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I AGRICULTURAL ENGINEERING

Traceability system of olive oil: a case study based on the performance of a new software cloud

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Abstract. For all the European agrifood establishments from the year 2005 it became mandatory the Regulation EC 178/2002 which obliges them to implement an internal system for tracking and tracing (T&T) of the products; the Regulations that has introduced an ‘obligatory route’ that consists of the construction of the ‘certified historic’ of a food or an ingredient along the supply chain.

The Regulation concerns all food companies and in particular those in which there are different actors that contribute to obtaining the final product as in the case of the supply chain of olive oil.

Informatics with modern technology allows us to provide the company with a software solution, usable as a web application, everything housed on a system cloud server.

The centralization of data provided by the software in question permit the various figures of the supply chain of olive oil to collaborate in an environment where you get all the information in real time. The system implements algorithms that provide notification messages that indicate if there are any delays in production/processing in terms of quality of the olive oil sought.

The operators and final customer will be equipped with an APP free for smartphones, which allow you to detect in a simple and immediate all data (in synchronize with the cloud system) and to get the product traceability.

Key words: Traceability, safety, quality, olive growing, oil.

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Fruit Drying Process Investigation in Infrared Film Dryer

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Abstract. The work analyzes three different product (apple slices, banana slices and grape halves) drying process in the infrared film dryer. Such drying takes place at low temperatures (to 40 °C), allowing to keep the maximum value of fresh products. The drying process is analyzed in detail in the first 8 hours. The quantity of water runoff, drying product temperature changes and flowing air humidity changes during drying were analyzed. It demonstrates the impact of the product placement on the drying progress. Using the experimental data, average diffusion coefficients are obtained for each product group. The results showed that diffusion coefficients were changing during the drying process. Using mathematical modelling and experimental data, the concentration-dependent diffusion coefficient for apple slices was obtained. The study finds that apple and banana drying using the infrared film is comparatively successful, but the drying process of the half of grape berry is slower. This can be explained by the impact of grape peel on the water diffusion.

Key words: infrared film, fruits, drying coefficient, model, moisture.

Determination of the Areas with Drainage Problems on Coastal Region in Çarşamba Plain (Turkey) using Different Interpolation Methods

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Abstract. In this study, the spatial distribution of drainage problems area on agricultural fields of Carsamba Plain (north of Turkey) were evaluated using different interpolation methods such as Ordinary Kriging (OK), Simple Kriging (SK), Universal Kriging, Inverse Distance Weighted (IDW) and Radial Basis Function (RBF). Ground water depths were measured from 59 observation wells at four different seasons in 2012 and 2013. Statistical indices of root mean square error (RMSE) and mean absolute error (MAE) for cross validation were used to select the best methods for groundwater depths. A comparison of interpolated and observed values indicated radial basis function (RBF) to be the optimal method for interpolating groundwater depth in April 2012, in September 2012 and in February 2013, whereas Simple Kriging (SK) was found to be the optimal method for June 2012. The watertable depth was determined to be between 0 and 2 meters in April 2012 and February 2013 in most of the study area. It was determined that groundwater depth decreased with the effect of evaporation in summer season. The watertable depth was measured to be between 1.5 m to 2.0 m in 30% of the study area in July 2012 and September 2012. The areas with drainage problems are considered to be likely to have very high salinity problems

Key words: Water table depth, drainage problems, interpolation methods, salinity.

Use of thermal images for optimizing burner height, operating pressure and burner angle of a weed flamer

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Abstract. A two-meter wide prototype weed flamer was developed as a tool for thermal weed control. The weed flamer consists of an LPG tank, pressure regulator, back pressure valve, flow valves, and burners. The burner adjustments are flexible with height setting from 0 to 450 mm and flame angle setting from 0 to 90°. The thermal camera images were studied at different heights (150, 200, 250, and 300 mm), burner angles (30 and 45°), and pressures (0.1, 0.15, 0.2, 0.25 MPa) to determine the best settings under stationary operating conditions. Based on thermal camera image results, it was found that the burner should be set at 200–250 mm with 0.2–0.25 MPa to obtain the highest temperatures and longest flames. The initial tests of the gas burning system were completed as a broadcast flaming machine and gas doses from 15 to 90 kg ha⁻¹ were applied from 0.25 m above the ground at 30° flaming angle at 0.2 MPa. The dose-response curves of a weed (*Convolvulus arvensis* L.) were generated to determine the effectiveness of the weed flamer. *C. arvensis* could be controlled with gas doses from 40 to 82 kg ha⁻¹ depending on the growth stage at 14 day after treatment (DAT). The theoretical field capacity of the 2 m wide flamer varies from 0.32 to 1.62 ha h⁻¹ depending on the gas dose to be applied.

Key words: weed control, flaming, thermal image, dose-response, LPG.

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Spraying pattern of an Electro-Jet sprayer in different spraying pressures and Jet oscillating frequencies

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Abstract. Conventional field crop sprayers mostly have a horizontal boom and these booms are consisted of at least three sections and more. During spraying operations, boom sections are opened and kept a constant height position in the field. But, due to high travel speed of sprayer, uneven filed surfaces and mechanical defects of boom, boom vibrates and droplet spectrum and each nozzle pattern are declined. Few companies in Turkey have manufactured an alternative sprayer named as electro-jet sprayer to conventional boom sprayer for higher spraying speeds in herbicide application. These sprayers have only 3 high pressure jet nozzles and an oscillating system for three jet nozzles. However, there is no information about spraying parameters of these types of sprayers such as frequency effects of oscillating and pressure on spray pattern of these sprayers.

In this study, effects of pressure (10, 20 and 30 bar) and nozzle oscillating frequency (slow and fast) on spray pattern of an electro-jet sprayer were determined. According to the results, higher spraying pressure increased in the width of lateral spray pattern and worsened in Cv value of spray pattern uniformity. Slow oscillating speed of jet nozzles achieved better Cv value for spray pattern distribution than the fast oscillating speed of three nozzles on the sprayer. Optimum swath width was cahanged between 5.4 and 8.8 m depending on spraying pressure and nozzle ossilating speed.

Key words: electro-jet sprayer, spray pressure, oscillating jet nozzles, optimum spray width, spray pattern distribution

Mechanical harvesting in traditional olive orchards: oli-picker case study

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Abstract. Olive harvesting is one of the most laborious and expensive agricultural practices. Indeed, it absorbs 50% of the product value, and this is due to the continuous increasing of labour from one hand and to the lack of labourers from the other hand. Traditional olive orchards are characterized by the presence of large, century old trees and a very low planting density. These conditions make it difficult to plan sustainable and highly productive harvesting models, and therefore require the employment of partially or fully mechanized harvesting systems. In this context, experimental trials were carried out in a traditional olive orchard, situated in Calabria (Southern Italy), in order to assess technical and economic aspects of a commonly used harvester named oli-picker. This machine allows olive harvesting from tree canopy thanks to a spiked cylindrical comb mounted on a hydraulic articulated arm. Particularly, data about operational working time as well as working productivity were collected for technical purposes, whereas economic evaluation considered harvesting cost expressed in terms of cost per hour, cost per unit of product (1 kg of olives) and average cost per hectare. The obtained results highlighted that working productivity referred to the operative time, was 0.37 trees h⁻¹ worker⁻¹, while the cost per kg of harvested olives was 0.20 € kg⁻¹. From the conducted study, it emerges that encouraging results may be reached by mechanizing harvesting operation even in century old orchards.

