential Geometric Modelling and Trajectory Optimization for Quadcopter Navigation

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Abstract: We present a differential geometric framework for modelling and optimizing smooth trajectories in mobile robotics, with a focus on quadcopter navigation. Our approach includes a rigorous mathematical treatment of configuration spaces and their tangent bundles, complemented by intuitive visualizations to make the abstract concepts more accessible –especially for those with an engineering background who may not be familiar with the underlying mathematics.
Differential geometry provides a powerful language for describing complex mechanical systems by allowing a natural decomposition into pure motion (the system's evolution in physical space) and shape motion (internal actuation such as rotors, fins, or flaps). This separation is formalized through the concept of a trivial connection, which clarifies the structure and meaning of the equations of motion.
Building on this foundation, we propose a method for quadcopter trajectory optimization on Riemannian manifolds with obstacles. The Safe Corridor on Manifolds (SCM) technique formulates the problem as a constrained optimization task that avoids equality constraints, removing the need for projection back onto the manifold. This improves both efficiency and robustness in real-time robotic applications.

Key words: differential geometry, trajectory optimization, quadcopter navigation, Riemannian manifolds.

Design, Build and Testing of a Universal Wheel Torque Transducer for Agricultural Tractors

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Abstract. A universal wheel torque transducer was designed, built, and calibrated for use on tractors up to 200kW for research and educational purposes. The design in-corporated an extension shaft with two interchangeable adaptors that fit between the tractors rear wheel rim and axle flange. Strain gauges were bonded to the shaft for torque measurement and a telemetry system was used to transfer the strain signal to a DEWE 43A data acquisition system onboard the tractor. The DEWE 43A also collected controller area network (CAN) bus signals from the tractor: engine actual percentage torque, engine fuel consumption, wheel speed, and engine speed. Static calibration conducted on the torque transducer demon-strated excellent linearity (R2=0.9954) and repeatability (±0.323%), and good sensitivity (0.04054 mV V-1 kNm-1). However, hysteresis was significant (P<0.001). Furthermore, the effects of bending moment (P<0.001) and side loading (P<0.001) were also significant. Following calibration, the performance of the wheel torque transducer was tested on a tarmac surface, removing the com-pounding factors associated with soil. For testing purposes, the wheel torque transducer was fitted to a Case Maxxum 125 front wheel assist tractor with a rat-ed engine power of 85.6kW. Performance criteria investigated included steering, braking, and acceleration/deceleration operations under no load. The wheel torque transducer signal responded satisfactorily to different testing conditions and was comparable with the CANBus data, validating the performance of the torque transducer and effectiveness of collecting wheel torque data over a variety of driving conditions.

Key words: Wheel torque, Transducer, Instrumentation, Agricultural tractor, CANbus.

Acknowledgements. Harper Adams University.

Reduced agricultural traffic and tillage management systems enhancing soil properties and crop yields

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Abstract. Soil compaction caused by the use of heavy agricultural equipment adversely affects soil conditions and the performance of crops. It has been estimated that more than 33% of European subsoils are highly susceptible to soil compaction. Soil compaction occurs when soils are subjected to loads and stresses, often from agricultural equipment, that exceed the soils' inherent strength. A long-term 3×3 factorial experiment was established at Harper Adams University, United Kingdom, in 2011 to determine the effects and interactions of three traffic farming management systems: standard inflation pressure tyres (STP), low tyre inflation pressure (LTP) and controlled traffic farming (CTF30% / CTF15% trafficked area) on soils managed with three tillage systems: deep (25 cm), shallow (10 cm) and zero tillage on (i) on crop establishment and growth and (ii) crop yield grown in a sandy loam soil in the UK. The results of this continuing long term study have shown:
-An increase in porosity of the CTF soil for the shallow and deep tilled soils over the no-tilled profile. The preservation of soil porosity in deep tilled soils by the use of LGP tyres or CTF. Greater hydraulic conductivity of the CTF managed soils than LGP and STP, so improving both infiltration and water movement. An increased soil biological activity in the CTF and LGP soils compared to STP tyres. Fewer earthworms in deep tilled soils compared to shallow and zero tilled soil. The highest soil organic carbon content in the CTF zero tilled soil compared to STP deep tilled soil and LTP zero tilled soil in the 0-300 mm soil depth range. Marginally greater soil organic matter in the surface layer of soils managed using reduced traffic and tillage.
-Improved crop yields of CTF 30%, CTF 15% and LGP by an average of 6%, 8.5% and 5%, respectively. The beneficial effect of LGP compared to STP for the deep tilled soils from 0% to 11% with an average 5% increase in crop value. No yield advantage between the deep and shallow tilled soils, which gave the best compromise between yield and soil structure. Lowest crop yields initially produced by the zero tilled soils produced; however, these improved with time as the soil structure improved. Over the period of the study the mean crop yield from zero tillage was 5.5% lower than the mean crop yield of the deep and shallow tillage.

Key words: Controlled traffic farming, Low tyre inflation pressures, Tillage systems, Crop yield, Soil properties.

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Theoretical Study of a Pneumatic Device for Precise Application of Mineral Fertilizers by an Agro-Robot

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Abstract. This article presents the development of a new pneumatic device for the precise application of mineral fertilizers, designed for use in precision agriculture systems involving field robots. The relevance of this research is driven by the limitations of existing technologies, which fail to provide differentiated fertilizer delivery directly to the root zone of each plant. Unlike the most common continuous application method, this device operates on a periodic basis. The proposed device is mounted on an autonomous agricultural platform and utilizes a machine vision system to determine plant coordinates. Its operating principle is based on accumulating a single dose of fertilizer in a chamber and delivering it precisely to the plant's root zone using a directed airflow. The study includes a theoretical investigation of fertilizer movement inside the applicator tube under the influence of airflow and rotational motion of the tube. A mathematical model has been developed to describe both the relative and translational motion of the fertilizer. The equations, which account for frictional forces, inertia, and air pressure, enable the determination of optimal structural and kinematic parameters of the device depending on operating conditions and the properties of the applied material. The use of numerical methods to solve the developed mathematical model allows synchronization of the device's operating time parameters with the movement of the agricultural robot along the crop rows. The obtained results and the developed device improve the accuracy and speed of fertilizer application, minimize fertilizer consumption, and reduce soil impact, making the proposed device a promising solution for precision agriculture.

Key words: technological materials, pneumatic transport, agricultural robot, parameters, pressure, time.

Design and Optimization of a Welded Framework for a Mobile Power Station with Complex Geometry

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Abstract. Energy storage and its deployment, regardless of location, allow critical services and machinery to operate in remote or isolated areas—such as rural zones, islands, or conflict and disaster-stricken regions. Modern energy generation and storage systems can ensure a stable power supply where electrical infrastructure is insufficient or damaged. Challenge in designing mobile energy solutions is minimizing structural weight while maintaining strength and structural functionality. To achieve this, the primary material chosen is lightweight yet durable heat-treated and artificially aged aluminum alloy profiles, forming the structural framework for both the station and its solar panel mounting and movement system. The strength of the structure depends on the welds and base material joining these profiles. Building renewable energy stations from advanced lightweight materials offers major energy and sustainability advantages, including lower material consumption, improved fuel efficiency, and reduced carbon emissions. The study underscores the need to understand the metallurgical behavior of heat-treated aluminum alloys, especially after welding, to preserve structural integrity—particularly for aluminum alloy 6082-T6. Welding heat-treated aluminum alloys can degrade their mechanical properties due to microstructural changes. Material properties were assessed using reverse engineering method and destructive test data analysis A case study on a mobile power station demonstrates the practical application of this knowledge, highlighting the role of metallurgical expertise in maintaining low weight – high strength structural performance. Reducing heat energy during manufacturing lowers overall energy consumption. Lightweight construction manufacturers can maximize the alloys' mechanical benefits in lightweight structures, broadening their use in industries prioritizing weight reduction and durability. These insights contribute to innovative engineering solutions in renewable energy station transport, aerospace, and marine applications. Ultimately, selecting the right manufacturing technology, materials, and methods enhances energy efficiency and enables innovative designs for complex welded framework.

Key words: Energy production; mobile renewable power station; solar power; structure welding; structural integrity.

Digital Twin Technology for Electric Propulsion in Software-Defined Electric Vehicles

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Abstract. Digital Twin technology is revolutionizing electric propulsion in Software-Defined Electric Vehicles (SDEVs) by enabling real-time simulation, optimization, and predictive maintenance. This presentation explores how Digital Twins create virtual replicas of propulsion systems, enhancing performance, efficiency, and reliability. By integrating AI, IoT, and cloud computing, these intelligent models support advanced control strategies, fault diagnostics, and energy management. The discussion highlights key benefits, challenges, and future trends, demonstrating how Digital Twin technology is shaping the next generation of smart, software-driven electric mobility.

An Energy-Efficient and Adaptive Battery Monitoring System for Agricultural Robotics Using CAN Bus Communication

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Abstract. Improving energy efficiency is a key priority in modern agricultural robotics, particularly in off-grid environments where power resources are limited and battery lifespan directly impacts productivity. This paper presents an energy-aware and modular battery monitoring system specifically designed for agricultural robots equipped with CAN-based Battery Management Systems (BMS). The proposed system enables real-time acquisition and long-term logging of critical battery parameters—including voltage, current, temperature, and state of charge—while maintaining ultra-low power consumption.

A core innovation is its adaptive polling mechanism, which dynamically changes data acquisition frequency based on real-time current flow and temperature thresholds. This strategy reduces unnecessary logging operations during idle periods while preserving high-resolution tracking during active or critical conditions. Power consumption benchmarks, recorded using laboratory-grade instrumentation, show substantial energy savings compared to conventional fixed-rate polling approaches. A Raspberry Pi Zero 2 W serves as the main computing platform due to its efficient performance-to-power ratio. Key system components include a local e-ink display for on-site feedback, a web-based API for remote access, and a centralized configuration database that allows flexible adjustment of all runtime parameters.

Unlike traditional BMS products designed for industrial or marine contexts, this solution prioritizes field-deployable efficiency, configurability, and modularity. The system contributes toward more sustainable robotic operations and is aligned with the goals of the EU Renewable Energy Directive III (RED III). Future work will focus on integrating AI-driven diagnostics and optimizing energy storage through intelligent charge-discharge management.

Key words: Energy-efficient embedded systems, Adaptive data logging, CAN bus battery monitoring, Agricultural field robotics, Low-power hardware, Remote diagnostics API.

Development of Autonomous Robotic Platform for Precision Blueberry Cultivation

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Abstract. The increasing demand for sustainable and efficient agricultural practices has accelerated the adoption of robotic solutions in precision farming. Blueberry cultivation, particularly on peatlands, presents unique challenges due to soft terrain, high labor costs, and the need for precise handling. This study focuses on the development of an autonomous robotic platform tailored for precision blueberry cultivation, integrating mobile robotics, AI-driven perception, and automated servicing infrastructure. The research explores the engineering of a robotic system capable of executing key agricultural tasks. The platform features a mobile robot manipulator equipped with robust object detection and navigation technologies optimized for field conditions. Additionally, the study evaluates the economic feasibility of robotization in blueberry plantations by comparing long-term cost efficiency against traditional manual practices. A crucial aspect of the proposed system is its support infrastructure, including a dedicated servicing station equipped with battery-swapping and charging capabilities. The research investigates the impact of field layout on automated operations, ensuring seamless interaction between the robotic platform and its servicing station. Initial prototype testing demonstrates the potential of autonomous systems in improving productivity and sustainability in precision blueberry cultivation. The results indicate significant advancements in reducing specific costs. The findings provide valuable contributions to agrorobotics, demonstrating scalable automation solutions for perennial crop cultivation.

Key words: Agrorobotics, Precision Agriculture, Autonomous Mobile Robots, Blueberry Cultivation, Servicing Stations, Economic Feasibility.

Design and assembly of an autonomous data acquisition device for graphical monitoring of environmental data

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Abstract. The project presents a compact home weather station that measures indoor and outdoor environmental conditions, including temperature, humidity, pressure, and CO_2 levels. Unlike existing solutions, it enables real-time data visualization, long-term analysis, and weather prediction while ensuring full sensor autonomy. The system consists of a wireless sensor module and a receiver unit with a built-in display and data storage for reliability. Designed for efficiency and autonomy, it integrates embedded systems, electronics, and predictive modelling to enhance home climate monitoring.

Edge AI System for Enhanced Grain Sorter Feedback

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Abstract. The IntelliDry grain and legume monitoring project is a collaborative research initiative between the University of Tartu and the IntelliDry startup, focused on developing an AI-driven machine vision system for real-time grain purity assessment. The project's primary goal is to deliver rapid, quantitative feedback to operators of old sorting machines, enabling more precise adjustments to equipment settings and significantly reducing grain contamination and waste.
A specialized hardware device was engineered to stabilize grain flow and capture high-resolution images at speeds of up to 30 frames per second, minimizing disruption to existing sorting processes. These images were processed on-site using edge computing hardware, specifically a Hailo 8L accelerator paired with a Raspberry Pi 5 single-board computer, achieving inference performance speeds of approximately 10 milliseconds per frame.
Using over 70 GB of image data collected from real agricultural sorter outputs, AI models based on the YOLOv11-seg architecture were trained and validated. Results demonstrate that consistent segmentation accuracy exceeded 95% in differentiating grain from contaminants. While the purity assessment quality matched human-level performance, the AI-driven analysis notably outperformed traditional manual methods in speed.
The developed monitoring system offers significant economic benefits by enhancing sorting efficiency, reducing operational costs, and enabling farmers to make informed, data-driven decisions in real time. Additionally, automated continuous sampling contributes substantially to improved quality assurance for agricultural products.

Key words: AI in agriculture, grain sorting, grain purity, edge computing.

Synthetic Blueberry Image Generation for Smart Farming Using Variational Autoencoders

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Abstract. Data scarcity remains a significant challenge in smart farming, particularly acquiring high-quality plant images from diverse environmental conditions, such as different growth stages, and uncommon scenarios like pest infestations and disease outbreaks. Synthetic data generation offers a promising approach to producing realistic data with greater variability, which could enhance the generalization capabilities of machine learning models. In this study, we leverage Convolutional Variational Autoencoder (CVAE) with attention head and residual connections to generate realistic synthetic blueberry images. The model learns a probabilistic latent space representation using a small number of images combined with their geometric augmentations. CVAE effectively captures the underlying variability of real-world images and generates diverse samples that preserve key morphological and textural features. Our CVAE-based synthetic blueberry image generation pipeline demonstrates the potential to produce realistic and diverse images that enrich training datasets for smart farming applications, including phenotyping, disease detection, root collar detection, and various plant management activities. Preliminary results indicate that the synthetic images generated by our CVAE model exhibit a high degree of visual resemblance to real-world images, particularly in terms of morphology and texture. Quantitative evaluation using the Structural Similarity Index Measure (SSIM) and Multi-Scale SSIM (MS-SSIM) yielded values of 0.67 and 0.81, respectively, confirming a strong perceptual similarity between synthetic and real images. These findings suggest that CVAE can effectively diversify datasets, enhancing data availability and potentially improving model generalization in smart farming.

Key words: Convolutional Variational Autoencoder, synthetic image generation, blueberry, smart farming, machine learning.

Latent Statistics from Convolutional Variational Autoencoder for Plant Size Classification

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Abstract. This study presents a novel approach to plant size classification for smart farming applications by utilizing the latent representations of a convolutional variational autoencoder (CVAE) instead of conventional CNN-based classifiers. Since smart farming practices such as fertilization, irrigation, and pest control depend on precise plant size classification (small, medium, large), we propose a method that extracts statistical features from the latent space of a pre-trained CVAE model. From each encoded image, 90 statistical descriptors are computed per sample (over 99.9% dimensionality reduction), including spatial moments, global maxima, quartiles, and higher-order statistics (interquartile range, skewness, median absolute deviation) across the mean and standard deviation of each latent dimension, resulting a compact yet expressive vector. These features train a lightweight feedforward neural network (750,083 parameters), achieving 84.51% test accuracy on blueberry plant classification, with consistent validation (84.91%) and training (88.60%) performance. These results demonstrate the strong discriminative power of the CVAE's sampled latent space. Beyond accuracy, this approach decouples feature learning from classification, captures spatial patterns linked to plant traits like size and shape, and reduces computational demands - making it practical for real-time, resource-constrained field deployment. Overall, it highlights the potential of pre-trained CVAE latent spaces as transferable and scalable representations for smart farming.

Key words: Latent space feature extraction, Convolutional Variational Autoencoder, plant size classification, smart farming, blueberry, machine learning.

Open-Source Robotics in Agriculture: Tailored Innovation for Modern Farming

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Abstract. As the global population grows, food production must rise by around 70% by 2050. This puts pressure on agriculture to become more efficient and sustainable. However, current proprietary technologies are often expensive and controlled by large corporations – making them out of reach for many farmers, especially in developing regions. Open-source robotics offers a powerful alternative. These tools are affordable, transparent, and fully customizable. Farmers, engineers, and researchers can adapt them to fit local needs – whether it's for planting, weeding, harvesting, or monitoring crops. Projects like FarmBot, AgROS, and other open-source agribots show how these technologies are already being used in the field. The benefits are clear: lower costs, flexibility, and a global community that shares ideas and solutions. But challenges remain, including the need for technical knowledge, reliable infrastructure, and better integration with traditional farm equipment. Still, open-source solutions can play a key role in the future of agriculture – making advanced tools more accessible and helping farmers everywhere meet the growing demand for food.

Key words: Agricultural robots, Open-Source hardware, Open-Source robotics, precision farming.

III ERGONOMICS AND ERGODESIGN

The effect of therapeutic exercises on healthcare workers with neck pain

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Abstract. Healthcare workers are exposed to several ergonomic risks at work that negatively affect the musculoskeletal and connective tissue systems. Forced working postures, monotonous tasks, and long working hours contribute to discomfort or pain in specific body parts (Yasobant S, Rajkumar P., 2014). Neck and shoulder pain are among the most common complaints reported by healthcare workers (Dong H, et al., 2020). The aim of this study was to analyze the causes of pain among employees in a healthcare facility and apply therapeutic exercises to alleviate neck pain in employees with chronic pain. To research an active exercise, who impact on chronic neck pain, comparing the change of the pain, the Neck Disability Index and biomechanic of the muscles before and after exercises. The research was made from 100 participants: 84 women and 16 men, doctors and nurses. All participants was divided into 2 groups. The active exercises were applied to one of the group using exercises with sling (Group 1) and active physiotherapy exercises were applied to the second group (Group 2). Two standard exercise programs were worked out. For participants were applied complex evaluation, which included structured interview, assessment of pain syndrome (VAS), the Neck Disability Index and Physical Functioning scale of Health Survey (SF-36). All work was done individually, all together 4 physiotherapists worked with the participants. The Myoton-3 device was used to determine the biomechanical properties of muscles before and after therapeutic exercise. Statistical data processing and analysis was performed using the SPSS17.0, Microsoft Excel. Both groups mentioned prolonged staying in static positions as the main cause of pain group 1-70%, group 2-54%. After performing the exercises, pain decreased by 70% in group 1 and by 64% in the group 2. The therapeutic exercises improved the results of the Neck Disability Index in group 1 - 49%, group 2 - 28%. There is an existing correlation between the pain and the Neck Disability Index in both groups (group 1 r=0.345, p=0.01, group 2 r=0.554,p=0.00). Such biomechanic adjectives as decrement and stiffness are improved in muscle trapezius upper part in both research groups. The causes of neck pain in healthcare personnel are forced working postures,monotonous tasks, and time constraints. The effect of therapeutic exercises can be measured in pain reduction, decrease of muscle tension and improvement of the Neck Disability Index results.

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Key words: neck pain, nurses, doctors, therapeutic exercises.

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Indicators of occupational health and safety policies in EU countries under military and epidemiological threats: a scoping review

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Abstract. The aim of the article is to study the indicators of occupational health and safety policy in the EU countries in the context of potential military and epidemiological threats, as well as to prepare a scope review based on the collected data.
This topic is relevant. The scientific community has accumulated significant experience in identifying socio-economic and military drivers, as well as inhibitors of the spread of infectious disease epidemics.
The article examines a set of public health factors and medical, fiscal, socio-economic, environmental, political-institutional and military determinants that can lead to differentiation of the vulnerability of EU countries at the state and regional levels to epidemiological and military threats.
Medical and social determinants including pandemic vulnerability indicators: the number of people infected with disease; the number of recovered; the number of patients; the number of persons vaccinated; number of medical teams; number of doctors, anesthesiologists; et al.
Environmental determinants including indicators of the level of environmental pollution: current expenditures on environmental protection, euro; capital investments for environmental protection, euro; expenses for environmental protection, euro; emissions of pollutants into the atmospheric air from mobile sources; et al. Socio-economic determinants including: export of goods and services; import of goods and services; GDP growth; inflation; consumer prices; personal remittances; gross savings; GNI per capita; household consumption; unemployment rate. Impact on the economic sphere: income and expenses of the population; et al.
Financial and budgetary determinants including: the ratio of bank capital to assets; non-performing bank loans to total loans; commercial bank branch; general reserves; government debt; et al. Political-institutional determinants including: corruption perception index; numerical indicator of democracy effectiveness; index of property rights; voice and accountability; et al.
The article presents a set of indicators that will be selected from Eurostat and national databases and subjected to further analysis.
Research methodology: taxonomy, predictive modeling.
Practical usefulness of the results:
- for state and local authorities, an analysis of indicators will be provided for selecting scenarios for responding to military and epidemiological threats; - the range of understanding of weaknesses in terms of epidemiological and military vulnerability will be expanded;
- recommendations will be given on the formation of state and regional anti-crisis programs.
Thus, our study will help to conduct a situational analysis that takes into account not only quantitative but also informal qualitative parameters; construct diagrams of cause-and-effect relationships between them taking into account the time lag; identify the most significant parameters using block diagrams; model the development of crisis situations in various conditions.

Key words: occupational health, safety policies, military threats, epidemiological threats, indicators.

Deciphering the paradox: the role of organizational identification in workaholism versus burnout

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Abstract. This study explores the complex relationship between organizational identification, workaholism, and burnout. Organizational identification, denoting individuals' psychological connection to their workplace, significantly influences their work-related attitudes and behaviors. While it often correlates with workaholic tendencies characterized by excessive work engagement, it does not directly cause burnout—a state of emotional exhaustion due to chronic work-related stress. Utilizing a qualitative grounded theory approach, we conducted a comprehensive literature review using Scopus, analyzing 141 articles to identify the antecedents of workaholism, burnout, and organizational identification. Our findings reveal that organization-related factors, such as job demands, social support, job autonomy, and organizational culture, significantly impact both organizational identification and burnout. Conversely, workaholism is primarily driven by personal factors like perfectionism, low self-esteem, and family background. These insights suggest that fostering positive organizational factors can enhance organizational identification and mitigate burnout, while addressing personal factors is crucial in managing workaholism. This research contributes to the economic understanding by highlighting the role of organizational culture and job design in employee well-being, which can impact productivity and organizational performance. The study underscores the importance of developing interventions that balance organizational identification with healthy work habits to promote a resilient and productive workforce. Future research should focus on empirical tests to better understand the influence of organizational and personal factors on these constructs, paving the way for more effective strategies to foster employee well-being.

Key words: burnout, organizational identification, workaholism, stress.

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Organizational identification, workaholism, and burnout: a cross-sectional study of age, gender, tenure, and work arrangements

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Abstract. This study investigates the relationships between organizational identification (OI), workaholism, and burnout among employed individuals in Latvia, with a focus on how gender, age, and tenure moderate these relationships. Data were collected from May 29 to October 27, 2024, using the QuestionPro platform, resulting in 954 total responses, of which 879 were completed (completion rate: 92.14%). The results demonstrate that high OI significantly predicts burnout ($\beta = 1.167$, $p = 0.002$), particularly when combined with workaholism ($\beta = 2.045$, $p < 0.001$). Employees exhibiting both high OI and workaholism reported the highest levels of burnout. A negative association between tenure and burnout ($\beta = -1.3419$, $p = 0.020$) suggests that experienced employees develop better coping strategies. Gender differences were also observed: women in the high OI group reported significantly higher burnout levels ($\beta = 2.2538$, $p = 0.045$), whereas women in the low OI group experienced lower burnout levels ($\beta = -3.2624$, $p = 0.020$). These findings highlight the complex interplay between organizational identification, workaholism, and burnout, emphasizing the need for organizational interventions targeting workaholism and gender-specific challenges. Future research should further explore the impact of cultural and organizational factors in shaping these dynamics.

Key words: burnout, organizational identification, workaholism, stress, gender, tenure, age.

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Heat stress prediction for simulated wildland firefighting

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Abstract. Predicted heat strain model (PHS, ISO 7933) utilizes clothing, environment and activity data in calculations. Online tool versions from FAME Lab (PHS-FL) and Lund University (PHS-LU) allow input of intermittent conditions and data input outside the validity range of the model. The study aimed to validate both algorithms for intermittent firefighter scenarios. This paper compares results from wildland firefighting simulations in laboratory conditions (WLF). It has to be noted that some of the used environmental conditions, activity levels and clothing properties were outside the validity range of the standard. Also, PHS- FL had no input for clothing evaporative resistance, and might have used instead insulation and evaporative resistance relationships and utilized permeability index of normal clothes (0.38). Four firefighters dressed in turnout gear performed intermittent activities in a climate-controlled room (Ta = 30.4 ± 1.0 °C, RH = 28.4 ± 11.0 %, va<0.15 m/s). The work load was simulated by walking on treadmill at 2.1, 3.5 and 4.5 km/h, corresponding on average to metabolic rates of 145, 187 and 226 W/m2. In each test, each activity level was performed twice, with planned exercise start and end with 2.1 km/h. However, all test persons did quit exercise before the intended heat exposure time (90 minutes), and the last exercise at 2.1 km/h was missing or incomplete. For the whole exposure radiation load of 1 kW/m2 was applied at the right shoulder level simulating solar load. Between minutes 25 and 55, the radiation load was increased to 3 kW/m2 for 2 minutes at the start of each 5 minutes, i.e., for 12 minutes in total. As PHS_FL did not allow for enough timesteps for each radiation change, then a time weighed radiation load for this period was calculated and utilized in predictions in both model versions. After quitting the heat, the test persons removed jacket, helmet and gloves and followed 30 minutes recovery period at room temperature (Ta = 18.5 ± 3.3 °C, RH = 44.6 ± 15.4 %). Measured exposure parameters and clothing properties were used as the PHS models' input data. Rectal (Trec) and mean skin temperatures (Tsk), and body water loss (mwl) were compared with PHS predictions. Predictions were made for each individual test person and then the average predicted values were calculated. Both online tools showed significant differences with the measured data. The discrepancies in temperatures increased over time being statistically not significant in the first half of the test periods and becoming statistically significant ($p < 0.05$) in Trec towards the end of heat exposure and recovery (PHS-FL) or within recovery period (PHS-LU), Predicted values stayed always lower than the measured values, and difference reached finally above 1 °C. Differences were statistically significant for Tsk in the middle of heat exposure and reached 2.6 °C as the highest during recovery with the predicted values being lower than the measured ones. At the same time differences in measured and predicted mwl did not reach statistical significance, in spite of observably higher predicted values ($p>0.05$). Expected higher mass loss in predictions may be a reason also for lower predicted skin and rectal temperatures. Other clearly noticeably differences in measured and predicted values were lower start Trec in predictions or when using real Trec as input, forcing Trec initially to drop; slower Trec increase in predictions; higher predicted Tsk at start; considerably quicker predicted Tsk changes at the start and stop of radiation that then quickly levelling off; and considerably quicker predicted Tsk drop at the start of recovery. The behaviour of predicted Tsk may indicate that the model does not count with mass and thermal inertia of the protective clothing system, and in this way affects also Trec. At the same time quicker initial changes of predicted Trec and diminished raise later maybe also indicating poor consideration of human body mass and thermal inertia, too. Neither PHS tool gave a good prediction in WLF scenario. More tests are needed to suggest adjustments of ISO 7933 or support a need for a dedicated user standard for intermittent heavy work in protective gear.

Key words: firefighter, protective clothing, thermal insulation, predicted heat strain, model validation.

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Integrating human factors into occupational accident investigation: a literature review of methodologies and their applications

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Abstract. Accident investigation is essential in safety management, aiming to identify causes and prevent recurrence. Despite various methodologies, gaps remain in information collection and human factors integration. Since data collection is the foundation of investigations, deficiencies can compromise conclusions. This study reviews literature on human factors, focusing on their integration into investigation of occupational accidents. The review explores the nature of human factors and investigation methods that address cognitive, psychological, and organisational dimensions. The study also proposes an integrated investigation flow that combines these methodologies to enhance the accuracy and effectiveness of accident investigations. A literature review was conducted using academic databases. Keywords included 'accident investigation', 'human factors', and 'occupational safety'. Inclusion criteria focused on articles, books, and reports from 1990 to 2025, covering topics of interest and safety-critical industries. Relevant literature was screened and analysed based on its contributions to the research topic. Key investigation methodologies were analysed for their strengths and limitations. The study revealed a multitude of methodologies available, each with its own set of strengths and limitations. HFACS, HEART and FMEA methods were analysed for their potential to systematically integrate human factor. While these methodologies demonstrate significant promise, their implementation remains inconsistent due to challenges related to training, organisational culture, and resource allocation. This review emphasizes the importance of integrating human factors into accident investigation methodologies to enhance workplace safety. While traditional methods remain valuable for their accessibility, systemic approaches are essential for addressing complex socio-technical systems. Future efforts should prioritize investigator training and promotion of positive organisational culture to mitigate human factor challenges and improve investigative outcomes.

Key Words: Occupational accident investigation, human factors, investigation models, safety-critical industries.

Diminished work ability as a contributing factor for farmer's interest in switching to organic production

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Abstract. Previous studies suggest organic producers have diminished work ability, but it is unclear if this is due to pre-existing conditions or work exposures in organic production itself. The current study explored whether diminished work ability is a contributing factor to the interest in switching from conventional to organic production. The study used data from 2018, Finnish farmer questionnaire, analysed by machine learning -based approach and logistic regression modelling. Nearly half (46%) of the survey respondents (n=2,948) had a diminished work ability score. Seventeen percent (n=501) of the respondents reported being interested in switching to organic production. Farmers with diminished work ability had greater odds (OR 1.56, 95% CI: 1.26-1.92) for showing interest in switching. Those growing horticulture and special crops (vs. cereals) (OR 0.55) and those age 55+ years (vs. less than 35) (OR 0.51) showed less interest in switching. The interest in starting or expanding organic production was higher among those who already had an organic agreement on part of their farm (OR 5.7) and those who had other business activities on the farm (OR 1.36). In summary, this study suggests that diminished work ability predicts farmer's interest for switching to organic production. Measures to protect the health and well-being of farmers and workers during and after switching to organic production is critically important in achieving not only policy goals to increase organic production, but also good quality of life of farmers.

Key words: agriculture, logistic regression, machine learning, social sustainability, well-being at work.