Key words: Olive orchard, mechanization, oli-picker, harvesting costs.

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Theory of the oscillations of a toothed disc opener during its movement across irregularities of the soil surface

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Abstract. The paper presents the main provisions of the new theory of oscillations of the versatile combined opener assembly of the breeding seed drill with a spring-suspended furrow opening toothed disc in the vertical longitudinal plane during its movement across irregularities of the soil surface. Basing on the improved design of the opener assembly, an equivalent schematic model has been developed, which takes into account the forces applied to the structural components of the opener, forces in the springs as well as the reaction of the soil acting on the toothed disc, the hoe-type seed conductor and the packing wheel. The system of differential equations has been set up, which describes the movement of the opener across irregularities of the soil surface depending on the opener's design parameters and the kinematic modes of performing the drilling work process. The derived mathematical model makes it possible to determine the amplitudes and frequencies of the translational oscillations of the device in order to assess their impact on the drilling work process. The developed theory provides also tools for the assessment and lowering of the energy characteristics of the versatile breeding seed drill related to the oscillating movements of its openers in soil.

Key words: seed drill, combined opener, toothed disc, oscillations, frequency.

Theory of vertical oscillations and dynamic stability of combined tractor- implement unit

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Abstract. Currently, throughout the world quite extensive use is made of combined tractor-implement units, which are capable of performing several process operations in the same pass. At the same time, the state-of-the-art ploughing and general-purpose tractors that can carry as front- so rear-mounted implements and accordingly feature both the front and rear PTOs, also able to travel efficiently as forward so in reverse gear, are most suited for the performance of such operations. Authors developed and successfully tested a combined tractor-implement unit on the basis of a wheeled ploughing and general-purpose tractor, which can in one pass efficiently chop the after harvesting crop residues with a front-mounted rotary chopper and simultaneously perform tillage with a rear-mounted plough. The aim of this study is the elaboration of the theoretical basis for the process of vertical oscillation of the combined ploughing and chopping tractor-implement unit and the validation of its dynamic stability in the longitudinal and vertical plane. The research has been performed with the use of the methods of designing the analytical mathematical models of functioning of agricultural machines and machine assembly units based on the theory of tractor, the vibration theory, the theory of automatic control and dynamic stability and the methods of computer programme construction and PC-assisted numerical computation. The dynamics of the said unit have been studied basing on the analysis of the amplitude frequency characteristics of the unit as a dynamic system responding to external perturbations appearing in the form of soil surface irregularities. Following the results of the undertaken analytical study, first the equivalent schematic model of the discussed combined tractor-implement unit in the longitudinal and vertical plane was developed, the unit's characteristic points were defined, the linear and angular displacements specified and acting forces applied. Each pneumatic-tyre wheel of the unit represented by its elastically damping model had point contacts with the soil surface irregularities defined by the respective elevations. Using the original dynamic equations in the form of the Lagrange equations of the second kind, first we defined the generalised coordinates and the formulae for the kinetic and potential energy, dissipation functions and generalised forces, then, after performing the necessary transformations, we set up the system of four differential equations, which described the motion of the dynamic system under consideration. Further, we applied the Laplace transformations to the obtained differential equation system, which provided for obtaining the system of equations in the operator form and preparing them for the representation suitable for PC-assisted numerical calculations with the use of the developed computer programme. In accordance with the numerical computation results, graphs were plotted for the amplitude and phase frequency response characteristics of the tractor's vertical oscillations at different stiffness coefficients of its steering wheels, the amplitude frequency response characteristics of the chopper's oscillations depending on its mass and its support wheel tyres' stiffness coefficient as well as the characteristics of the plough's oscillations at different stiffness coefficients of its pneumatic-tyre ground support wheel.

Key words: tractor-implement unit, dynamic system, elastically damping model, oscillation, modelling.

Influence of blade shape on mulcher blade air resistance

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Abstract. Mulching is an energy-intensive agricultural operation. The efforts to reduce the energy intensity makes the designers explore new solutions which would reduce the energy intensity. One of the possibilities to reduce the energy intensity of mulching is to use a work tool of different shape. The paper introduces comparison of several shapes of blades intended for the mulcher with vertical axis of rotation, where especially the rake and cloth angle is changed. The measurement was performed by means of a laboratory model of a one mulcher rotor and in the field conditions where the mulcher Bednar MZ 6000 with a range of 6 m and three rotors had been used. The measurement was performed particularly from the point of view of the energy loss caused by drag of knives. The measurement done by means of the model of the mulcher has confirmed the hypothesis that larger cloth causes increased resistance of the mulcher and higher rake angle results in decreased mulcher resistance. However, larger cloth may contribute to better work quality in the field conditions.

Key words: Mulcher blades, mulching, energy loss, rake angle, cloth angle, air resistance.

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Dependence of digestate briquettes durability and sorption properties on represented particle size

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Abstract. Digestate, product of anaerobic digestion process is traditionally used as liquid fertilizer. Beside agriculture use, became a possibility to dry its separated solid part and compress it to briquette or pellet form. In context of briquettes characterization, mostly mechanical properties of texture components and distribution of particles in briquette space are described. In order to define these properties and understand relations between mechanical part and influencing factors, researchers started to identify relation between particles size distribution in briquette and sorption properties thus mechanical properties. Objective of the present research was to compare size distribution of particles in different digestate samples and to study its connection to water sorption by briquettes and durability of briquettes made from two kinds of digestate material. For comparison were used two types of digestate, where particles were split into few size files, according to sieve size. Via using digital image analysis particles dimensions were measured and compared with values measured by calliper. Sorption properties were measured through experiment: exposing briquettes to water source and water absorption was determined via moisture content. Other mechanical properties were represented by toughness and rate of abrasion. As result, digestate is an appropriate sorption matter which can multiply its initial mass five times, if water supply is sufficient. In case of particles dimension measurement, digestate texture is represented by particles with one prevalent dimension, in most cases length. Length of particles was approximately from 1 mm to 9 mm. The digestate has been proven to be a good water adsorbent and can be applied in various sectors of agriculture.

Key words: anaerobic digestion, absorption, physical properties, distribution, image analysis.

ACKNOWLEDGEMENTS. The study was supported by the Internal Grant Agency of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, research grant number 20165012 and by National Agency for Agricultural Research (NAAR – NAZV), identification number: QJ 1210375.