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Farmer Mental Health Help Seeking Knowledge Development and Use

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Abstract. Purpose| Farming is consistently associated with mental health risks. The DCU-led FarMHealth project, funded by the Department of Agriculture, Food and the Marine (DAFM), aimed to design an intervention to improve farmer mental health help-seeking and literacy by surveying prevailing attitudes and identifying community and stakeholder perspectives and preferences for an intervention. This abstract provides key project outcomes and indicates how they have impacted farmer mental health policy and practice.
Design| Irish farmer mental health help-seeking and literacy was examined across three studies. 1. A quantitative survey to establish prevailing opinions of mental health help-seeking and literacy in farmers, 2. Qualitative semi-structured interviews and focus groups to examine barriers and facilitators to mental health help-seeking and literacy in farmers, and 3. A tailored intervention designed to increase mental health help- seeking and literacy in farmers.
Findings| Key findings across publications included farmers reporting willingness to seek help for their mental health but having low literacy and poor knowledge of how to access services (Firnhaber et al., 2023; O'Connor et al., 2024a), high levels of burnout (O'Shaughnessy et al., 2022; O'Connor et al., 2024b), a prevailing culture of self-reliance and stigma surrounding seeking mental health support (Firnhaber et al., 2024a; Firnhaber et al., 2024b), and a strong community identity and desire to see mental health services that understood the needs of farmers (Malone et al., 2025). These findings informed the development of a tailored intervention in the form of a once-off, farmer-specific discussion on resilience in Irish farmers. Participants reported increased knowledge of how to access mental health services, more willingness to seek help when needed, increased confidence in how to address mental health issues, and decreased stigma around discussing mental health (O'Connor et al, under review).
Practical and theoretical implications| The issues identified in this project such as stress, sleep and burnout are associated with poor occupational safety and health (OSH) in agriculture. Hence the project provides valuable information to assist with improving farm OSH through communications and advisory and education and training activities. Mental health issues as identified in this project are known to interface with ergonomic and ergodesign issues. For instance poor mental health including sleep and burnout are associated with musculoskeletal disorders. A number of papers in this project provide frequency data associated with musculoskeletal disorder rates for the farmer sample surveyed. Farm work and farmyard design, including ergodesign, are associated with the solution to mental health issues identified in this study such as farmer sleep and burnout.
Farmers must have the tools needed to access mental health services to engage with them. FarMHealth demonstrated farmers were willing to grow their mental health literacy skills, and seek help from services and their community if they were supported to do so. The project has influenced policy and practice through the publishing of eight papers, collaboration with key farming bodies such as the DAFM, the Minister for Agriculture, and Teagasc, engagement with national media outlets such as RTÉ Brainstorm, and public outreach through social media. Its publications were cited in the recent mental health report by the European Agency for Safety and Health at Work (Donohue et al., 2024). Future research is needed to roll out the intervention nationally.
Further, at a European level, the EU Horizons project, SafeHabitus (https://www.safehabitus.eu/) has held a policy seminar in 2024 and prepared a Literature Review on mental health in farming.

Key words: Burnou, Ergonomics, SafeHabitus project, Sleep; Stress.

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Psychosocial work environment risks for museum workers in Latvia

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Abstract. In Latvia, as elsewhere in the world, psychosocial risks at work are considered to be a topical occupational risk in every sector of the economy, including the cultural sector. The aim of this study was to investigate the psychosocial risks of the working environment for museum workers in Latvia. The study involved 303 respondents from different museums in Latvia. A staff survey was conducted, and psychosocial risks at work were assessed using the short version of The Copenhagen Psychosocial Questionnaire - COPSOQ III. The survey found that 73-77% of museum employees are women, with about a quarter of respondents reporting working more than 40 hours per week. Work is often performed in a forced posture, 28.1% of respondents complain of overwork, 70.3% of respondents report an unsuitable working environment, almost half of respondents indicate that they are exposed to harmful chemicals at work, and almost all employees report low pay. The results of the COPSOQ survey show that the main reasons why the majority of respondents have chosen to work in the existing museum are: the support of colleagues, a good atmosphere, the opportunity to use knowledge and skills, as well as the meaning of work. Future research will focus on using cognitive tests to better understand the psychosocial risks faced by museum workers.

Key words: COPSOQ, museums, psychosocial risks, work environment.

IV BIOENERGY AND BIOFUELS

Levoglucosan from woody biomass: sustainable valorisation approach

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Abstract. Lignocellulosic biomass predominantly made up of cellulose, hemi-cellulose and lignin, is an underutilized resource, generated in large quantitlies offering significant potential for producing biofuels and high value biochemicals. One such product is levoglucosan (LG), a valuable anhydrosugar with broad applications in synthesizing industrial biochemicals via fermentation as some of the microorganisms can utilize it as a sole carbon source. LG is predominantly derived from the pyrolysis of cellulose present in the lignocellulosic biomass. Pyrolysis is a thermochemical conversion process in which the biomass is heated at a rangeof 500- 700° C under inert atmosphere producing a solid biochar, liquid bio-oil and non-condensible gases. The concentration of LG in the bio-oil depends on the pyrolysis conditions and composition of the biomass. Efficient production of LG from lignocellulosic biomass is challenged by the inherent structural complexity of the biomass matrix and the formation of undesired by-products during pyrolysis. The presence of lignin and hemicellulose interferes with the selective thermal degradation of cellulose to LG. However, with suitable pretreatments, optimizing pyrolysis conditions and recovery techniques, LG yield can be enhanced. The research focusses on exploring ecofriendly, cost effective pretreatments like torrefaction and nitrogen explosion. Torrefaction, a mild thermal treatment in the range of 200–300 °C, has been shown to degrade hemicellulose and disrupt lignin structures, thereby improving cellulose accessibility and increasing its pyrolytic conversion to LG. Similarly, nitrogen explosion, a physical disruption technique, promotes the loosening of biomass structure and enhances cellulose concentration. These pretreatments not only improve the homogeneity and reactivity of biomass feedstocks but also suppress catalytic effects of inorganics and lignin-derived radicals that otherwise lead to LG decomposition. Pyrolysis process parameters such as temperature, residence time, and heating rate that influnce LG production is also studied. In addition to production, various extraction approches are to be explored to obtain an integerated recovery process for improving the purity of LG. Beyond thermal conversion, the microbial valorization of LG represents an emerging frontier in the integrated biorefinery approach leading to energy efficient, commercial scale processes in the future. Hence, a combination of selective pretreatment, controlled pyrolysis, and microbial production forms a promising route for valorising lignocellulosic biomass and contributing to circular bioeconomy.

Key words: Lignocellulosic biomass, Levoglucosan, thermochemical conversion, Microbial valorisation, Biorefinary.

Integrating residual biomass use and intermediate crop cultivation: A systems approach to sustainable agriculture in Sweden

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Abstract. Developing the bioeconomy is a promising pathway to achieving sustainability goals by reducing dependency on fossil resources. Agricultural residues are an attractive feedstock since, unlike other biomass sources, they do not directly threaten food production. However, their removal from arable land raises concerns due to potential trade-offs with soil health, nutrient balance, and broader environmental impacts. This research explores strategies to harmonize the removal of crop residues with the cultivation of intermediate crops, considering their potential as a sustainable intensification strategy while mitigating resource depletion and environmental consequences. The study utilized Swedish national agricultural data and spatial modeling to assess the availability of crop residues and land for intermediate crops, using oilseed radish as a model species. Crop rotation sequences, biomass yields, and spatial soil property data were integrated to estimate biomass production potential and environmental outcomes. Intermediate crops contribute an additional 383 kt of biomass annually, complementing the 2139 kt of available crop residues. However, spatial disparities were evident due to variations in soil texture, yields, and crop rotation sequences. These disparities result in varying carbon inputs across the landscape, demonstrating spatial differentiation in the potential of intermediate crops to compensate for residue removal. The second phase of the project assessed how biomass utilization for biogas production could affect long- term soil carbon storage, considering the application of digestate in agricultural systems. Cultivating intermediate crops increased soil organic carbon (SOC) stocks by an average of 1.93 t C ha−1 (~3%), while digestate application further increased SOC by 3.3 t C ha−1 (~5%). Combining these practices generally had positive effects on SOC, though notable spatial variations were observed. However, SOC gains were not always sufficient to fully offset losses from complete crop residue removal. Beyond biomass availability, this research has investigated the impacts of these practices on nutrient dynamics, greenhouse gas emissions, and other key metrics. A current phase focuses on simulating nutrient flows and losses using the VERA and DNDC nitrogen models across diverse agroecological zones in Sweden. These simulations aim to refine our understanding of nutrient cycling, including nitrogen efficiency and trade-offs such as leaching or emissions. Future work will integrate life cycle assessment (LCA), incorporating ReCiPe midpoint impact categories to evaluate broader environmental impacts, such as global warming potential, eutrophication, and resource depletion. Socio-economic analyses will complement these findings, providing insights into how these systems can balance sustainability with economic viability. This research highlights the need for systemic and location-specific approaches to optimize biomass use in the bioeconomy while addressing environmental, economic, and social dimensions. The results offer critical guidance for policymakers and stakeholders aiming to implement sustainable agricultural practices.

Key words: Bioeconomy, Biomass, Sustainable intensification, Nutrient dynamics, Soil organic carbon.

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Advanced Sequential Extraction of Microalgal Metabolites for Reducing Environmental Impact and Promoting Sustainability, Circular Economy and Zero-Waste Strategy

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Abstract. Microalgal biomass is an increasingly attractive resource for sustainable biofuel production and the extraction of high-value co-products due to its fast growth and high lipid content. However, conventional extraction methods often rely on large volumes of solvents, contributing to environmental degradation. This study proposes innovative approaches to reduce solvent use and waste production while maximizing the recovery of valuable metabolites. It evaluates the most effective cell disruption techniques for enhanced lipid extraction and sequential recovery of multi-products. By employing advanced ultrasonic and microwave pretreatment methods, the current study aimed to enhance lipid extraction efficiency from Porphyridium purpureum by effectively disrupting its rigid cell walls and reducing the need for excessive solvent volumes. Ultrasonic extraction at 30% power for 20 min., using a methanol-chloroform mixture, was the most effective technique, significantly improving lipid recovery. Following lipid extraction, a sequential recovery process was applied to valorize the residual biomass with reduced solvents, targeting the extraction of proteins, carbohydrates, and other bioactive compounds. Two extraction sequences after the main product extraction, protein-lipid-carbohydrate, and lipid-protein-carbohydrate, among tested methods, achieved a maximum co-product recovery of 69% lipid and 57% carbohydrate and 65% protein and 52% carbohydrate, respectively. These sequential extraction processes maximized resource utilization, minimized waste and demonstrated a zero-waste approach aligned with sustainable development goal 7 and circular economy principles. The findings highlight the potential of microalgal biorefineries to reduce the environmental impact of biofuel and biochemical production by adopting green, solvent-minimizing extraction technologies that enhance resource efficiency and sustainability.

Key words: Pretreatment, Sequential extraction; Porphyridium purpureum; Sustainable Development Goal ; Zero waste.

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Rhamnolipid production from torrefied aspen waste

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Abstract. Torrefaction is a thermal pre-treatment, wherein biomass is heated at 200°C-300°C for 1 h or longer in an inert environment at atmospheric pressure. The initial application of torrefaction was to improve biomass-derived fuel characteristics. However, torrefaction at low temperature yields biomass with fermentable sugars arising from the partial breakdown of lignocellulose. Herein, we report the proof-of-concept of microbial conversion of these sugars to rhamnolipids, a biosurfactant, by Burkholderia thailandensis E264. Aspen wood chips torrefied at 225°C–300°C were characterized and used as a substrate for fermentation experiments. The produced rhamnolipids had good emulsification indices (23.1%-64.1%), with lower temperature pretreatments resulting in stable emulsions lasting >40 days. Both emulsification indices and rhamnolipid concentrations decreased with increasing torrefaction temperature. The integration of torrefaction and rhamnolipid production could improve efficiency, in addition to the circularity of the process.

Key words: biosurfactant, lignocellulose, torrefaction, rhamnolipid, biorefinery.

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Torrefaction-based bio-surfactant production: A proof-of-concept of low-value waste valorization to specialty chemicals

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Abstract. Torrefaction is a thermochemical pretreatment in which biomass is treated at 200°C–300°C for 30–60 min in an inert atmosphere, which has been traditionally used to improve the fuel characteristics of biomass to the level of low-grade coal. However, its relevance is currently reduced because burning of biomass has negative effects on the environment, rendering several established torrefaction plants less useful. In our previous experiments, we observed that its fibre components make it a suitable substrate for biochemical production. Herein, we demonstrate the proof of concept for the utilization of torrefaction as a pretreatment for low-value wood waste into biosurfactants, a high-value specialty biochemical. Wood waste was torrefied at 225°C, 250°C, 275°C, and 300°C and comprehensively characterized. We observed the direct utilization of torrefied wood waste by the microorganism. The biosurfactant was recovered via centrifugation. Total surfactant yield, tensioactivity, and emulsification activity decreased with higher torrefaction temperatures (>250°C). Highly stable emulsions lasting >40 days were observed. The present research offers feasible solutions for the cost-effective chemical-free production of biosurfactants as well as environment-friendly wood waste management, incorporating circular economy principles.

Key words: biosurfactant, lignocellulose, torrefaction, biorefinery, wood waste.

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Qualitative assessment of beach wrack and the influence of pretreatment methods on fuel characterization for energy production

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Abstract. The accumulation of beach wracks poses significant challenges to coastal management, particularly in tourist areas, affecting environmental quality and aesthetics. This study explores the qualitative characteristics of beach wrack as a biofuel source for combustion appliances. Samples collected from beaches in Veneto, Italy, were analyzed according to EN ISO standards for solid biofuels. Proximate and ultimate analysis, heating value, and ash melting behaviour were determined. Raw samples (BW-R) exhibited high moisture content (77%), a substantial ash content (44%), and low heating value (10.7 MJ/kg), making them unsuitable for direct energy applications. Pretreatments were performed to enhance the properties of the material. One portion was mechanically sieved (BW-S) to remove sand, while another was sieved and washed (BW-SW) to remove the remaining salt and sand. Sieving reduced the ash content to 24% and increased the heating value to 15.3 MJ/kg. The key improvements came from washing and sieving, which lowered ash content to 13% and increased heating value to 18.1 MJ/kg. Washing also raised the ash deformation temperature to 1290°C, enhancing thermal stability. Pretreatments increased C and H content while reducing S and O, with no significant change in N. Due to high ash content, mixing with sawdust was necessary, resulting in mixtures showing better properties: 4.0% ash for Mix30 (30% beach wrack, 70% sawdust) and 6.9% for Mix50 (50% each) and increased heating values. However, challenges remain in converting beach wrack into viable fuel due to material losses during pretreatment, high costs, and environmental concerns from plastics.

Key words: Bioenergy, Biofuels, Algae, Marine Biomass, Energy recovery.

V LIVESTOCK TECHNOLOGY

Sub-clinical respiratory infection identified on farms by monitoring weight changes of pigs with the Weight-Detect instrument

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Abstract. The essential task of growth rate monitoring of pigs is usually undertaken on farms using electronic scales, but new technologies are now available to continuously monitor the weight of pigs. One of these systems (Weight-Detect, WD, PLF Agritech, Brisbane, Australia) has been introduced on a commercial pig farm in Spain as part of the EU funded aWISH project to (1) assess the applicability of the technology and (2) use this information to assess the general welfare status of pigs. The WD unit was installed in early 2024 and manual weight recordings were undertaken periodically using an electronic scale to validate the WD system. In terms of absolute values, the manual measurements indicated that the WD system was able to predict the average pen weight of the pigs with 1.7% (2.0 kg) precision. More importantly, this case study demonstrated that the WD unit was able to detect weight reduction in pigs six days before the clinical signs of a respiratory disease infection were noticed. According to the WD measurements the study pigs achieved an average daily gain (ADG) of 882 g/d between the 20/03/24 and 16/04/2024. However, between the 17/4/2024 and 30/04/2024 their ADG dropped dramatically to 286 g/d. The animals were diagnosed with respiratory disease on the 22/04/24, six days after the dramatic reduction in ADG was recorded by the WD system. This period of ADG stagnation has caused an approximate 14-day delay in reaching the desired slaughter weight, (approx. 130 kg), potentially creating significant financial losses for the producer. After the 1/05/24 pigs recovered and achieved an ADG of 645 g/d until their last recorded weighing day on the 20/5/24. These results highlight the WD system's ability to alert livestock managers about impending health problems before clinical signs appear, so appropriate mitigation measures can be implemented to reduce the negative impacts on welfare and production performance.

Key words: ICT tools, image analysis, profitability, smart technologies, weight detection.

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ET4D project: Using advanced data management system to improve environmental sustainability and transparency in dairy farming

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Abstract. Europe's agri-food sector is changing due to increasing societal, economic and environmental demands, which is making the system more complex. Digital technologies can help quantify and manage this complexity, but their adoption has been slow because of high costs, technical issues, usability problems and a lack of motivation to collect and share data. ET4D is a project that brings together companies, academic research institutions and universities to increase information flow on and from dairy farms to consumers and other groups in the milk value chain through a web application. The project aims to demonstrate, expand and validate an existing semi-commercial data management system with built-in sensors for environmental monitoring in dairy cattle barns. The project will also assess ways to include data from external sensor systems and the possibility of developing a simplified sensor system for small farm holders. Extensive measurements are being conducted at trial and demonstration sites in various European countries. Since poor internet connectivity is common in many rural areas, the project team is studying data traffic patterns and communication needs on farms and has proposed several ways to improve connectivity at different agriculture sites. The information system being developed will provide information about dairy farm production and products tailored to different groups. To achieve this, the research team has studied the expectations and needs of different data users in the milk value chain to support sustainable milk production decisions. The main result of this project component will be a modular web application to provide the relevant information customized for different groups. As a final step in the project, the benefits associated with the transferred environmental information from farms to consumers (and other groups) will be evaluated in order to create incentives for the data and information sharing. It is hoped that the ET4D data management system will motivate farmers to upgrade their business models, improve the internet connectivity and apply more resilient production methods. Therefore, the ET4D project may positively influence product marketing, farm economic performance, improve product quality, and strengthen farmers' capabilities to adapt to structural changes.
Key words: connectivity, data management, dairy cattle, digitalization, environmental monitoring, ICT tools, smart technologies, social diagnosis.

A literature review of plants with antiparasitic properties against horse endoparasites

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Abstract. In light of the expansion of anthelmintic resistance, this literature review focusses on plant use against common endoparasites in horses: strongyles, cyathostomins, and ascarids, all of which negatively impact the horse's quality of life. Evidence-based literature from databases such as *ScienceDirect* and *PubMed* and search engines such as *GoogleScholar* was selected, and publications that met the criteria were included in the review. The plants included in the review are native species in Europe or can be easily grown in the provided climate. The search provided a total of 5936 publications from which, after evaluation, only 12 were included in the review. The main aim of the research was to compare the efficacy of selected plants by evaluating the information of the study design, a plant component or preparation and its concentration used in the investigation, and the results obtained, while also describing the bioactive compounds that are responsible for the potential antiparasitic effect. The search covered commonly mentioned plants with anthelmintic potential for equines, and in the result, only eight of the plants had their effectiveness evaluated in the form of research, *Artemisia absinthium, Hippophae rhamnoides, Onobrychis viciifolia, Allium sativum, Inula helenium, Zingiber officinale, Cichorium intybus* and *Pimpinella* anisum. The results emphasize the necessity for further explorations to be made - the results tend to be inconsistent with each other, showing that there might be a possibility for the plants to become a part of routine anthelmintic therapy, but many of the findings have not been convincing enough so far.

Key words: horses, herbal medicine, parasites, ethnoveterinary, strongyles, cyathostmins, ascarids.

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A Machine Learning Framework for automatic early detection of mastitis in dairy cattle

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Abstract. Mastitis, an inflammation of the mammary gland, is a prevalent and costly disease affecting dairy cows, leading to reduced milk yield, diminished milk quality, compromised cow welfare, and increased treatment costs. Early and accurate mastitis detection helps cut treatment costs, control the disease, retain milk production levels and maintain milk quality grade. In addition to cutting financial costs and retaining revenue from milk, early detection helps cows by protecting them and relieving the pain caused by the disease. Early detection is challenged by lack of visible symptoms until clinical stage when a cow is seriously ill. The stage before visible symptoms appear is called subclinical stage where milk properties start undergoing change. Early detection attempts to identify subclinical stage from altered milk properties. Computational models of early detection of mastitis can help achieve the above stated goals by aiding farmers in adopting timely and suitable cattle treatment regimes and preventing healthy cows from becoming infected. This research explored advanced methods for early mastitis detection using data from a commercial farm with a robotic milking system in South Canterbury, New Zealand. This high-tech farm milks approximately 1,900 cows in a single 13,000-square-meter barn. During each milking session, robots collect data on various milk quality and quantity parameters. For this study, data were collected over 370 days, at the quarter level within the robotic milking system. The dataset included records from a herd of more than 1,900 cows, with 198 identified as having clinical mastitis. Milk yield, electrical conductivity, and the fractional deviation of a quarter's electrical conductivity from the smallest electrical conductivity were used as input variables. The study began with data preprocessing strategies, emphasizing data cleansing, normalization, and feature engineering, to remove noise enhancing the quality and robustness of the subsequent analysis. To help identify subclinical stage clearly by a model, this study first comprehensively captured the whole mastitis spectrum. Initially, Self-Organising Map (SOM) with unsupervised learning was employed to visualize data in a lower-dimensional space and explore the ability of SOM to capture the mastitis spectrum on a 2-D map and reveal potential clusters representing different health stages. The map captured the mastitis spectrum remarkably well revealing at least 3 potential health clusters, healthy, subclinical, and clinical stages, despite the lack of specific labels for the subclinical stage. This enabled early detection of the subclinical stage, that could facilitate timely intervention and improved cow health management. Building on the insights gained from unsupervised learning with SOM, we then trained a Bidirectional Long Short-Term Memory (BiLSTM) network to forecast the cow health state for the following day using supervised learning. The BiLSTM model was developed on an enhanced dataset with new labels reflecting different health states - Healthy, Subclinical, and Clinical- derived from the SOM analysis. To address the challenge of class imbalance between the three health states classes, and ensure a robust representation of various disease stages, we utilized the Synthetic Minority Over-sampling Technique with Edited Nearest Neighbours (SMOTE-ENN) as a preprocessing step. Class imbalance can significantly impair the performance of machine learning models, especially in scenarios where certain classes are underrepresented. By applying SMOTE-ENN, we ensured that the dataset was balanced, allowing for more reliable training of the BiLSTM model. The performance of the BiLSTM model was evaluated using a confusion matrix and other metrics such as accuracy, precision, recall, and F1-score. The results demonstrated the model's high efficacy in forecasting the health state for the next day. For the Healthy state, the precision, recall, and F1-score were 0.99, 0.97, and 0.98, respectively. for the Subclinical state there were 0.92, 0.98 and 0.95. and finally, the Clinical state showed these metrics to be 1.00, 0.95 and 0.97. By leveraging the SOM approach for organizing and labelling the data and the BiLSTM model for temporal forecasting to ascertain future health state, this approach significantly advances mastitis detection methodologies. The integrated method not only enhances detection accuracy but also provides a deeper understanding of the progression of mastitis, facilitating timely and targeted interventions. This powerful tool for early diagnosis and precise management of cow health represents a noteworthy advancement in the field, opening new possibilities for precision dairy farming practices with improved economic outcomes.

Key words: Mastitis Detection, BiLSTM, SOM, SMOTE-ENN.
Acknowledgements. Lincoln University.

Pasture-grazed lamb growth parameters for Latvian darkhead breed

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Abstract. Lamb fattening on pasture feed is widely used in the world and in Latvia most Latvian darkhead (LT) breed lambs are grazed on pasture with some addition of hay and straw. Clarifying the changes in pasture grass chemical composition during the grazing season and comparing with growth performance of lambs can enable farmers to predict their fattening pace. The experiment was conducted during grazing seasons of year 2020 and 2021 at the ram breeding station owned by the Latvian Sheep hearder association. Pasture was composed of 60% grasses with up to 20% of legumes and other broadleaf low grasses. Vegetation in the area is recultivated every 4 to 5 years, grazing is organized in rotational system and pastures are regularly cut. Total of 24 male LT breed lambs were used in the experiment. Pasture feed chemical composition was analysed from 13 samples in year 2020 and 9 samples in year 2021. Such elements as dry matter, protein, fiber (NDF and ADF), metabolizable energy ME, Ca and P, as well as dry matter intake were obtained, later to be compared with the lamb growth performance. Used performance measures were the duration of fattening, average daily gain, end liveweight and age before slaughter. The results show that pasture feed quality differs significantly from year to year and lower feed quality prolongs duration pf fattening period. Regardless of variation in quality, pasture grass feed use efficiency on lamb growth performance was confirmed as optimal.

Key words: average daily gain, feed chemical composition, lamb fattening, Latvian darkhead sheep breed, pasture.

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Using machine learning techniques to assess the technology adoption readiness levels of livestock producers

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Abstract. This study examines technology adoption barriers in precision livestock farming (PLF). For this, a survey of 266 farms across multiple countries in the European Union (such as Sweden, Hungary, Denmark, Poland, etc.) and Israel has been conducted. The questions were designed to capture information about existing infrastructure and attitudes toward smart devices/technologies used in smart farming practices. Based on these attributes, farmers have been clustered into two categories of technological readiness. Critical attributes that separate the clusters have been highlighted, as well as common characteristics, by utilizing a combination of unsupervised and supervised machine learning approaches. The findings provide insights into technology adoption barriers and support the development of targeted strategies to promote PLF in agriculture.

Key words: Precision Livestock Farming, Machine Learning, Survey Design, Technological Barriers, Cluster Analysis.

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Prediction Method and Result Analysis of Cellular Network Performance in Rural Dairy Farms

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Abstract. A need for dependable wireless communication systems in dairy farms is underscored by the rapid digital transformation of agriculture, which is propelled by Internet of Things (IoT) advancements. Although 5G technology promises lower latency and higher data throughput, the widespread availability of 4G networks— particularly in rural regions worldwide—renders 4G analysis a critical undertaking. Despite mounting enthusiasm for next-generation connectivity, the practical deployment of 5G in rural areas is impeded significantly—relative to urban centers—by infrastructural, economic, and policy constraints. Therefore, essential operations such as real-time herd monitoring, automated feeding systems, and environmental control are predominantly conducted through 4G networks in many dairy farms. A pressing need to evaluate and optimize current 4G cellular performance in rural dairy farming environments is addressed in this research, to bridge a notable gap in existing literature, which often prioritizes urban or suburban network studies. To fulfill this objective, established radio propagation models—including Free Space Path Loss (FSPL), Close-In with Height adjustment (CIH), the 3rd Generation Partnership Project Rural Macrocell (3GPP RMa), and COST 231—were thoroughly reviewed, with attention paid to their applicability in remote settings characterized by open terrains, dense vegetation, and unique structural designs. Under the auspices of the ET4D project, six locations were selected for in-depth investigation—one in Germany, four in Poland, and one in Estonia. A variety of topographies and building materials were featured at each site to provide a comprehensive understanding of real-world challenges. Automatic distance measurements were carried out using the Haversine formula, which refined network planning processes and enabled precise calculation of distance-dependent losses. In tandem with these measurements, the interplay of transmitter-receiver separation, transmit power, carrier frequency, cable losses and antenna height on signal degradation was evaluated using MATLAB-based simulations. It was indicated by the results that, while 4G networks generally offer adequate coverage outdoors, the transition to indoor environments leads to a marked decline in signal quality. At one location, a particularly striking example was observed in which the Received Signal Strength Indicator (RSSI) deteriorated from approximately –78 dBm immediately outside a farm building to around –105 dBm, just a few centimeters inside. These pronounced penetration losses encountered in rural structures—often incorporating thick walls and insulating materials—were highlighted by this dramatic drop in signal strength. Consequently, reduced data rates, increased latency, and intermittent connectivity may be experienced by farmers utilizing IoT devices indoors, thereby undermining the benefits of digital automation. The importance of tailoring propagation models and infrastructure planning to the specific demands of rural dairy farms is underscored by these findings. Vulnerabilities of 4G networks in such settings are exposed, thereby laying a foundation for targeted improvements—ranging from external antenna installations to the strategic placement of repeaters or small cells—that can mitigate indoor attenuation effects. In doing so, the immediate optimization of 4G systems is informed, and valuable insights for future 5G rollouts are provided, ensuring that agricultural stakeholders can harness the full potential of digital technologies in even the most remote environments.

Key words: Rural Connectivity, IoT Applications, Dairy Farm Technology, 4G Network Performance, Precision Livestock Farming.

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Metabolic hormone profiles pre- and post-fattening in sheep breeds in Latvia with varying feed efficiency

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Abstract. In sheep farming, livestock fattening drives income, and economic efficiency depends on feed efficiency (FE), which is influenced by the animal's hormone-regulated physiological condition. Monitoring hormone levels as biomarkers can significantly optimise the lamb fattening process, improving outcomes. The study aims to analyse the hormone IGF-1, insulin, total T4, ACTH, haematocrit (HCT), haemoglobin (Hb), and glucose levels in sheep breeds raised in Latvia at different ages and with FE indicators. Blood samples and phenotypic data were collected from 76 lambs (~81 days old) and 92 lambs (~150 days old) in two intensive fattening groups, with ~60% being the Latvian Dark-Head breed. After intensive fattening, IGF-1, insulin, haematocrit, and haemoglobin levels were statistically higher, while glucose was higher before the fattening. IGF-1 and insulin levels were statistically different before and after fattening across five and three breeds, but HCT and Hb levels differed significantly in one breed each. Before fattening, IGF-1 and glucose levels show statistically significant correlations with after-fattening FE scores. In a regression model, hormone levels measured before intensive fattening explain 24.7% of FCR, 22.8% of RGR, and 31.6% of KR during fattening. Results demonstrate breed-specific differences in hormone levels among sheep raised in Latvia and highlight the potential of hormone levels as biomarkers for assessing and optimising feed efficiency. This highlights the need to study hormone levels across breeds and at different fattening stages.

Key words: Breeding, fattening, feed efficiency, metabolic hormones, Latvian sheep.

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VI PRECISION AGRICULTURE

Non-destructive determination of water content during plant ontogenesis

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Abstract. With the requirement of non-destructive measurement, visible/near-infrared spectroscopy, as a rapid and non-destructive analytical technique, has been widely used in the detection of food and agricultural products including plant water content determination. The ability to measure water content without damaging plant tissues is crucial for monitoring plant health, assessing irrigation needs, and studying plant – water relations. As alternative we can used the direct determination of the water content in plants by oven drying method, which are widely used, but is destructive, need long-time process and consumes a lot of energy. Water is not just a physical necessity for plants—it is also a key player in every biochemical and physiological process. From facilitating nutrient uptake to enabling photosynthesis and maintaining structural integrity, water is the foundation for life in plants. The objective of the study was to find out the water indices best correlated with results obtained by oven drying method. In this study, spectral data in the range of 350–2500 nm acquired by near-infrared hyperspectral imaging were used to detect the water content of maize and field beans leaves. Water Index (WI), Normalized water index (NWI), Moisture stress index (MSI), Normalized Difference Water Index (NDWI), Normalized Difference Water Index centred at 1640 nm (NDWI 1640), Normalized Difference Water Index centred at 2130 nm (NDWI 2130) and Normalized Difference Vegetation Index (NDVI) were calculated. The experiment was set up in 5 L vegetation containers, in which 5 field bean seeds or 3 corn seeds were sown, where, when the plants reached the 3 true leaf stage, 1 corn and 4 field bean seeds were left in each container. A two-factor experiment was set up, where the first factor was the moisture (watering) regime with 2 gradation classes and the second factor was the plant species. The experiment was set up in 6 replications. Samples were collected and analyzed at four developmental stages. Reflectance spectra were recorded with a Spectroradiometer RS-3500 (Spectral evolution), but the dry matter content was determined by drying for 24 h at 60°C. The results showed that the studied indices are better applied in the final period of plant vegetation, when the dry matter content is sufficiently high. The most suitable indices are WI, MSI, NWI, where a positive correlation is observed. It was concluded that all the indices tested in the study are more suitable for determining the water content of field beans than corn, since the correlation coefficients are on average two to three times higher. The watering factor has a significant effect, especially in the plant growth phases.