Soil microbiological activity depending on tillage system and crop rotation

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Abstract. Soil management practices include various tillage systems that influence plant growth and activity of microorganisms. Minimum tillage without soil inversion is increasingly being used because the conventional soil tillage with soil inversion is a more energy-consuming operation and affects the biodiversity of agroecosystems. The present study was aimed to estimate the effect of conventional and minimum tillage systems on soil microbiological activity. The trials were established in the experimental fields of the Latvia University of Agriculture. The intensity of soil respiration and the ratio of microbial biomass between minimum tillage and conventional tillage were calculated from 2011 to 2013, and cellulose degradation intensity – from 2012 to 2014. The conventionally tilled plots were ploughed to the depth of 23 cm, but minimum tillage was done at the depth of 10–12 cm without soil inversion. Soil samples were collected at two depths: 0–10 cm, and 11–20 cm. The crops were cultivated both in a monoculture (winter wheat) and using crop rotation (winter wheat–rape). Soil microbiological activity was characterised by soil respiration, cellulose degradation intensity, and biomass of soil microorganisms. The results suggest that microbial biomass of soil increased in the fields under minimum tillage compared to those under conventional tillage. It was found that crop rotation had no significant effect on the microbial biomass and soil respiration intensity. Although the upper soil layer has a higher potential of microbiological activity, the cellulose degradation intensity showed a tendency to decrease at both soil depths in the experimental plots without crop rotation.

Key words: cellulose degradation, soil minimum tillage, soil respiration.

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Domestic wastewater treatment in rural parts of Turkey (natural treatment systems – constructed wetlands)

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Abstract. Water and food demands are ever increasing with rapidly increasing world population. There is an increased stress placed on limited water resources. Besides, agricultural, domestic and industrial sectors are in continuous competition for limited water resources. Continuously polluted waters, decreasing water resources due to global warming and climate change, increasing labor and energy costs all brought the water and treatment technologies into the first place of the world's agenda. To overcome the water-related problems, water losses in agricultural, domestic and industrial uses should be prevented, effective and efficient water use should be provided and possible use of wastewater and treated water should be investigated. Wastewaters are most of the time discharged into seas, rivers and other water bodies without any treatments due to high treatment costs both in Turkey and throughout the world. These systems are specially designed systems imitating natural wetlands and include soil, plant and microorganisms to remove pollutants from wastewaters. An excavated constructed wetland basin is lined with compacted clay or synthetic membrane and filled with graded sand-gravel substrate. Today, constructed wetlands are widely used to treat domestic wastewaters, agricultural wastewaters, industrial wastewater and runoff waters. In present study, general issues to be considered in design, construction, operation and maintenance of constructed wetlands commonly used in rural parts of Turkey for domestic wastewater treatment purposes were assessed and potential mistakes made in their design, construction, operation and maintenance were pointed out and possible solutions were proposed to overcome the problems experienced in different phases of these systems.

Key words: Wastewater, natural treatment, constructed wetland, water pollution, Turkey.

Importance of monitoring and evaluation for the success of land consolidation projects

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Abstract. Land consolidation studies are crucial for the improvement of agricultural structures. With the land consolidation studies plot sizes are increased, the number of plots per enterprises is decreased, and plot shapes became suitable for agricultural mechanization.

Land consolidation studies required high investment costs. Post-project monitoring and evaluation is required for land consolidation project as well as all engineering projects. Physical structure and ownership profile, created by land consolidation works, is expected to continue in future without deterioration.

A large part of the expected targets from the land consolidation such as decrease in plot numbers and smoothness of plot shapes are realized in the short term. In the long term, there are several expectations from land consolidation studies such as change and improvement in agricultural, social and cultural structure. These are increase in farmers' income, improved mechanization and education level, improvement of living conditions in village, specialization of farmers on certain products, implementation of effective cooperative etc.

In this study, the necessity for post-project monitoring and evaluation of land consolidation studies is discussed and the evaluation criteria for monitoring and evaluation is also presented.

Key words: Land Consolidation, Monitoring and Evaluation.

Security methods for agricultural buildings

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Abstract. The problem of security methods affects a large proportion of intrusion and hold-up alarm systems (I&HAS). In a time of increasing property crime, it is highly important for security methods agricultural buildings to be able to achieve efficiency, reliability and faultlessness. In the case of proposal for placement of detectors it is naturally important determine position of detector, the type of detector, but also to guarantee their capability of detection for using in agricultural production. Proposals made at the individual security methods in agricultural production, examined the cost and safety of the final system. These security proposals are important both from an informative perspective and also of the possibility of using individual proposals security of agricultural production in practice.

Key words: security risks, sabotage, security methods, agricultural buildings, intrusion and hold-up alarm systems.

Translocation of soil particles during primary soil tillage

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Abstract. The loss of soil particles due to water erosion is a crucial problem of current farming on the soil. However, soil tillage may also contribute to the undesirable transport of soil particles. It is to note that the effects of particular working elements used on implements for soil tillage have not been described in a sufficient way. To determine the translocation of soil particles, measurements were done in the Central Bohemian region. Three basic machines for soil tillage were used for measurements: disc tiller, tine cultivator and five-share plough. Measurements were performed on sandy-loamy Cambisol after harvest of a spring cereal crop. White limestone grit was used for the indication of soil particle translocation. Great translocation of soil particles was observed after soil tillage with tine cultivator and mouldboard plough - the average translocation rates ranged between 0 and 0.9 m. Disc tiller displaced the soil particles into smaller distance (into 0.3–0.45 m). The dependence of tracer weight on a distance from the original location could be described for disc tiller and tine cultivator by an exponential function. The type of soil particle translocation by a mouldboard plough was completely different from the translocation by a disc tiller and tine cultivator. Topsoil turning over by a plough showed the lengthwise and crosswise movement of tracers with a typical dependence of their weight on a distance from the original location. The dependence of tracer weight on a distance from the original location could be described for mouldboard plough by a quadratic function. Individual machines for primary tillage have a different character of translocation of soil particles.

Key words: soil particles transport; soil erosion; machines for soil tillage.

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Modification of the rheological properties of the honey in the honeycombs prior to its extraction in the production conditions

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Abstract. This paper addresses the issue of honey extraction in difficult conditions (prevailing cold weather) and the extraction of highly viscous honey from the honeycombs. The objective was to design and validate a technology that will reduce the viscosity of honey in the honeycombs by warming up by infrared radiation and shorten the total time of honey extraction. To verify the proposed procedure three groups of samples of the capped honeycombs were selected that contained honey of different botanical origin and rheological properties. The honeycombs were warmed up to the targeted temperature (from 15 °C to 40 °C). Warming was carried out by two low-temperature emitters of the infrared radiation. The time dependence of honey extraction on the temperature of the pre-heated honeycombs was monitored. The measured values indicate that the dependence of the rheological properties of honey on temperature is technologically significant. Operational monitoring shown that the optimal rheological properties for the processing of the honeycombs are at a temperature above 30 °C as the time necessary for the honeycombs extraction reaches its minimum value. The optimal temperature for the honeycomb extraction can be considered the temperature above 30 °C which corresponds to the extraction time for about 4 minutes. The evaluation of the obtained results demonstrates the operational reliability of the proposed technology. Measurements proved that the infrared radiation is suitable for warming up of the honeycombs, warming up is quick and results in time reduction of honey extraction from honeycombs is dependent on temperature.

Key words: honey, honey extraction, infrared radiation heating, viscosity.

Characteristics of natural tuff storages in Nevşehir (Cappadocia) region of Turkey

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Abstract. Storage is one of the most important elements that provide the consumption continuation throughout the year for various products. Nevşehir, the center of Cappadocia, is the candidate for being 8th wonder of the world, presents visual feast to World Tourism by its marvelous geography and its natural formations. Most of us don't know there is another side of this geography and nature secret underground. The biggest natural underground stores of the world which someone seen doesn't believe in his eyes and someone seen can never imagine take place in Cappadocia. Unlike the modern storage facilities in the world, underground storage facilities have been built in the layers of volcanic tufa in the Cappadocia region to store potato, apple, citrus and onion. These storages do not require any cooling equipment and use only the cooling impact of natural tufa. There is no need for heating and cooling in these storages, thus the investment costs are quite lower than the conventional storages. The volcanic tuff storages used for storage in the region are formed by tunnel boring machines easily. In this study, general characteristics of these natural storages used to store agricultural products were provided and their advantages over conventional storages were pointed out.

Key words: Storage, natural tuff storages, Nevşehir, Turkey.

Performance Evaluation of TDR Soil Moisture Sensor

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Abstract. Optimization of irrigation scheduling and water management greatly benefit from soil moisture sensors that accurately measure soil water content since accuracy of soil moisture sensor directly affects the irrigation efficiency. In this study, a performance evaluation of TDR-Slammer with a 40 cm waveguide was done under field conditions. Experimental data were collected in a drip irrigated pumpkin (*Cucurbita pepo* L.) field, Kayseri, Turkey during the 2015 growing season. Measured soil water content values on a loamy soil were compared with corresponding values derived from gravimetric samples. Results showed that TDR-Slammer could be safely used as an acceptable, reliable and accurate method for measuring soil water content on loamy soils.

Key words: Time domain reflectometry, soil water content, calibration, dielectric constant.

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The effect of soil tillage technologies on the surface of the infiltration speed of water into the soil

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Abstract. Water erosion is a problem of global significance. Water erosion causes destruction or damage to enormous areas of agricultural land every year (Morgan, 2005). Agricultural land in the Czech Republic is largely exposed to the risk of water erosion on grounds of habitat, but as well agro technology. More than half of agricultural land is endangered by water erosion in the Czech Republic (Janeček, 2005). Due to water erosion the soil is depleted of its most fertile part – topsoil. The physical and chemical properties of the Earth's surface are deteriorating, the content of nutrients and humus in the soil reduce, and the thickness of the soil profile decreases. However the grimmess increases and prevents the growth of vegetation. The field trial was set up to evaluate the tillage technology. The measurements were carried out in Nesperská Lhota. The experiment was placed into a sandy loam Cambisol. The measurements took place in four variants of field trial which differed in soil tillage for maize. It was a different method combination of no-till and plough tillage. The simulation of intense rain was used to measure. A square area of the size 0.5 sq m was surrounded by sheet metal strips around the whole perimeter. The pantograph was placed on their underside and collected the runoff water. The soil washout was collected into the pipe and then into a graduated container. The surface runoff was collected in the container and weighed on automatic scales. Its values were recorded on a portable computer. The result of the measurement showed the difference between the various types of tillage. The beginning of the surface runoff at conventional tillage with ploughing was the shortest of all the variants. While the beginning of the surface runoff was reduced significantly longer by reduce tillage than by conventional tillage with ploughing. The results of the surface runoff speed and the speed of infiltration of water into the soil at the simulation of intense rains are in compliance with the results of those authors who report significant benefits of soil conservation tillage technology. This technology reduced the surface water runoff during the intense rainfall and increased water infiltration into the soil.

Key words: maize production; rainfall simulator; water erosion.

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Seed passage speed through short vertical delivery tubes at precise seeding

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Abstract. The development trend of precision seed machines is the use of central seed hopper. Another requirement is to increase the driving speed during precise sowing up to 10–12 km h⁻¹. This involves increased demand for uniformity of the seeds movement between the dosing mechanism and seed coulters. Previous measurements of seed passage speed showed undesirable changes in distance of seed during passage by long delivery tubes. The research was therefore focused on the evaluation of flyby seed parameters in short vertical delivery tubes of inner diameter 10, 12 and 14 mm and a length of 0.50 m. The aim of the experiment was to evaluate the dependence of the seed passage speed of corn, winter wheat and oilseed rape on the air pressure in the supply hose from the fan to short vertical delivery tubes and to recommend appropriate settings of air pressure in the intake air to delivery tubes. Logarithmic function was chosen for the description of dependence of flyby speed of three crops seeds on air pressure in the vertical tubes. The speed of the seed at the end of seed tubes, established as necessary for high-speed seeding (10 m s⁻¹) was achieved in all three test seed tubes when the air pressure in the supply pipe 3.0 kPa. Air speed in the vertical delivery tubes was 3.15 to 4.2 times higher than the speed of the seeds. Based on the correlation index values from 0.90 to 0.96, the high quality of the regression model was found in all cases. It was found that the short vertical delivery tubes of internal diameter 10, 12 and 14 mm are useful for a new developed seeder. On the other hand, deviations of seed passage speed for winter wheat seeds occur at higher air speed. Higher internal diameter of downtube decreased significantly seed passage speed for maize seeds.

Key words: precise seeding, flyby speed of seeds, short vertical delivery tubes.

New design of roller separation line and its effect on the separation of hop matter

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Abstract. This article deals with the roller conveyor which constitutes a part of a machine line to separate the hops harvested from low trellises. Various parameters affecting the right operation of this roller conveyor are examined. In the last season a model of roller conveyor designed and constructed for this purpose was subject to experimental verification with the objective of integrating it in the actual line. Dependency of hop matter falling through on the gap size between rollers was examined. They were standard, commonly used rollers.

In 2015 rollers with a different diameter and different profile of metal welded collars were designed and produced. The new construction allows for reducing the gap between rollers up to 20 mm. As compared to the former solution including rollers of 60 mm in diameter, this one constitutes a difference of 28 mm.