Key words: Maize, field beans, vegetation index, NDVI, WI.

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Weight-Detect instrument predicted the onset of respiratory infection a week before clinical signs appeared

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Abstract. Regularly monitoring the growth rate of pigs is a standard industry practice. Weight monitoring on pig farms is usually done periodically using electronic scales, but new technologies are now available on farms that will enable farm managers to continuously monitor the weight of pigs in the pens. One of these systems (Weight-Detect, WD, PLF Agritech, Brisbane, Australia) has been introduced on a commercial pig farm in Spain as part of the EU funded aWISH project (HEurope grant 101060818) to (1) assess the applicability and feasibility of the technology and (2) use this information to assess the general welfare status of pigs. The machine-vision based weight and behaviour monitoring system has been described before in various publications. The WD unit was installed in early 2024 and manual weight recordings were undertaken periodically using an electronic scale (WA08, Meier-Brakenberg, Extertal, Germany) to validate the WD system. In terms of absolute values, the four (4) manual measurements indicated that the WD system was able to predict the average pen weight of the pigs with 1.1% (1.0 kg), 0.5% (0.6 kg), 2.4% (2.8 kg) and 2.7% (3.5kg) precision, respectively. More importantly, this case study demonstrated that the WD unit was able to detect weight reduction in pigs six days before the clinical signs of a respiratory disease infection were noticed. According to the WD measurements the study pigs achieved an average daily gain (ADG) of 882 g/d between the 20/03/24 and 16/04/2024. However, between the 17/4/2024 and 30/04/2024 their ADG dropped dramatically to 286 g/d. The animals were diagnosed with respiratory disease on the 22/04/24, six days after the dramatic reduction in ADG was recorded by the WD system. This period of ADG stagnation has caused an approximate 14-day delay in reaching the desired slaughter weight, (approx. 130 kg), potentially creating significant financial losses for the producer. After the 1/05/24 pigs recovered and achieved an ADG of 645 g/d until their last recorded weighing day on the 20/5/24. The pigs were slaughtered on the 21/5/24 and achieved an overall ADG throughout their growth period of 690 g/d. These results highlight the WD system's ability to alert livestock managers about impending health problems before clinical signs appear, so appropriate mitigation measures can be implemented to reduce the negative impacts on welfare and production performance.

Key words: smart technologies, ICT tools, image analysis, weight detection, profitability.

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Evaluating the efficiency, environmental impact, and operator benefits of gps guidance and autosteer technologies in agricultural field operations

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Abstract. This study evaluated the benefits of GPS guidance and autosteer technologies in agricultural operations through a three-year field experiment conducted at the Smart Bioeconomy Testbed in Central Finland. Adjacent fields were sown either with or without the use of GPS guidance and autosteer, while all other variables were standardized to isolate the impact of the technologies. The movement of the tractor–seeder combination was precisely tracked using RTK GPS with centimetre-level accuracy, and operational parameters were recorded via ISOBUS, supplemented by external measurements of environmental and agronomic factors. The results revealed significant differences in efficiency, environmental impact, and operator well-being and comfort between manual and automated operations. Automated operations reduced work time by 9.7 % compared to manual driving, primarily due to a decrease in the distance driven per area. GPS guidance optimized pathing and reduced overlap and unnecessary movement by approximately 21 %. As a result, GPS-guided operations produced more uniform traffic patterns, which helped to reduce the risk for localized soil compaction. Additionally, fuel consumption was 20 % lower, leading to a corresponding reduction in CO_2 emissions per hectare. The use of autosteer also led to a 10 % reduction in the operator's average heart rate, indicating improved physical comfort and reduced stress. In conclusion, GPS guidance and autosteer technologies significantly enhance operational efficiency by reducing fuel use, field time, and emissions. These benefits are particularly pronounced in smaller fields, such as those typical in Finland, where improved manoeuvrability yields greater returns. While the technologies contribute positively to operator well-being, individual responses may vary. Further research is needed to assess long-term impacts, explore integration with advanced technologies such as robotics and AI-driven decision support systems, and address the challenges associated with broader adoption.

Key words: autosteer, environmental impact, GPS guidance, operational efficiency**,** precision agriculture**.**

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Impact of Row Distance and Plant Spacing in the Row on Weeds and Yield in Spring Barley

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Abstract. The objective was to develop weed control methods that combine the weed-suppressing ability of the barley crop with harrowing, in order to achieve cost-effective and environmentally sustainable management of annual weeds in the organic cultivation of spring barley. Seeders with wide row distance reduce the wed-suppressive effect of the plant population due to poorer spatial seed distribution. This study investigated how varying row distances and plant spacings within the rows influence the suppression of annual weeds and harvest in organic cultivation of two spring barley varieties (Hordeum vulgare), Irina and Planet. The trials were conducted using a seeder from Väderstad, Rapid Turf, on a sandy loam soil at the SITES Lönnstorp Research Station in Lomma, Sweden. Mechanical weed control methods, including false seedbeds, blind harrowing, and selective weed harrowing, were applied in a randomized split-plot design. To describe how the plant population of spring barley, combined with harrowing, controlled the weeds, the ground cover of annual weeds and the crop was visually assessed. Additionally, a traditional count and weighing of the weeds were conducted. The yield level of the spring barley and its quality were also evaluated. In 2022, narrower row distance (6.25 cm) provided better weed suppression than wider distance (12.5 cm) at seed rates exceeding 230 seeds per m² for Planet and 300 seeds per m² for Irina. Weed pressure outside the trial plots was high, but within the plots, weed biomass was reduced by a factor of 10 to 40 due to the crop's competitive ability. Yield also improved with narrower row distance and higher seed rates. However, blind harrowing before emergence and selective weed harrowing after emergence reduced yield compared to plots where no mechanical weed control was applied. In 2022 yields were 8–15% higher (500–1000 kg/ha) at 6.25 cm row distance compared to 12.5 cm at a seed rate of 500 seeds per m². Even at 300 seeds per m² , yields were 2–7% higher (100–400 kg/ha) for row distance at 6.25 cm. In 2023, Irina showed increased yield with narrower rows and higher seed rates, even under dry early summer conditions on soil with good water-holding capacity. However, Planet's yield in 2023 was unaffected by row distance and declined with higher seed rates, on a soil with low water-holding capacity. Even in 2023, with the early summer drought, the narrower row distance, 6.25 cm, resulted in better control of the annual weeds. In 2024, Planet showed increased yield with narrower rows and higher seed rates, under more normal weather conditions. Yields were 4–9% higher (180-440 kg/ha) with seed rates varying from 225-475 seeds per m² . Also in 2024, we observed a positive response in controlling annual weeds by using narrower row distance in combination with an increased seed rate. In conclusion, sowing organic spring barley at 6.25 cm row distance instead of 12.5 cm at standard or higher seed rates improves weed suppression and increases yield. However, results may vary depending on soil properties, water availability, and barley variety.

Key words: Row Distance, Plant Spacing, Weeds Yield, Spring Barley.

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Effect of zeolite, clay and peat on salt stress tolerance of lettuce (Lactuca sativa L.)

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Abstract. The present study aimed to investigate the effects of natural zeolite, clay and peat amendments on the growth and NaCl absorptions of lettuce (*Lactuca sativa* L.) under gradually increasing salinity. Four different growing media based on quartz sands with 10% additions of zeolite, clay and peat were tested. The worst effect of NaCl on plant biomass was evident at the highest salinity levels for zeolite applications. While adverse salinity impact on leaf and root biomass was least pronounced in treatments with peat additives. As expected, the lowest Na concentrations in plant tissues were found in the growing media supplemented with zeolite. In the case of Cl, however, it was the opposite - lettuce leaves accumulated significantly higher chloride concentrations in the zeolite variants in salinity treatments above 20mM NaCl. In the control, clay and peat treatments, as the substrate salinity increased, the Cl level in the plant increased similarly. Adverse changes in leaf chlorophyll concentration (SPAD) and photosynthetic rate (µmol m^{-2} s^{-1}) parameter appeared under salinity concentrations above 20mM and were more pronounced in zeolite and sand substrate. According to the obtained results, peat additives can effectively mitigate the harmful effects of excessive salts by binding and immobilizing them as well as improving the water-holding capacity and nutrient availability. The study also concluded that natural zeolite successfully immobilizes cationic sodium, but the harmful effect of chlorine significantly reduced plant growth and photosynthetic performance. Clay additives to the growth medium showed the potential to reduce the adverse effects of salinity on lettuce, however, under the experimental conditions implemented, the effect was small.

Key words: sodium chloride, pot experiment, organic matter, plant biomass, photosynthesis.

Process of heat treatment and changes in garlic properties

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Abstract. This paper aims to present the results of research focused on the heat treatment of garlic (*Allium sativum*) into black garlic. The research compared three varieties of classic kitchen garlic (Dukat, Topaz and Sabagold), grown in the Czech Republic. The course of heat treatment in a hot air dryer was investigated at 60 °C. Changes in the weight and moisture of the samples were monitored gravimetrically for 78 days. The dry matter content was measured gravimetrically after drying at 105 °C. There were certain differences between the varieties studied. The intensive decrease in water content, dry basis u (g g^{-1}) during the first 20 days was the fastest in the Topaz variety, when it dropped below 0.4 (g g^{-1}) after only 9 days. In the Dukat and Sabagold variety water content, wet basis w (%), from the original values w = 62 to 66% dropped below 30% within 20 days, and in the Topaz variety below 20%. Changes in the colour of garlic cloves were measured by A CM-600d spectrophotometer. During the black garlic processing, its gradual darkening occurred. Lightness L* decreased in the Dukat variety from 80.39 to 27.47, Topaz from 78.29 to 29.09 and Sabagold from 83.64 to 28.72. In all varieties, colour changes occurred. Greenness (-a*) changed from the 9th day to a redness (a*) whose saturation gradually decreased. The yellowness (b*) of all varieties also decreased significantly.

Key words: CIELAB system, colour, garlic, heat treatment, Maillard reaction, moisture, spectrophotometer, temperature.

Advancing precision agriculture: a case study of open source autosteering with AgOpenGPS and RTKbase

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Abstract. Precision agriculture increasingly relies on Real-Time Kinematic (RTK) services to perform highly accurate tasks in the field. Robotics are gradually entering farming, demanding precise and reliable correction signals. However, before widespread adoption of autonomous field robots becomes a reality, automated tractors will remain in use for a significant period, becoming progressively more advanced. The market is currently filled with various manufacturers offering aftermarket autosteering systems, which incrementally bring farmers closer to the functionality of fully autonomous field robots. This study explores open-source solutions for cost-effective autosteering systems and RTK base stations. The project involved retrofitting a single farmer's tractor with an autosteering system and establishing an RTK base station. As the pilot progressed, word of the implementation spread, leading to the creation of a dedicated communication channel for interested farmers. This platform has facilitated knowledge sharing and further adoption. Information about the project also reached other regions, inspiring similar initiatives that have significantly increased the number of RTK base stations in just two years.
The results of this project demonstrate a strong demand for alternative solutions. Many farmers lack the financial resources to invest in expensive, proprietary systems or are unwilling to commit to recurring subscription fees. The goal remains the same, regardless of the implementation method, agriculture is moving steadily toward smarter, more precise practices and the eventual adoption of field robotics.

Key words: AgOpenGPS, autosteering, open source, Precision agriculture, RTK2Go, RTKBase.

Temporal analysis of pasture vegetation cover in central-western Brazil using remote sensing

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Abstract. Brazil is the world's leading exporter of beef, consolidating beef cattle farming as an important branch of national livestock farming. The expansion of livestock farming and agriculture in recent decades has resulted in a notable increase in pasture areas in Brazil. However, the country faces the growing challenge of pasture degradation, a problem that threatens sustainability and food production. On the other hand, livestock farming in Brazil's Central-West region, the country's largest cattle-producing area, particularly in the state of Goiás, can cause environmental damage when sustainable practices are disregarded. Thus, the objective of this article was to evaluate pasture degradation, at different levels, in the Ribeirão Serra Negra Watershed, in the municipality of Piracanjuba, Goiás, Brazil. Using images from the Sentinel-2A orbital sensor, the NDVI (Normalized Difference Vegetation Index) vegetation index and the vegetation cover classes of pastures were obtained between 2017 and 2021. During this period, the results showed that more than 98% of the areas had some level of degradation, with an average coverage of 6,586.1 ha. There was an upward evolution in the levels of vegetation cover between 2017 and 2019, with the best pasture conditions predominating in 2019. These assessments help identify areas that require greater attention and often necessitate conservation practices and management plans. In this context, monitoring degraded areas is a practice that facilitates the improvement of existing pastures, promotes the rational management of inputs, conserves natural resources, and aligns with development programs focused on sustainability.

Key words: livestock grazing, pasture quality degradation, remote sensing, sustainable, vegetation indices

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Correlation of changes in the protection factors of Nicotiana tabacum plants under the influence of insertion and expression of heterologous transgenes

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Abstract. Plant adaptation to various stressors necessitates specific defense mechanisms to be present and operational. Genetic engineering facilitates the expedited acquisition of new quantitative or qualitative traits in plants. Nonetheless, many facets of the transformation process itself, particularly regarding intracellular physiological and biochemical mechanisms, remain inadequately understood. Specifically, the process of transgene insertion and expression can influence the accumulation of organic compounds that play a crucial role in the metabolism and adaptive characteristics of plants, including carbohydrates. Sugars enhance the resilience of proteins against various physical and chemical stressors that may lead to their coagulation. Consequently, sugars are significant in frost, drought, and salt resistance, primarily due to their role in stabilizing protein molecules. Another critical factor in preserving cell integrity and its interaction with environmental conditions is the fatty acid composition of membrane phospholipids. Desaturases, which are enzymes that facilitate the formation of double bonds in fatty acids, convert saturated fatty acids into unsaturated ones. This natural process enhances the quality of a plant's resistance to various abiotic stressors. However, the transfer, incorporation, and expression of transgenes may yield both beneficial and adverse effects. This study examined the levels of polyfructans and variations in fatty acid ratios in tobacco plants expressing genes of diverse origins and characterized by distinct substrate specificity. The model organismchosen for this research was the tobacco plant Nicotiana tabacum. The study included wild-type N.tabacum as well as transgenic plants expressing either the desA gene (which encodes for Δ12-acyl-lipid desaturase from the cyanobacterium Synechocystis sp. PCC 6803), the desC gene (encoding the Δ9-acyl-lipid desaturase from the cyanobacterium Synechococcus vulcanus), or the HuINFα-2b gene (which encodes the recombinant human interferon alpha-2b). Notably, the transgenic plants exhibited no morphological differences when compared to the control plants. The levels of polyfructans and changes in the fatty acid profile were assessed under standard physiological conditions and following exposure to low-temperature stress (0°C for 20 minutes and -5°C for 60 minutes). Under normal conditions, the polyfructans content was highest in plants expressing the HuINFα-2b gene, while wild-type tobacco plants displayed lower sugar levels, and the plants with desaturase transgenes had the lowest levels. Following hypothermic stress, both wild-type tobacco plants and those expressing the interferon gene exhibited increased sugar accumulation. Prior to cold exposure, the fructans content in control plants was measured at 7 ± 0.57 mg/g of fresh weight, which increased to 15 ± 1.28 mg/g after low-temperature exposure. Similarly, in plants with the interferon gene, fructans accumulation rose from 15 ± 0.63 mg/g to 22 ± 3.21 mg/g. Conversely, plants expressing the cyanobacterial desaturase genes showed no statistically significant changes in sugar accumulation. Post-freezing stress, the fatty acid composition altered in tobacco plants with the interferon transgene. The proportion of palmitic acid rose (from 64.35% to 66.83%), while the levels of stearic acid (from 23.35% to 22.586%) and linolenic acid (from 12.3 to 10.579%) decreased. Overall, a reduction in total fatty acid content was noted, likely linked to mechanical damage incurred by stress (such as cracks and tears) and loss of cellular fluid. No significant differences were observed in wild-type tobacco. Tobacco plants containing transgenes for cyanobacterial desaturases from Synechocystis sp. PCC 6803 and Synechococcus vulcanus also exhibited changes in fatty acid composition. In plants expressing the desA gene, palmitic acid content decreased from 46.81% to 38.187%, along with reductions in stearic (from 16.29% to 4.966%) and linoleic acid (from 1.8% to 0.91%), while linolenic acid increased from 35.09% to 55.93%. In plants with the desC gene, similar trends were observed, with oleic acid levels decreasing from 21.45% to 19.57% and linolenic acid increasing from 15.8% to 17.586%. The findings of this study indicate a correlation between the introduction and expression of transgenes and the outcomes of two plant defense mechanisms: the accumulation of polyfructans and an elevation in the proportion of unsaturated fatty acids. In plants expressing the cyanobacterial desaturase gene, the desaturation mechanism was activated, resulting in alterations in the fatty acid profile. Conversely, control plants and those with the human interferon gene demonstrated changes in polyfructans accumulation levels. Overall, the dynamics of polyfructans accumulation in response to temperature variations appear to be influenced by the substrate specificity of the proteins encoded by the transferred genes.