The measurements in the season of 2015 were conducted using these new rollers and there were two parameters to examine. They were the gap size between rollers and rotation frequency of the rollers. The measurements were carried out using a hop matter sample taken from low trellises. The dependency of the hop matter falling through was being examined for 3 gaps (28, 24 and 20 mm) between rollers and for three rotation frequencies of the rollers. The measurements revealed that with a setting resulting in the smallest possible gap between rollers (20 mm) by up to 15% more leaves can be separated, compared to the rollers of 80 mm in diameter, and by approx. 60% more leaves compared to the former solution including the rollers of 60 mm in diameter. Furthermore it was found that a change in rotation frequency of the gaps does not affect the separation of leaves in any significant way.

Key words: hops, separating machine, roller conveyor.

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Measurement of mulcher power input in relation to yield

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Abstract. Mulching is one of relatively energy-demanding operations in plant production. That is why the knowledge of mulcher power input is very interesting and can be used e.g. for mulcher design improvement etc. Field experiments were arranged in order to measure mulcher power input also in relation to yield. The field of about 1.25 ha area was harvested by mulcher MZ6000 produced by BEDNAR FMT Co. This machine has three rotors with vertical axis, working width 6 m and was aggregated with JD 7930 tractor. Power input was measured by torque dynamometer Manner MFI 2500 placed at tractor PTO shaft. Measured data were processed by A/D converter Labjack U 6 and saved. After the harvest, the samples of harvested material from area 6 x 1.65 m were weighted by hands on 102 places in almost regular grid. Average measured mulcher power input was relatively high, 76 kW, with peaks reaching up 145 kW. The yield of harvested material on experimental field was very unbalanced and varied from 0.6 to 13 tonnes per hectare. The amount of measured data allowed the creation of power input and yield maps. By comparing the results from power input and yield measurement it was found that power input significantly depended on the yield. Information of mulcher power input can be used also for harvested material yield mapping.

Key words: mulcher, cutting, power input, yield mapping.

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Identification of worm-damaged chestnuts using impact acoustics and support vector machine

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Abstract. Chestnut has both economically and nutritional values, and its production in the World is about 2 Mt. Turkey is one of the important chestnut producers with a production amount of about 60,000 t. Worm damage is one of the reasons which may reduce economical value of chestnut. Aim of this study was to reveal possibilities of distinguishing of worm-damaged chestnuts from healthy ones using impact acoustics and sound analysis methods. A Turkish local variety called 'Osmanoglu' was chosen for the study. A sound acquisition station was comprised, and acoustic emissions of worm-damaged and healthy nuts were acquired at a sampling quality of 192 kHz and 16 bit. Each sample was labelled according to worminess situation by shattering the nut after acoustic measurements. A band-pass filter between cutoff frequencies of 70 Hz and 100 kHz was designed and applied to sound samples to alleviate negative effects of unwanted noise. Various signal features such as variance, standard deviation, kurtosis, zero crossing rate, and spectral centroid were calculated. A relevant feature subset was determined using feature selection technics. An identification model was trained using Support Vector Machine and cross-validation rules. Performance of the classification system was measured on a test set. In this study, reporting the preliminary results of an ongoing and comprehensive research project, promising results were obtained for identification of worm-damaged chestnuts with proposed system.

Key words: Chestnut classification, Worm Damage, Impact Acoustics, Support Vector Machine.

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Productivity of Vimek 404 T5 harvester and Vimek 610 forwarder in early thinning

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Abstract. The scope of the study was to evaluate productivity of small size forest machines in early thinning, as well as to identify opportunities to use this technology to Latvia. The study was implemented in Sweden using Vimek 404 T5 harvester and Vimek 610 forwarder. The machines were driven by experienced operators; harvesting and forwarding methods were adopted to the operators' experience. Time studies were done by team of researchers from Latvian State forest Research Institute 'Silava'. The study demonstrated that Vimek 404 T5 harvester has considerable advantages in compare to conventional forest machinery to produce limited number of assortments like biofuel or mixture of pulpwood and biofuel in early thinning. Annual capacity of a single harvester working in one shift is 800 ha or 25,000 m³; however, application of the machine is limited – it might not work efficiently in commercial thinning in Latvia due to large number of assortments required by customers, and it has limited possibilities of utilization during seasonal restrictions of forest operations. Productivity of Vimek 610 forwarder is comparable with conventional middle size forwarders; however, it becomes less beneficial with increase of forwarding distance. Prime cost of biomass, including harvesting, forwarding and road transport to a 50 km distance is 14.3 EUR m⁻³. Hourly cost of Vimek 404 T5 and 610 is similar – 26–28 EUR h⁻¹.

Key words: Vimek 404 T5, Vimek 610, early thinning, productivity.

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Analysis of organic agricultural waste usage for fertilizer production

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Abstract. Waste management, especially biodegradable (organic) waste, is highly relevant in agriculture. Increasing the intensity of agricultural production inevitably increases pollution of soil, water and air due to chemical, biological and other effects because of untidy agricultural waste. Currently there is a search for new and more rational ways to use waste for new forms of energy, making fertilizer, building materials and other products. One of the processes of biodegradable waste management is pelleting; i.e., the processing of recyclable materials into organic ecological products.

The SWOT analysis-expert, literature survey methods were used for the analysis of animal and plant origin organic agricultural waste's suitability for production of fertilizer. The analysis has shown that the granulation of animal waste allows making better use of nutrients, significantly reduces the amount of fertilizer needed to be deposited into the soil and reduces the cost of storing, transportation and spreading into the soil. SWOT analysis motivated the need for further research of manure waste and its pelletizing.

Key words: Composted manure, agricultural plant wastes, pelletizing, SWOT, fertilizer.

Estimation of mulching energy intensity

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Abstract. Mulching is one of the energy-intensive activities in agriculture. The energy is gained from the consumed fuel. Besides the consumed fuel the combustion engine produces harmful and unharmed exhaust gases. The general trend is to reduce the production of harmful constituents of emissions as well as carbon dioxide. This can be achieved by various construction modifications or additional modifications of exhaust gases. It is possible to estimate the energy intensity in advance by several different ways. The paper presents the estimation based on measured complete characteristics of emissions production and the fuel consumption of used combustion engine and on the measured on-board data. The results show that the estimation of fuel consumption and thus also production of carbon dioxide can be relatively successful. The estimation differs quite significantly for other emissions components. During different transition modes of the combustion engine there is a change of emissions production which is hard to describe. The solution could lie in use of other parameters determining the operation mode of the engine in addition to the commonly used speed and torque of the combustion engine.

Key words: Fuel consumption, emissions, operation modelling, combustion engine.

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Freshwater sapropel (gyttja): its description, properties and opportunities of use in contemporary agriculture

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Abstract. Sapropel (gyttja or dy) is a type of fine-grained and loose sediments, rich in organic matter, deposited in freshwater bodies. Properties of sapropel and quite wide possibilities of extraction makes it as an important natural resource that can be used predominantly in agriculture, horticulture, forestry, farming. Sapropel and its processing products are environmentally friendly, non-toxic, with a definite content of nutrients. The aim of the current paper was to gather the available information about the sapropel properties and its application in agriculture as soil fertilizer or soil amendment, indicating the efficiency and possible ways amounts of application. Another reason why the investigation of sapropel is important in the Baltic States and northern Europe is its wide distribution and availability in freshwater bodies that leads to find out new ways of extraction and bioeconomically-effective utilization of this highly valuable natural resource, obtainable in economically significant amounts, with high opportunities of its use in agriculture. Contemporary agriculture strongly desiderates in new products of high effectivity enhancing soil and crop productivity and quality hand in hand with sustainable development and careful attitude to the nature and surrounding environment.