Key words: abiotic stress, polyfructans, acyl-lipid desaturases, Nicotiana tabacum.

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Dual-camera visual odometry for high precision plant treatment machines

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Abstract. With recent developments of interrow and plant-level precision crop management (sowing, thinning, spraying, pests and weed fighting etc.) a need for precision motion estimation emerges. Usually, millimeter level precision relative to treatment object is necessary. A typical closed loop workflow consists of detecting situation in treatment area (e.g. with image sensor), finding objects of interest, transforming coordinates to real world, positioning end-effector and making actual treatment. To increase effectiveness and throughput of the machine movement on field should be as fast as possible. Thus, all the actions should be performed on the fly, when camera sensor and end-effector are constantly moving over treatment surface. Such process is common for most of prototype and commercial precision mechanical weeders, laser weeders, precision sprayers, gas burners and other equipment. These machines can be in form of autonomous robot or tractor-mounted implement. Image sensor and treatment unit cannot be placed physically at the same place. This implies, that image sensor detection area and treatment unit end-effector workspace may not overlap and the machine should move before treatment of captured area can take place. For a continuously moving machine treatment unit will change its position relatively to object of interest captured by camera during this time and this movement should be taken into account in order to accurately perform treatment procedures. Solution would be to make end effector always visible in camera so its position could be adjusted, but this approach may take more computing resources and getting worser with increase of moving speed of the machine. Moreover, this is not always technically feasible. Odometry can be used to track distance covered between image capture and position, where end-effector can begin treatment. A standard solution is speed wheel with precise enough encoder. A serious issue with speed wheels is their reliability in agricultural applications on different soils and soil conditions. They can build up mud, block, slip, jump from larger bumps and thus loose precision. Also, precision is affected by swings of tractor implement giving additional translation and rotation components for treatment unit trajectory and single dimension speed wheel cannot measure them. Displacement is successfully measured using non-contact means in other applications, for example for UAV (Unmanned Areial Vehicles) in GPS denied environment. Camera and height sensor (e.g. laser time of flight) information is used. At first pixel motion is calculated on series of images using some optical flow algorithm. Then pixel motion is converted into real world units by knowing distance to captured object obtained from range sensor. This is referred as monocular visual odometry method. Also, there is a stereo visual odometry approach with using two cameras and calculating distance to object on images by differences on two image sensors, thus range sensor is not necessary up to distances where stereo effect takes place. This is mostly used in autonomous vehicles and robots. In the case of an agricultural machine moving close to the ground the main challenge is dealing with surface unevenness, where height of bumps and pits is relatively large in comparison to distance to the camera limiting monocular visual odometry. Computing resource demanding stereo visual odometry in its turn may be too slow to track fast moving pixels. In this study a new approach of using two downward-looking cameras at different heights (different coordinates on Z-axis) is proposed. Each camera is capturing a small spot from ground surface avoiding unevenness, then calculates its optical flow for full image. Lower camera will always have larger pixel motion compared to higher. Difference in motion as well as known height difference is used to calculate camera displacement over two axes in real world units. The main novelty in this approach is eliminating any external height measurement sensor as it would be for monocular visual odometry solution and resource consuming feature matching algorithms in the case of stereo visual odometry. Exact mutual camera position on X and Y axes is not important as long as it stays constant and even surface of the same height is captured on both cameras. Virtual and real word experiments prove this method to be success.

Key words: plant level treatment, visual odometry, optical flow, motion estimation, biological agriculture.

Carbon and nitrogen accumulation by agricultural crop residue under three cropping systems

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Abstract. Agricultural crops produce different biomass during their growth, including varying amounts of residue which accumulate a significant amount of carbon (C) and nitrogen (N). Assimilation capacity depends largely on species, variety and growing condition. Carbon accumulation in soil contributes to both – the agricultural production and maintenance of environmental quality reducing atmospheric C and greenhouse gas emissions. In this study, the amount of plant residue left on the field by above-ground and below-ground residue and the amount of C and N accumulated in them in three different cropping systems: organic (Bio); integrated with a low input of N fertiliser (Int-low-N) and; integrated with a high input of N fertiliser (Int-high-N) were evaluated. The most commonly grown cereal crops in Latvia were tested: winter wheat (WW); summer wheat (SW); winter rye (WR); winter triticale (WT); summer barley (SB); summer oat (SO); and buckwheat (BW) as pseudo-cereal crop. The highest biomass of dry matter of total harvest residue in all cropping systems was recorded in WR: 853.3±40.76 g m^{-2}; 1482.0±105.06 g m^{-2}; 1628.3±115.49 g m^{-2} – in Bio; Int–low–N; Int–high–N cropping systems, respectively. The highest amount of carbon (g C m^{-2}) using organic cropping system was accumulated by residue of: WR (268.6±28.68), BW (239.4±10.50) and WW (234.5±27.41). The highest amount of carbon (g C m^{-2}) using integrated cropping system was accumulated by residue of: WR – 473.8±64.9; 496.6±62.54 and WT – 458.2±32.57; 521 1±46.26 in Int–low–N and Int–high–N, respectively. Higher proportion of root biomass cereals formed using organic cropping system.

Key words: above-ground and below-ground residue, cereal crops, integrated cropping system, organic cropping system.

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Influence of Conservation Farming Practices on Soil Stability and Fertility

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Abstract. Soil degradation caused by intensive agricultural practices poses a significant challenge to sustainable agriculture and global food security. Conservation farming, which involves minimal soil disturbance, maintaining permanent soil cover, and diversifying crops, offers a promising solution to mitigate soil degradation while enhancing soil health and resilience. This study combines findings from long-term field experiments conducted from 1999 to 2023 to evaluate the effects of conservation farming practices on soil stability and fertility. The experiments on loamy soils under varying climatic conditions compared conventional tillage systems with no-till systems and different straw management techniques, providing valuable insights into their impacts on soil properties. The primary objective of this research is to investigate how conservation farming practices enhance soil's physical, chemical, and biological properties. Key parameters analysed include soil bulk density, pore size distribution, water retention capacity, nutrient availability, and microbial diversity. The results indicate that conservation farming significantly improves soil aggregate stability, increases organic matter content, and optimises nutrient cycling, contributing to higher soil fertility. These practices also enhance the content of mesopores and macropores, which are critical for water infiltration and retention, making soils more resilient to climatic stressors such as drought and heavy rainfall. Long-term experiments revealed that no-till systems combined with straw retention promote higher water retention across all soil depths, especially in the upper 5–10 cm layer. These systems also demonstrate reduced soil erosion and compaction, as improved bulk density values and increased biological activity indicate. Additionally, integrating diversified crop rotations further enhances microbial diversity, creating a stable environment for essential soil microorganisms that support nutrient cycling and plant growth. In conclusion, this study provides comprehensive evidence of the positive impacts of conservation farming on soil stability and fertility. The integration of long-term empirical data underscores the potential of these practices to serve as a cornerstone for sustainable agricultural development. The findings contribute to the scientific understanding of conservation agriculture and offer actionable recommendations for its broader adoption, addressing the dual goals of productivity and environmental sustainability.

Key words: Conservation farming, soil stability, soil fertility, long-term experiments, sustainable agriculture.

Effect of changing fertilization system on winter wheat grain quality

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Abstract. From both environmental and economic perspectives, the regulation of nitrogen resource use has become. increasingly significant. One promising strategy for enhancing the fixation of freely available biological nitrogen in nature is the application of airborne nitrogen-fixing microorganisms residing in the soil. This study aimed to evaluate whether microbiological preparations capable of fixing free nitrogen, such as Azotobacterin, could reduce the reliance on synthetic nitrogen without compromising crop yield and to assess their impact on harvest quality. The research was conducted at the Institute of Agricultural Resources and Economics on Endoluvic Stagnosol (Loamic) soil (WRB, 2014), representative of typical soil quality indicators in the Vidzeme region. Trials were carried out, focusing on winter wheat ('Skagen') fertilization practices. Nitrogen doses ranged from N140 to N220. In each variant, up to 50 kg of synthetic nitrogen was replaced with the microbiological preparation Azotobacterin. Yield data revealed that across all tested variants, replacing 50 kg of synthetic nitrogen with the microbiological preparation maintained equivalent yield levels. However, the effect on yield quality indicators, such as 1000-seed weight, volumetric weight, and protein content, varied significantly across the two study years. These results highlight the potential of microbial preparations that fix free nitrogen in the soil to support sustainable nitrogen management, while highlighting the strong influence of environmental and other external factors on crop quality.

Key words: Sustainable food production, Nitrogen, Microbiological preparations, Winter wheat, Grain quality.

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Review: Unmanned Aerial Vehicles and Artificial Intelligence in Precision Agriculture

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Abstract. To meet the needs of sustainable intensification in crop and animal production, farmers use a set of technologies which are referred to as Agriculture 4.0 to 5.0 or digital agriculture. Differences compared to traditional precision farming techniques are in extensive use of UAV, smart sensors implemented in machines, crops, animals and in the soil, cloud computing, IoT, together with extensive use of AI for data analyses. Unmanned Aerial Vehicles (UAV), also called drones, have become an essential tool in digital agriculture. UAVs have witnessed remarkable development in the past decades and so in the recent years, the topic of agricultural UAVs has gained the attention of many farmers. The submitted paper provides a review on recent scientific literature dedicated to the utilization of agricultural UAVs. The utilization areas are reviewed in monitoring (remote sensing), interventional applications of various inputs, and other areas of possible utilization. The novelty of this review highlights the importance of the integration of UAVs with artificial intelligence (AI) and the Internet of Things (IoT). Sophisticated artificial intelligence and machine-learning algorithms are developing to analyse UAV-collected data, enhancing the accuracy and efficiency. Machine learning models in combination with artificial intelligence are capable of yield prediction and crop management, effecting future decision-making processes. Several key opportunities can be identified for future research, including the development of more sophisticated decision-making processes and machine learning methods based on artificial intelligence, the automation of agricultural crop production, improved UAV autonomy, and the potential use of UAV swarms in different field operations.

Key words: artificial intelligence; drone; precision agriculture; unmanned aerial vehicle; unmanned aerial spraying system.

VII PRODUCTION ENGINEERING

Analysis of Feed Force in Drilling of Structural steel S355JR

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Abstract. The analysis of forces arising during drilling is a critical research area aimed at improving hole quality, optimizing tool life, and reducing costs in industrial cutting processes. This study focuses on measuring and analyzing feed forces during drilling with different diameter twist drills. The research employed a CNC milling machine Haas Minimill and a Kistler Multichannel Charge Amplifier measuring device to record forces during three drilling phases: entry, cutting, and exit. The experiments examined two twist drills of different diameters (6 mm and 10 mm), made from HSS and HSS-Co materials. Measurements were conducted under varying feed rates and cooling conditions. The results revealed that drilling forces increased with rising feed rates, while the use of cooling reduced tool wear and improved hole quality. Lower speeds were found optimal for HSS drills, whereas HSS-Co drills enabled efficient cutting at higher speeds. Chip analysis highlighted that ideal chips should be short and discontinuous to prevent the formation of longer spirals, which could disrupt the drilling process. Additionally, regulating feed rates during the entry and exit phases of drilling was found to help reduce forces and tool wear. The study's results provide significant contributions to the optimization of drilling processes, enabling greater efficiency in industrial operations and cost reductions. Future research could focus on drilling more complex materials, such as composites, tungsten carbides, and Hardox, as well as analyzing the impact of vibrations.

Key words: Drilling forces, feed rate, HSS, HSS-Co, chip analysis.

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VIII VEHICLES AND FUELS

Analysis of charging capacity for electric vehicles in soviet-era apartment districts from the perspective of substation power availability

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Abstract. In this article a Soviet-era substation (Lammi substation) is evaluated to see if it could accommodate the rising demand for electric vehicle (EV) home charging in a densely populated residential area. The main aim was to quantify whether the existing transformer would reliably support charging at least one EV in each of its 360 apartments. The study employed hourly electricity consumption data for one year, and performed analyses with three different EV charging scenarios: dynamic load management based on weekly peak load, fixed nighttime load management, and dynamic load management supporting all units. Results revealed statistically significant differences between scenarios. New dynamic load management based on a weekly peak power supported up to 96 EVs on a weekly basis. A fixed nighttime load management, limited to 90% of the substation's rated capacity, could accommodate about 218 EVs. For approximately 242 kVA, a minimum transformer capacity was needed to dynamically manage the load for all 360 apartments. Your results give important infrastructure needs and practical lessons learned for network operators and with housing associations. The team found that if load management strategies are tailored to local conditions, it's possible to integrate EV charging into the current electrical grid efficiently and without immediate, large-scale upgrades to existing infrastructure.

Key words: charging, electric vehicles, load management, residential charging, substation capacity.

Climate impact on electric vehicle energy consumption in the baltic region

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Abstract. Electric vehicles (EVs) have seen increased interest in recent years as a lower-emission alternative to internal combustion engine (ICE) vehicles, with much of their growth driven by government subsidies and incentives across Europe. However, as these incentives have slowed, the EV market faces new challenges, particularly in the Baltic countries where the climate significantly impacts EV performance. Low temperatures, common in Baltic weather, can notably affect EVs' range and energy efficiency, influencing operational costs and user satisfaction. Understanding how Baltic weather conditions, primarily temperature, influence the energy consumption of EVs is essential to gaining a deeper understanding of their efficiency in low temperatures and harsh weather conditions. The main aim of this study is to assess the impact of varying weather conditions on EV energy consumption, providing valuable insights into their efficiency under cold and variable climatic conditions. The primary goal is to identify the factors most responsible for increased energy consumption in these conditions. In this study, a series of controlled real-world driving tests were conducted, during which an EV (Nissan Leaf) was driven multiple times along identical routes under different weather conditions. The temperatures during these tests ranged from 20°C to -15°C. The 2024/2025 winter season was unusually warm in the Baltic region; therefore, tests could not be conducted at lower temperatures. Variables such as distance, temperature, battery state, and the use of accessories were recorded and subsequently analysed. Additionally, energy losses during EV battery charging were measured and evaluated. The collected data was analysed statistically, and mathematical models were developed to provide accurate predictions of battery usage under varying ambient temperatures. The results indicate that low temperatures increase EV energy consumption due to the additional energy required for battery and cabin heating. A more detailed analysis reveals that the most significant increase in energy consumption occurs at an ambient temperature of -10°C. Overall, this study demonstrates that Baltic weather conditions can lead to a substantial decrease in EV range and efficiency, with low temperatures being the most impactful factor. By providing real-world data, this study contributes to a deeper understanding of EV efficiency in the Baltic region, offering practical insights for EV users and researchers.