Key words: lake sediments, humic substances, organic fertilizer, soil amendment, natural resources.

Soil physical characteristics and soil-tillage implement draft assessment for different variants of soil amendments

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Abstract. The article discusses the results of measurement of soil physical properties and implement draft that has been done within field trial established at Sloveč in the year 2014. Different variants of treatment with substances for soil (PRP Sol) and manure (PRP Fix) amendment with organic fertilisers of various origins have been examined in terms of their influence on several parameters including energy demand for soil tillage. In the first stage, soil physical properties, i.e. soil bulk density and cone index, were measured. The results indicate that at soil upper layer, cone index of all the trial variants dropped relative to control regardless of the manure origin, manure treatment with PRP Fix, or the application of PRP Sol. Concerning soil bulk density, observed drop in values can be discerned with the application of cattle manure, and with majority of variants using pig manure where there are high dosage rates, but the drop was found also with PRP Sol alone. Subsequently, draft of chosen tillage implements was measured in order to assess potential decrease in energy demand of treated variants. There was almost 3% drop in aggregate unit draft after manure, and soil and manure activators' application compared to the control. The decrease was attained in all variants except three. Two of them were the variants of untreated manure (cattle and poultry origin) application and the third was the variant of poultry manure treated with PRP Fix with additional application of PRP Sol. Here though, the difference was minor only.

Key words: draft, activator of organic matter, manure application, soil properties.

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Impact of cultivation method on the soil properties in cereal production

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Abstract. The aim of present paper is to give an overview about results collected in 2012–2014 related to impact of cultivation method on the cereal field soil properties. Experiments were conducted on Estonian farmers' production fields to compare no-till and plough-based tillage practices. Studied properties were among others soil bulk density, structure, water content, microbial activity and weeds seeds content.

The bulk density, gravimetric moisture content and structure of soil from 0–10, 10–20 and 20–30 cm layers were evaluated. For microbial activity an enzyme dehydrogenase, which occurs in all viable microbial cells, was determined in soil layers 0–10 and 10–20 cm. Soil samples were taken from 0–25 cm layer to determine weed seeds content. Seeds were extracted from the soil using a flotation-method. The seeds were counted and species identified under the microscope.

The cultivation method has significant impact on some soil properties and insignificant to other. Cultivation method had no significant impact on ratio of agronomically preferred soil particles (2–4.75 mm). No-tilled fields soil bulk density had no differences between layers except 0–10 layer in Pärnumaa ($p < 0.05$). Soil bulk density differences ($p < 0.05$) between layers occurred in Soth-Viljandimaa and Pärnumaa tilled soils, in which plough pan in layer 20–30 cm was noticeable.

In average the abundance of weeds seeds was higher on no-tilled fields, compared to tillage accordingly 60,975 and 29,250 weed seeds m^{-2} ($p < 0.003$).

Results showed higher soil dehydrogenase activity in the no-tilled soils layer 0–10 cm than in 10–20 cm layer ($p < 0.05$). In the tillage the dehydrogenase activity had no significant difference between soil layers.

Key words: no-till, tillage, soil physical properties, soil dehydrogenase activity, weed seeds.

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Realtime soil moisture measurement during field work

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Abstract. Soil moisture affects grain germination. If the seeds are sown in dry soil the germination is poor and the emergence is uneven. In Finland, the fieldwork during the spring sowing season takes a couple of weeks and during this period the soil is drying or it is wetting if there are rains. If the seeds can be sown to optimal soil moisture content this enhances germination and increases the yield.

Soil moisture content and temperature was measured before spring tillage. By utilizing these results a prototype of soil moisture measurement system was built utilizing commercial NIR-technology moisture sensor. This system could be used in harrows and drills so that the work is done to proper soil moisture content. The principle functioned reliably when properly calibrated and mounted. The measuring system could be further improved with narrower light beam so that the falling soil aggregates would not have interference to the results. This kind of instrumentation could be used in implements.

Harrowing and sowing season could be prolonged with a small impact on yield if the seeds could be sown to advantageous moisture content. This would be also economical because the work capacity and machine sizes could be reduced. Also risk of soil compaction would be less.

Key words: moisture, precision farming, tillage, NIR-technology.

The relationship between precompression stress and rut depth of different soil types in Estonia

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Abstract. In agriculture as well for other purposes off-road vehicles have to move cross-country. Precompression stress is used to describe the load bearing capacity of different soils. The aim of the study is to investigate the relationship between precompression stress and rut depth for different Estonian soil types after 1 and 10 passes of a vehicle. Traffic experiments were conducted at eight experiment sites throughout Estonia using a 7 t truck and a 23 t wheeled vehicle. The experiment sites were selected based on the Estonian soil map. Rut depth was measured after the first pass and ten passes. Undisturbed soil samples were collected from topsoil and from subsoil right next to the track. Soil samples were compressed in an oedometer at stresses of 25, 50, 100, 200, 400 and 600 kPa. The Casagrande procedure was used to determine the precompression stresses. In topsoil, if the moisture content of a soil is high, then the differences in the precompression stress values of the various soil types disappears while in the subsoil layer the precompression stress is more dependent on the soil properties. The precompression stress cannot by itself be used as a threshold value to determine small and large sinkage. The choice of fitting methods for composing of stress compaction curve is critical and led to the preference of the logistic curve. The values of logistic functions at the points of their maximal curvature and calculation based on the area on stress-compaction graph can be used for prediction of rut depths.

Key words: soil bearing capacity, sinkage, soil compaction, logistic curve.

Current situation and future of trends in vineyard floor management

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Abstract. Agriculture is a strategically important branch of Armenian economy. Viniculture is one of the leading branches of the agro-food sector of Armenia. For developing this branch and producing consistently high yields it is essential to improve vineyard cultivation techniques and technologies, in particular, the mechanization of the most time and labour-consuming technological cultivation operations, such as inter-row cultivation and cultivation between the bushes. In this article we consider widespread methods and techniques for weed control, improving the structure of soil and the methods of cultivating the areas between the plants in the vineyards; compare and characterise the methods from the financial perspective, and also provide necessary agrotechnical parameters for cultivating this kind of crop.