Key words: Baltic climate, electric vehicle, energy consumption, range efficiency, real-world driving tests.

Performance and emissions of an agricultural diesel engine with hydrogen injection under different load modes

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Abstract. Excessive use of fossil fuels in transport sector in the last decades stimulated rise in global energy consumption in such way leaving harmful effects on human health and environment. The scale of decarbonization of transport sector in the next decade could be challenging for European Union (EU) as demand for renewable energy, like wind, solar and hydro, will definitely rise. The aim of this study is to find whether hydrogen could be optimal solution for emission reduction in agricultural machinery. In this regard, research was carried out with KOHLER KDI 1903 M diesel engine looking on main performance parameters, as also regulated emissions operating engine with conventional diesel fuel and different hydrogen injection volumes under different loads. Fuel consumption was measured with AVL KMA Mobile device, while emissions was determined using AVL SESAM FTIR exhaust gas analytical system. During the tests, it was observed that the addition of a higher hydrogen concentration provides more substantial benefits that includes a larger impact on fuel consumption and carbon dioxide (CO_2) emissions. Other emissions such as carbon monoxide (CO) emissions had smaller but positive impact, while the addition of hydrogen gas had various impact on nitrogen oxide (NO_x) emissions. At the same time decrease in particulate matter (PM) emissions was observed with higher hydrogen concentrations and more substantial impact was observed during higher load conditions and higher hydrogen concentration.
Key words: diesel engine, emissions, hydrogen addition, performance, torque.

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IX RENEWABLE ENERGY

Development and Validation of a Methodology for Studying the Tilt Angle of Solar Photovoltaic Panels

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Abstract. With the development of alternative energy technologies, energy production from renewable sources is gaining wide application. One of the types of renewable energy sources is solar power. In the last 5 years, solar cells have become very popular for both private electricity microgeneration and large power plants. There are mostly two options for installing solar photovoltaic panels: on the roof of a house or the ground – on specially made frames. When installing solar cells on the roof, it is not always possible to choose a tilt angle that is appropriate for all seasons, since the angle is mainly adjusted to the plane of the roof. When installing solar cells on the ground, it is usually possible to choose both the orientation relative to the cardinal points and the tilt angle relative to the ground. There are various theories about the best tilt angle of solar cells for producing the most energy during the year. Therefore, the aim of the present research study is to develop an original research methodology for determining an optimal tilt angle for solar cells. The research study examined six different tilt angles of solar cells, 0°, 30°, 35° 40° 45° and 50°, orienting the cells towards the south. The research study used 18 identical monocrystalline solar panels with a power of 20 W. Three solar panels were set at each angle. In this way, the experiment had three replications at each angle of solar cells. The measurements were recorded by a GWL840 data logger with an interval of 10 s. The experiment was conducted by placing all solar cell modules on the roof of the building at Lat. 56.66181° and Long. 23.75238°.

Key words: photovoltaic, angle of installation, optimal angle, efficiency, experimental evaluation.

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X FOOD SCIENCE AND TECHNOLOGY

Assessment of consumer awareness regarding the implementation of innovative food packaging

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Abstract. Food packaging fulfills many practical functions. They protect against harmful external factors and facilitate transport, distribution on the market, and storage of products in households. They also provide information on food products' type and composition, preparation method, and shelf life. The important role played by packaging contributes to their continuous improvement. An example of this improvement is the implementation of innovative solutions, including active and intelligent packaging. The question remains whether consumers know about these innovative facilities and whether they use them. In search of an answer to this question, a survey was conducted on 210 respondents in the Mazovian region (Poland). The survey aimed to assess consumer knowledge and awareness of active and intelligent food packaging. The study was conducted using the CAWI (Computer-Assisted Web Interview) method. As many as 79% of respondents did not know the term active packaging. It was similar in the case of intelligent packaging – 79% of respondents did not know this type of packaging. Respondents also showed a low level of knowledge regarding the different types of inserts in active packaging and examples of benefits offered by intelligent packaging. The survey results suggest the need to disseminate knowledge and benefits related to active and intelligent packaging.

Key words: active packaging, consumer awareness, intelligent packaging, respondents, survey.

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The Impact of Storage Conditions on Acrylamide Formation in Vegetable-Based Products

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Abstract. The aim of this study was to identify the most commonly cultivated potato, carrot, beetroot, and pumpkin varieties in Estonia and assess acrylamide formation after storage and processing. Data collection involved queries to crop cultivation organizations, farmers, food enterprises, and Statistics Estonia. This resulted a ranking of the most cultivated varieties in Estonia. Selected vegetables were stored at 3 °C and 8 °C for six months, followed by heat treatment to produce vegetable crisps and purees. For vegetable crisps, vegetable slices were fried at 175 ºC for 5 minutes, while purees were prepared using a food processor and autoclaved at 120 ºC for 30 minutes. Acrylamide analysis was performed at the Health Board Tartu Laboratory using an accredited LC-MS/MS method. Sample extraction was conducted using the QuEChERS method. The acrylamide detection and quantification limits (LOD 10–17 µg/kg, LOQ 30–50 µg/kg) were determined based on the food matrix, with an expanded uncertainty of 20%. The results showed that acrylamide levels varied significantly depending on the vegetable variety and processing method. Fried potato products made from varietis with lower reducing sugar content remained below the EU benchmark values, while those with higher reducing sugar content exceeded these values. In potato chips, acrylamide levels exceeded the benchmark regardless of the reducing sugar content. Among vegetable-based crisps, the highest acrylamide levels were detected in carrot crisps, followed by high-sugar potato crisps. For purees, the lowest acrylamide concentration was found in a puree made from the pumpkin variety Gold Medal, where levels were below the quantification limit. In contrast, purees made from the Big Mac pumpkin variety and other vegetable purees exceeded the EU reference values (40 µg/kg) for baby food. We found that storage conditions significantly influenced acrylamide formation. Potatoes stored at 3 °C accumulated higher reducing sugar levels, leading to increased acrylamide formation during heat processing. For example, after six months of storage, potato puree from the Birgit variety contained 686 µg/kg acrylamide when stored at 3 °C, compared to 221 µg/kg when stored at 8 °C. A similar trend was observed in the potato Laura variety, where reducing sugar content was 1.5 times higher in potatoes stored at 3 °C compared to 8 °C, resulting in a 1.4 times higher acrylamide level in the processed puree. High increase in acrylamide content was seen for carrots stored at 8 °C, which led to increased reducing sugars and increased acrylamide formation, particularly in the Berlin variety (1354 µg/kg). These findings emphasize the importance of selecting suitable storage temperatures and vegetable varieties to minimize acrylamide formation in processed products, especially for vegetable based infant foods. Further research is needed to optimize storage conditions and

Key words: acrylamide, storage conditions, reducing sugars, processing, vegetable-based foods.

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Sensory assessment and consumer acceptability of confectionery products made with pine cones

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Abstract. The non-timber part of the forest includes mushrooms, berries, cones, shoots etc. The aim of this study was to evaluate consumer acceptability of confectionery products made with pine cones. For the study two pine cone syrups using osmosis were prepared: pine cone syrup with white sugar (PSW) and pine cone syrup with brown sugar (PSB). Four jams were prepared: apple - pine cone jam without added sugar (AC), pine cone jam with white sugar (CW), pine cone jam with brown sugar (CB), and pine cone jam with stevia (CS). Also, four gummy candies were prepared using different thickeners - gelatine (CG), pectin HM (CpHM), pectin LM (CpLM), and agar - agar (CA). To all products sensory evaluation was performed. In total 23 participants participated in this study. The results showed that the PSW had the most intense colour, aroma, taste, and aftertaste, the sweetness in both syrups was the same. The obtained data for jams showed that the CB and AC was the most pleasant in terms of colour, while the CB and CS was the most pleasant in terms of consistency. For the gummy candies' colour and texture, the highest rated were CpHM. However, for the aroma, taste and aftertaste, the highest acceptance was found in CG. In conclusion, healthier confectionery products with reduced sugar content can be effectively developed by using a non-timber forest resource such as pine cones. This approach allows manufacturers to create confectionary products that satisfy consumer demand for enjoyable sweetness while addressing health concerns.

Key words: gummy candies, intensity test, jams, JAR test, stevia.

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Attitudes of organic food supporters and neutral consumers toward organic school meals

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Abstract. Background: The rising popularity of organic food has sparked important discussions regarding its benefits and implications, particularly in school nutrition. As parents seek healthier dietary options for their children, understanding their attitudes toward organic school meals is essential. Aim: This study aimed to compare the attitudes of parents with school-age children in Tartu toward organic food, particularly in schools, and their willingness to spend extra for it. Methods: A prospective cross-sectional survey was conducted among parents of schoolchildren enrolled in general education schools in Tartu. An electronic questionnaire collected responses from 483 participants (♀=429, 88.82%, average age 42.35). Statistical analysis was performed using t-tests and Chi-square tests. Results: One-third of respondents (n=167) identified as regular organic food consumers (OFR), consuming organic food at least 2–3 times per week or whenever possible. Nearly half (47.4%) believed that organic products are healthier, with a significantly higher proportion among OFR compared to non-regular consumers (OFN) (71.86% vs. 34.49%; $p<0.001$). Financial considerations played a crucial role in purchasing decisions. While 64.18% of respondents reported being satisfied with their economic situation, 3.52% faced serious financial difficulties. Interestingly, higher-income participants showed a stronger preference for organic food, suggesting that willingness to purchase organic may not be solely cost- dependent. OFR were significantly more willing to pay extra for organic school meals compared to OFN (89.22% vs 55.06 %; $p < 0.001$). However, despite differences in attitude, both groups preferred the variety, nutritional value, and taste over the exclusive provision of organic products in school meals. Conclusions: Regular organic food consumers had a more favourable attitude toward organic school meals, but overall meal quality was the primary concern for all parents. These findings suggest that efforts to improve school nutrition should focus on enhancing variety, nutritional value, and taste rather than solely promoting organic options.

Key words: organic food, parental attitude, school meal, consumer behaviour, school children.

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The impact of plant protein concentrates and exopolysaccharide-producing starter cultures on the properties of plant-based yoghurts

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Abstract. Growing consumer awareness of the environmental and health impacts of food production has driven a shift away from animal-based products, leading to the emergence of a wide variety of plant-based dairy alternatives. These products aim to closely mimic the sensory attributes of traditional dairy, but the primary challenge lies in the structural and functional disparities between plant and milk proteins, often resulting in lower viscosity in plant-based yoghurts. Enhancing the viscoelastic properties of these alternatives is possible through the use of exopolysaccharide-producing (EPS) lactic acid bacteria (LAB) strains and plant protein concentrates, which serve as alternatives to conventional hydrocolloids. This study investigated the effects of EPS-producing LAB and plant protein concentrates on the physicochemical and sensory characteristics of plant-based yoghurts. A commercial oat drink, two LAB starter cultures, and hemp and sunflower protein concentrates were used to prepare the plant-based yoghurt samples. Protein concentrates were added at concentrations of 1.5% and 3%. The samples were analysed for pH, titratable acidity, dry matter, dissolved solids, water activity, organic acids, colour, viscosity, and sensory properties. The results indicated that sunflower protein-containing yoghurt alternatives exhibited statistically significantly lower pH and higher titratable acidity ($p<0.05$), compared to hemp protein samples. Lactic acid was the predominant organic acid (3.6–11.4 g kg-1), with slightly higher concentrations in sunflower protein samples, although the difference was not statistically significant ($p>0.05$). Viscosity differences among sunflower protein samples were also not statistically significant ($p>0.05$). However, hemp protein samples fermented with high-EPS-producing LAB cultures showed significantly higher viscosity ($p<0.05$). Sensory analysis revealed visual similarity across all samples, with distinct sourness and sweetness profiles. Sourness was most pronounced in sunflower protein samples, while hemp protein samples exhibited significantly greater viscosity and elastic consistency compared to their sunflower-based counterparts. In conclusion, EPS-producing LAB and oilseed protein concentrates provide promising options for developing oat-based yoghurt alternatives. Nonetheless, further optimization of sensory and rheological attributes is required to improve product quality.

Key words: oat drink, hemp protein concentrate, sunflower protein concentrate, exopolysaccharides, lactic acid bacteria.

Assessment of microbiological safety and quality of plant-based meat alternatives

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Abstract. The shift from animal-based proteins to plant-based alternatives has gained significant momentum in recent years, largely driven by a combination of environmental, health, and animal welfare concerns. The global plant-based food market, which encompasses alternatives to meat, dairy, eggs, and other animal-based products, was valued at approximately 27 billion euros in year 2022. This market is expected to reach around 46 billion euros by 2027. This study aimed to assess the microbiological safety and quality of plant-based alternatives purchased from Estonian retail level within 8-months period in 2024 and 2025. Studies will further continue up to the year 2027. Sampling was done on a monthly basis and each month ~15 samples were analysed. Microbiological analyses were following ISO standard-based protocols and the following analyses were performed: enumeration of colony count at 30 °C, yeasts and molds, Escherichia coli, Clostridium spp. And Bacillus cereus. Additionally, both detection and enumeration of Listeria monocytogenes and Listeria spp. was performed. Altogether 115 alternative product samples were analysed in the mentioned study period. Our preliminary results show that alternative products are of high microbiological quality and safety. Within the study period all of the samples were negative for L. monocytogenes, Listeria spp. and E. coli. This can be explained with ultra-processing technologies often used for alternative products. Also, the use of high pressures and high temperatures in the production of plant-based alternatives is a common practice and is directly associated with bactericidal effect. High pressure processing will reduce the microbial load on plant- based alternative products, preventing contamination by foodborne pathogens such as L. monocytogenes Salmonella and E. coli. However, spore-forming bacteria are particularly resistant to high temperatures. The primary spore-forming microorganisms of concern in food safety include Clostridium species and Bacillus species (e.g. Bacillus cereus). According to our results Bacillus spp. was found in 15.6% of products (n=19), with average concentration of 1.04 x 102 cfu/g. Out of all tested samples (n=115), Clostridium spp. Was under the detection limit (10 cfu/g) in 80% (n=92) of samples. The average concentration of Clostridium spp. was 2.1 x 101 cfu/g (n=23). Aerobic plate count (APC) was under detection limit, 100 cfu/g, for 12.2% of samples (n=14). The average concentration for APC was 7.2 x 103. The concentration for yeast and molds was 5.2 x 103 cfu/g (n=35). The analyses of yeasts and molds resulted with under detection limit (10 cfu/g) in 69.6 % (n=80) of samples. The preliminary results show the presence of some pathogenic bacteria, but in low concentrations in plant-based meat analogues. However, there is need to strictly follow HACCP principles and prerequisite programs, especially food hygiene rules to avoid cross-contamination at post heat treatment processing steps. Our studies continue and will additionally include the most essential chemical hazards in plant-based alternative products.

Key words: Plant-based meat alternatives, ready-to-eat products, Bacillus, microbiology, food safety.

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Evaluation of biological value of high-protein ice cream based on camel milk

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Abstract. The camel (Camelus Bactrianus) is a versatile domesticated ruminant widely distributed in several countries in the world, including the Republic of Kazakhstan. In this work, the chemical composition, including amino acid composition, of camel milk (from camels Camelus Bactrianus), obtained from the western and southern regions of the Republic of Kazakhstan, was investigated as a source of high-quality protein for the production of high-protein milk based on it. Camel milk was obtained from 2 regions of the Republic of Kazakhstan, such as West Kazakhstan and Kyzylorda regions. The ice cream was developed by the National Standard of the Russian Federation (NSRF) 55577-2013, which ensured at least 20% of the product's energy value due to protein. Developed recipes of high-protein ice cream demonstrated the high biological value of the protein component of the product in comparison with the FAO WHO reference protein, 2011. Calculations were carried out using both well-known methods (amino acid score method, %) and unique calculation methods (coefficient of difference in amino acid score; biological value; coefficient of composition rationality, etc.) with evaluation of data according to the desirability function E.K. Harrington.