Soil management means the creation of the best possible conditions for proper grape plant growth. Proper and timely soil cultivation facilitates the creation of conditions for improved microbiological processes in the soil, the accumulation and preservation of moisture, and nutrient enrichment. This is why the selection of the proper method of soil cultivation and its appropriate implementation can be regarded as the foundation of harvesting future crops. Methods of vineyard cultivation depend on zonal and climatic particularities, type of soil, anatomic and physiological characteristics of grape varieties. In order to develop a strong root system and the portion of the plant that is above ground, the soil must be free from weeds that compete with grapevines for nutrients and moisture and aggravate the thermal conditions of the soil by shading. Consequently, the selection of the cultivation method depends on the concentration of weed vegetation as well. Mechanical cultivation, which can involve the management of spaces between rows and bushes; chemical weed control; cover cropping; mulching are most widespread methods of vineyard floor management.

Cover cropping is the most often applied method that has a beneficial effect on soil, plants, and the ecological system. It can be performed with different plants depending on soil texture, climate, planting density. The major limitation of cover crops is that other crops compete with grapevines for water and nutrients. All territories of grape cultivation in Armenia have an average annual rainfall below 500 mm, and the relative air humidity is below normal, which means that in such conditions, the vineyards definitely need artificial irrigation. Considering this argument, competing for moisture is inevitable. Another important problem of this method is that there are no cover spaces between bushes. Considering the features of Armenian grape varieties, this is a very important limitation to the expansion application.

Chemical methods of weed control mean using herbicides and fumigation. Weed control in vineyards includes using soil-applied (contact) herbicides as well as systemic products. Soil-applied herbicides mainly destroy annual weeds through their root system but perennial weeds are resistant to them. In order to destroy perennial weeds, systemic herbicides are used during vegetation—these penetrate into the plants through leaves and other above-ground organs, and then reach the roots through tissues, destroying the plants' metabolism and leading to their death. Constant implementation and low efficiency as well as the most important aspect—the fact that the resulting products are not environmentally friendly—restricts the use of this method in many countries.

Soil mulching is an old method of fighting weeds, soil erosion and preserving the soil moisture structure. Different plastic and organic materials such as polymer films, tar felt, hay, straw, manure, compost, saw dust, cut vegetation, etc. are used for mulching. The mulch blocks the light and prevents weed growth but also creates a favourable environment for insects, worms and rodents. Developed winemaking and olive countries dedicate a lot of work to the application of this method and its advantages but the necessity of covering and digging of the grape vines set some limits to the widespread use of this method.

Several studies have been conducted to compare different weed control methods and find the best solution but each of these methods has specific limitations in vineyards. The toxicity of some methods, their high cost, the need to use special equipment as well as their poor efficiency limit the application of these methods, at least in Armenia. These problems indicate to the need to develop a simple and cheap management system that must be also environmental friendly. In this case, effective weed control and good soil properties are guaranteed by mechanical cultivation.

However, mechanical cultivation is not simple either. Several countries have the necessary equipment for inter-row cultivation. However some questions remain relevant. Firstly, the application of advanced technologies does not always improve the efficiency of the work performed. For example, modern machines and equipment for cultivating the spaces between bushes in the vineyards bypass (Rinieri, Ostratický, Calderoni, Boisselet, FMR) the obstacles by using a sensor that is connected to a hydraulic system, which bypasses a vine or some other obstacle with the help of a sensitive probe that transmits a signal to the hydraulic system when it comes across an obstacle. The operating element is taken out of the space between bushes with the help of a hydraulic cylinder, and it returns into the operating position when the sensor is in the neutral position. This system makes the structure of the machine more complex, improves its metal intensity, reliability, operation, maintenance and repairs. The next very important reason for the low technological efficiency of these machines is the distinctive feature of Armenian grape varieties—the vine branches flare at the bottom and there is no clear and high trunk. Taking this characteristic into consideration, the probe can transmit false signals to the hydraulic system, thus affecting the efficiency of the process. The high level of mechanisation of the grape cultivation processes in the leading winemaking countries, especially of the cultivation of the areas between bushes, is feasible because of the comparatively simple mechanical structure of soil and favourable weather conditions in the areas, which rule out the technological processes of covering and digging. Another important factor is the price policy of the machines in question, since by virtue of using information technology and electronic equipment, such machines are quite expensive, while large investments can be unjustified and may lead to financial problems for smaller farming enterprises and the developing branches of industry. Secondly, most leading companies produce special machines, both with progressive and rotating motion, for cultivating the spaces between bushes and rows in vineyards. The machines with progressive motion (Rinieri, Ostratický, Calderoni) cultivate the areas between bushes with the help of flat cutters (blades). The flat blade cuts the soil from below at a certain depth without loosening it, and virtually does not displace the soil. As a result, the root systems of weeds are not destroyed properly, and the mechanical structure of the soil does not improve. At the same time, in some cases, the blade can go deeper into the soil than required, thus increasing the tractive resistance of the machine. Numerous research results have proved that, from the point of view of efficiency of soil cultivation, rotating soil-cultivating machines are very efficient when it comes to meeting all of the relevant agrotechnical requirements.

Taking into consideration all of the abovementioned characteristics, there is a need for developing a set of machines that take into account zonal peculiarities, the modern aims of resource and energy economy, and soil environmental safety. The new inter-row cultivator developed at the Armenian National Agrarian University consists of a Π -shaped frame attached to a tractor with two hydraulic power driven circular tillers with a vertical rotating axis. The working elements are knives, whereas both of the circular tillers are equipped with 6 knives. Depending on the density of a vineyard's contamination with weeds and stones, the number of L-type blades attached to the cutter varies from 3 to 6. Unlike similar machines listed above, the developed machine does not have a hydrosensor that is used for bypassing a vine. In this case, vines are bypassed with the help of a rubber bezel, which rolls down upon coming into contact with an obstacle or a vine and guides the operating element out of the space between bushes. After bypassing the obstacle using a spring of appropriate stiffness and the reactive force of the blades generated as the result of cutting soil the operating element gets back into the space between bushes. Soil density, an important fertility factor, depends on the number of the machine's operating cycles in the field. Rotating machines and equipment have the minimum number of operating cycles within which it is possible to cultivate the soil. Bearing this in mind, this machine fully meets requirements. The entire process of cultivating areas between bushes in vineyards is done manually within the shortest agrotechnical term possible. While covering and digging is also done manually, in the end, it is difficult to imagine the required physical work and connected financial expenses involved in these processes. From that point of view, the suggested machine will be used for grape cultivation and guarantee the cultivation of 4 ha within one shift, while 10 people would spend two days cultivating the same area manually.

Key words: vineyard, inter-row cultivation, weed control, agricultural machinery.