Key words: Camel milk, Biological value, ice cream, high-protein ice cream, protein.

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Extraction of bioactive compounds from Highbush blueberries (Vaccinium corymbosum L) using water-based extraction techniques

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Abstract. Because of the increasingly aging world population, disorders like cardiovascular diseases, metabolic syndromes, and neurodegenerative conditions such as dementia and Alzheimer's disease are projected to increase. These health challenges are particularly relevant in developed nations where sedentary lifestyles and unbalanced diets are prevalent. Oxidative stress is known to be a contributing factor in accelerating the illnesses commonly associated with aging, therefore efficient ways to reduce the oxidative stress are needed. One of the proven ways to reduce the risk or inhibit the development of various inflammation or oxidative stress related illnesses is dietary supplementation with foods that are rich in compounds that have antioxidative properties, for example anthocyanins or other polyphenols. One of the fruit species that accumulates high amounts of anthocyanins is Highbush blueberry (Vaccinium corymbosum L.). Typical anthocyanin extraction uses traditional methods like maceration paired with toxic solvents like acidified methanol, however such extracts are extremely difficult to adapt to food industry because complete removal of chemicals is costly in both time and set up, reducing their value as a food additive despite their high polyphenolic content. The use of the Green Solvents can be a solution to this problem. The cheapest and easiest green solvent for food applications to foods is of course water, but water traditionally is a very poor solvent choice for anthocyanin extraction because of low anthocyanin solubility in non-acidified water. However, it may be possible to increase the anthocyanin yield with the use of innovative extraction methods like Ultrasound Microwave Assisted Extraction (UMAE) and Rapid Solid-Liquid Dynamic Extraction (RSLDE). The aim of this study is to compare the total phenolic content and total anthocyanin content in extracts obtained using UMAE and RSLDE extraction methods using water as a solvent for extracting anthocyanins and lay the foundation for further optimization of anthocyanin extraction from V. corymbosum. Fresh V. Corymbosum 'Hortblue Poppins' berries were frozen and kept until extraction in -30°C. To prepare for the extraction berries were homogenized using a food processor Thermomix TM5 (Vorwerk, Germany). After homogenization, the samples were weighed and fastened in filter bags with 0,45 µm pores prior to extraction. Deionized water was used as a solvent. For RSLDE extraction device Naviglio Extractor mod. 2000 cc (Atlas Filtri Engineering, Italy) was used. Cyclical pressure was set to 9 bar and the extraction took 16 hours to complete. UMAE extraction was performed using E200 Ultrasonic Microwave extractor (IDCO, France). Ultrasonication was set to 1000 Watts for the duration of 2,5 minutes. Ultrasonication was set to 10 and 30 minutes. After the extraction all extracts were filtered using PVDF , Ø 25mm, 0,45 µm syringe filters. Total Phenolic Content (TPC) and Total Anthocyanin Content (TAC) were determined using spectrophotometer CDR Winelab (CDR Foodlab, Italy). The highest total anthocyanin and phenolic content in fresh weight were obtained using RSLDE extraction for 16 hours resulting in 50.05 mg/100 g FW and 218.35 mg GAE/100 g respectively; the lowest – using UMAE extraction with microwaves set to 2,5 minutes and ultrasonication to 10 minutes (31.9 mg/100 g FW; 108.9 mg GAE/100 g FW).

Key words: UMAE, RSLDE, Polyphenols, Anthocyanins, Extraction.

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Microbial growth inhibition by the use of selected plant powders in minced meat

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Abstract. This study aimed to evaluate the microbial growth inhibition effect of plant powders in minced pork and beef. Additionally, polyphenolic profiles of the plant powders were determined. Pomace powders of berries of blackcurrant, chokeberry, rowan and tomato were used. Additionally the powders of petioles of rhubarb, bulbs of garlic and apples were used. Apple powders were whole apples and apples without seeds. Plant material was dried at 50 °C, then the dried material was milled into a fine powder using a grinder and finally sieved to obtain a fraction of ≤1 mm. The plant powder was added at 2% (w/w) of the minced meat. Fresh minced pork with 28% fat content and minced beef with 18% fat content were used. The minced meats were purchased from a large-scale Estonian meat industry. The total phenolic content of the plant powder extracts in 60% aqueous ethanol was measured spectrophotometrically using the Folin–Ciocalteu method. Two percent of plant powders were added to the minced meats, and a mixer was used to ensure the plant powders were thoroughly incorporated. Pure minced meat was used as the control. The samples were packed in sterile screw-top cups and stored in the refrigerator at 4 ± 2 °C. All analyses were performed in duplicate on days 1, 4, 6, and 8, with additional analyses on days 11 and 14 for the rhubarb samples, which exhibited strong inhibition of microbial growth. Enumeration of aerobic mesophilic microorganisms, yeasts and moulds and presumptive Pseudomonas spp. was performed according to the ISO standards. At all time points, an estimation of pH and water activity was performed. We found that rhubarb powder in minced meat reduced the average total microbial counts by 10-fold, and the counts of Pseudomonas spp., yeasts, and molds by 100-fold compared to the control. Also, samples containing powders, such as blackcurrant, garlic, tomato and chokeberry showed lower total microbial counts than the controls. The low microbial growth inhibition effect was found for rowan berry pomace and apple powders in minced meat. Apart from organic acids, 27 distinct polyphenolic compounds from the classes of anthocyanins, dihydrochalcones, flavanols, flavonols, and hydroxycinnamic acids were tentatively identified in the plant powders. The highest number of polyphenolic compounds (n = 20), were found in blackcurrant, chokeberry and rowan berry powders, followed by rhubarb powder, which contained 16 different compounds. In the present study, rich composition of polyphenols was found in blackcurrant, which also showed good inhibition of microbial growth in enriched minced pork and beef samples. The lower pH and the presence of organic acids in samples can explain the best microbial growth inhibition effect of rhubarb powder. We suggest that plant powders with a rich composition of polyphenols can be applied for the valorization of different foods, both animal and plant-based food products.

Key words: plant powders, polyphenols, antimicrobial effect, valorization, food processing.

Acknowledgments. This work was supported by the Estonian Research Council grant PRG1441, and by the EU and Ministry of Education and Research via project TEM-TA52 „Safety and quality of high-risk plant-based foods and meat alternatives".

Assessment of opportunistic pathogen contamination in plant-based meat alternatives

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Abstract. The increasing popularity of plant-based diets has driven a rise in demand for plant-based meat alternatives, particularly ready-to-eat (RTE) products. Many plant-based meat alternatives are ultra-processed. The use of high-pressures and temperatures such as ultra-heat treatment (UHT) reduces microbial load and extends the shelf life of the product, but the potential for microbial contamination remains a concern, particularly during post-processing stages such as packaging and handling. This study aimed to evaluate the diversity of opportunistic pathogens in RTE plant-based meat alternatives available at retail outlets across Estonia focusing on pea-, mushroom-, and soybean-based products with minced or fibrous textures. Between April 30, 2024, and January 13, 2025, a total of 115 samples were analyzed. The samples were transported to the laboratory and stored at 4 ± 2 °C until analyses. For microbial analysis, 10 g of each sample was homogenized with 90 ml of sterile phosphate-buffered saline (PBS) in Stomacher bags using a BagMixer. Bacterial colonies were obtained from different media used for the detection and enumeration of Bacillus spp., Clostridium spp., Listeria spp. and aerobic mesophilic microorganisms, which all followed ISO standards. The plates were incubated at appropriate temperatures and other growth conditions. Species identification was performed from pure cultures at the National Centre for Laboratory Research and Risk Assessment (LABRIS) by using MALDI-TOF MS method. The results revealed bacterial diversity among the studied products, with several opportunistic pathogens detected in the samples. Micrococcus luteus and Micrococcus endophyticus were identified in 8 of the 115 +samples (6.96%), indicating a moderate prevalence of these organisms in the RTE plant-based meat alternatives. Enterococcus faecium was found in five samples (4.35%), while Staphylococcus hominis was detected in two samples (1.74%). Additionally, Staphylococcus warneri and Macrococcus caseolyticus were each found in a single sample (0.87%). These microorganisms, which are either opportunistic pathogens or commensals, can pose a risk to immuno-compromised individuals. Despite ultra-treatment during production, the presence of these pathogens suggests contamination may occur during slicing and packaging or other post heat-treatment handling. Additionally, some microorganisms may survive heat treatment, highlighting the limitations of UHT in preventing post-processing contamination. In conclusion, the study emphasizes the importance of strict hygiene practices during the handling, packaging, and storage of RTE plant-based meat alternatives to minimize the risk of microbial contamination. Enhanced quality control and food safety protocols are essential, particularly for protecting vulnerable consumers, including those with weakened immune systems.

Key words: plant-based meat alternatives, ready-to-eat products, ultra-heat treatment, opportunistic pathogens, food Safety.

Acknowledgments. This work was supported by the EU and Ministry of Education and Research via Project TEM-TA52 "Safety and quality of high-risk plant-based foods and meat alternatives".

Sensory, physicochemical, and techno-functional properties of alkaline solubilized-bacterially acidified pea protein isolate

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Abstract. Pea protein is widely used in the production of plant-based meat and dairy analogs, but its strong raw material flavor and bitterness limit its applications. To improve its sensory properties, various methods havebeen explored, and fermentation has shown great potential. Fermentation is typically applied either before or after protein isolation, however, fermentation during the wet isolation process is underexplored. A typical plant protein isolation method begins with alkaline solubilization, followed by gravimetric separation of the undissolved part, then a strong acid is used to precipitate the protein from the solution. But acidification can also be achieved through fermentation. Therefore, we aimed to investigate the effect of protein precipitation by fermentation with lactic acid bacteria on the sensory, physicochemical, and techno-functional properties of pea protein isolate. Three protein isolates were produced: 1) a control acidified with HCl, 2) a sample fermented with a starter culture that had a fast acidification rate, 3) a sample fermented with a slower starter culture but with a stronger ability to reduce the pea off-flavor, as determined in preliminary small-scale trials. The three samples were evaluated and compared based on protein yield and recovery, protein and total solubility, water and oil holding capacities, color, foaming capacity and stability, emulsification activity, trypsin digestibility, molecular weight distribution of proteins, free amino acids, and protein surface hydrophobicity. A descriptive sensory assessment was conducted by a highly trained sensory panel. Sample 2 completed fermentation in four hours and moderately improved sensory properties, while Sample 3 required two additional hours and exhibited the most pronounced pea flavor reduction. Notably, it decreased bitterness score from 6.1 to 2.2 on a 0–9 sensory scale. Protein recovery remained consistent across all samples, but fermented samples showed slightly decreased lightness due to prolonged heating, more peptides, free amino acids, and protein aggregates. Fermentation decreased total solubility from 74% to around 55%, but protein solubility and surface hydrophobicity changed little. The water holding capacity after fermentation increased from 0.8 to 1.5–1.7 g water/g powder, a phenomenon largely attributed to the reduction in total solubility, as the measurement method considers only the undissolved fraction, which increased. The oil holding capacity also slightly increased, from 1.65 to 1.70 g oil/g powder, and foaming capacity increased from 45% to 67–83%, while emulsification activity remained low, at around 38%. In conclusion, we demonstrated that fermentation with lactic acid bacteria can be effectively integrated into protein isolation processes, specifically for pea protein precipitation after alkaline solubilization, thereby significantly reducing undesirable flavors. The changes in sensory, physicochemical, and techno-functional properties of the pea protein isolates were contingent upon the starter culture used.

Key words: pea protein isolate, fermentation, physico-chemical properties, techno-functional properties, sensory, criteria.

Assessment of meat quality (freshness) with a simple device based on the contents of ATP breakdown products. The effect of plant materials on meat preservation

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Abstract. Plant material that could be used as a raw material for bioactive substances is usually discarded as waste from juice production. Therefore, we need knowledge about the possibilities of using residual plant material, for example, in preserving the freshness of meat during storage. The aim of the study was to evaluate the freshness retention of meats during storage in the refrigerator in the presence of various plant residues. Minced meats of chicken, pork, beef and trout were used. The plant additives were garlic (Allium sativum) bulbs, whole and seedless apples (Malus domestica); press residues of blackcurrant (Ribes nigrum) berries, chokeberries (Aronia melanocarpa), rowan berries (Sorbus sp.) tomatoes (Solanum lycopersicum), and rhubarb petioles (Rheum). The plant materials were dried at 50 °C and ground into a fine powder. The amount of powder mixed into the minced meats was 2%. The experiment lasted 14 days in a refrigerator at 4 °C. Samples were taken daily to analyze the freshness of the meat. One of the best ways to assess meat quality is to monitor the change in the breakdown products of adenosine triphosphate from adenosine triphosphate (ATP) > adenosine diphosphate (ADP) > adenosine monophosphate (AMP) > inosine monophosphate (IMP) > inosine (Ino) > hypoxanthine (Hx) > xanthine > uric acid. In AS Ldiamon, a cheap and simple device was developed to estimate the concentration of ATP and its breakdown products in meat samples. The operation of this instrument is based on well-known gel filtration principle, where the movement of smaller molecules (ATP degradation products) slows down during the run through the column. This device allows measuring the relative amounts of products that increase duringstorage. To correlate our results with information published, HPLC (Agilent 1100 series liquid chromatograph) was used as a second step to estimate the inosine monophosphate (IMP), inosine (Ino) and hypoxanthine (Hx) content of the samples. Fractions obtained by gel filtration, containing compounds below 5 kDa were stored at -20°C until further HPLC analyses. Best plant additives to keep meat freshness were press residues of tomato, blackcurrant and rhubarb. Both apples and garlic were less effective.

Key words: Meat freshness, ATP breakdown products, Meat preservation, Plant residues.

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Total phenols and anthocyanins content and sensory properties of non-alcoholic beer with frozen berries

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Abstract. Beer is one of the most popular drinks in the world after water, tea and coffee. The market of non-alcoholic beers nowadays is growing mainly because driving-drinking rules, religious and health reasons. However, consumers are not satisfied with the taste of non-alcoholic beer. Therefore, is important to adjust the aroma and taste of non-alcoholic beverages. Non- alcoholic beer aroma and flavor can be improved by adding some additives. The most popular additives in beer production are honey, aromatic herbs (linden and chamomile flowers, coriander seeds, lavender and mint leaves), fruits and berries (mangoes, pineapples, strawberries, raspberries, cherries, blueberries, currants). Because the fruits, berries and medicinal plants raw materials is seasonal, it is most appropriate to use frozen, dried, lyophilized and concentrated products or semi-finished products from them: extracts, puree for production non-alcoholic beer. By adding raspberries, blackberries and bilberries can not only improve the sensory properties of the beer, but also improve the quality. These berries are rich in polyphenols (anthocyanins) which not only give color, taste and aroma to beer, but also supplement it with antioxidants, which are important for the preservation of beer and have a positive effect on human health, various pharmacological effects (antioxidant, anti-inflammatory, anticancer, and others), can improve the state of health and well-being, and reduce the risk of various diseases. The aim of this work was to determine and compare the influence of frozen raspberries, blackberries and bilberries from local market on non-alcoholic beer quality, sensory properties and polyphenols content. Total phenols and total anthocyanins content was determined in Vytautas Magnus University Agriculture Academy by spectrophotometric and color, appearance, flavor, aroma, texture by using sensory analysis methods. The results showed that the highest total phenols and total anthocyanins content was in beer with bilberries 1.665mg g-1 and 0.571%. The sensory analysis results showed that beer with bilberries beer was the most acceptable and showed the best sensory characteristics.

Key words: Biologically active compounds, bilberries, blackberries, raspberries, sensory analysis.

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