Productivity and cost of biofuel in ditch cleaning operations using tracked excavator based harvester

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Abstract. Forest ditches is one of the poorly utilized sources of biomass for energy production and timber industry. Increase of productivity and reduction of cost of extraction of biomass from the ditches, retaining at the same time high quality standards, are the key issues of mechanization of harvesting operations in this area. The scope of the study was to evaluate productivity and cost of biomass delivered from forest ditches, when tracked excavator based harvester and different work methods are used. New Holland 215B excavator with Ponsse H7 felling head was used in trials. The machine was operated by experienced operators. The study was implemented in drainage systems managed by Joint stock company 'Latvia state forests'. Total extracted area 12 ha, extracted biomass – 734 m³. Duration of the study including harvesting and forwarding – 4 months. Average cost of roundwood production including road transport to 50 km distance in the trials was 27 EUR m⁻³, average cost of biofuel – 11 EUR m⁻³ (4.5 EUR LV m⁻³). The study approved advantages of excavators in ditch cleaning operations; however, several improvements are possible. The machine should be equipped with smaller accumulating felling head, delimiting and bucking should be done in parallel to a ditch direction, number of assortments should be reduced, as well as extraction of trees with diameter below 6 cm should be avoided.

Key words: excavator, ditch cleaning, productivity, biofuel, prime cost.

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II AGRICULTURAL ECONOMICS

Investigations about the impact of norms of the fertilisers and cultivars upon the crop capacity biomass of industrial hemp

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Abstract. Field trials were carried out in 2012–2014, on the Research and Study Farm ‘Pēterlauki’ of the Latvia University of Agriculture. Eleven sorts of industrial hemp (*Cannabis sativa* L.) – ‘Bialobrzeskie’, ‘Futura 75’, ‘Fedora 17’, ‘Santhica 27’, ‘Beniko’, ‘Ferimon’, ‘Felina 32’, ‘Epsilon 68’, ‘Tygra’, ‘Wojko’ and ‘Uso 31’ were sown in a sod calcareous soil (pH_{KCl} 6.7, P 52 mg kg⁻¹, K 128 mg kg⁻¹, the organic matter content 21–25 g kg⁻¹). The total seeding rate was 50 kg ha⁻¹. The plots were fertilised as follows: N-120, P₂O₅- 90, K₂O- 150 kg ha⁻¹. Hemp was sown in the middle of May, in 10 m² plots, triplicate. Hemp was harvested when the first matured seeds appeared. The biometrical indices, the height and stem diameter, the harvesting time, the amount of fresh and dry biomass and the fibre content were evaluated.

Yield of dry matter on average comprised 15.06 t ha⁻¹, depending on the cultivars. Cultivation year and cultivar notably affected hemp biomass yield. In 2012, the highest yield of dry biomass was produced from cultivars ‘Futura 75’ (21.33 t ha⁻¹) and ‘Tygra’ (20.87 t ha⁻¹), the lowest – from ‘Bialobrzeskie’ (11.95 t ha⁻¹). Significantly higher average yield of dry biomass was obtained from cultivars ‘Futura 75’ (17.76 t ha⁻¹), ‘Tygra’ (16.31 t ha⁻¹), ‘Wojko’ (15.51 t ha⁻¹) and ‘Epsilon 68’ (15.28 t ha⁻¹), the lowest – ‘Bialobrzeskie’ and ‘Uso 31’ (13.53 t ha⁻¹). Meteorological conditions influenced the dry biomass yield.

The aim of this study was find productive cultivar of industrial hemp (*Cannabis sativa* L.) and clarify nitrogen fertiliser rates impact for biomass production in Latvia.

Key words: *Cannabis sativa*, cultivars, biomass, fertilizers.

Economic considerations for using sexed semen on Holstein cows and heifers in Estonia

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Abstract. The study investigated economic and managerial considerations for using sexed semen as a tool for accelerated herd expansion and improvement of its genetic potential. Economic value of reproduction strategies based on conventional semen and sexed semen were analysed according to partial budgeting method by Victor E Cabrera and adjusted for the Estonian average indicators.

Data for the study were collected through a personal interview from Animal Breeders Association of Estonia. In order to evaluate the economic value of using sexed semen over conventional semen, five different reproductive strategies involving sexed semen were used and compared with conventional semen-based strategy.

Average conception rate from the first insemination with conventional semen was 66.4% and 50.0% with sexed semen for Holstein heifers in Estonia in 2013. Probability for birth of a female calf was 49.3% with conventional semen and 93.0% with sexed semen.

Net present value for all sexed semen based reproduction strategies was negative at the given conditions. Sensitivity analysis for key reproductive and economic variables showed that market price of female calves and conception rates had the most impact on the economic value.

Sexed semen can be a valuable tool for reproduction management in dairy farms, but the actual economic value of its application depends on the reproductive performance and objectives of an individual farm. Results of this study provide basis for further research about the situations, where using sexed semen would be economically justified for the farmers.

Key words: sexed semen, reproduction, conception rate, economic value

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Assessment of the economic value of cattle slurry and biogas digestate used on grassland

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Abstract. Concentration of dairy production and development of manure handling technologies has led to large amounts of cattle slurry produced as a by-product. Slurry can be used directly for fertilisation or input for biogas production. As a result of added organic materials, the nutrient content of the by-product of anaerobic digestion (biogas digestate) differs from nutrient content of slurry. The data from the 2012 to 2014 field experiment designed to evaluate the use of local organic fertilisers on grassland were used for the current study. The objective of this research is to present an approach for the fair reflection of the economic value of organic fertilisers. The approach is based on substitution relationships between mineral and organic fertilisation on a certain yield level of grass dry matter production. The economic value was assessed based on the nutrient content of cattle slurry and biogas digestate, application costs, and the cost of mineral fertilisation. Two categories of economic value were calculated: the total and the actually realised value. The total economic value shows the potential value of nutrients available for plant production. The actual realised value is formed through the nutrient usage by plants. The economic value of the biogas digestate used in the experiments appeared to be higher than the value of slurry, due to the equal application of ammonium nitrogen (NH₄-N), the higher content of potassium and lower application rates.

Key words: cattle slurry, biogas digestate, economic value, grassland.

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Pilot study of variability on demand and knowledge concerning organic food on an example of two Polish regions

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Abstract. The paper focuses on showing variability of knowledge and demand for organic food in two regions of Poland, i.e. Świętokrzyskie and Mazovian provinces. The selected for detailed investigations Polish regions differed in society wealth. Mazovia province with capitol (Warsaw) is reach as opposed to Świętokrzyskie – mountain province with dominance of more difficult conditions for comfort and affluent life. Basing on questionnaire the group of respondents' attitude towards organic food was recognized and compared. The problems included in the questionnaire there were factors influencing the organic food buying, factors which influence about the resignation of organic food buying, the availability of information about organic food, availability of organic food in selected regions, requirements for organic food, most frequently purchased organic products, place where consumers buy organic food, consumption frequency of organic food, factors influencing the choice of organic food. The comparison of two provinces indicated differences within the meaning of organic food as well as autonomy in consumer behaviour. Polish society is characterized by a growing interest in organic food. The production industrialization and mass food processing causes people to look for some alternatives. Organic farming gives people that chance. In the conclusions, we have formulated a term mean that due to the consumption of organic products – 'we are what we eat'.

Key words: consumer, demand, knowledge, organic food, Poland, production.

Methodological challenges in research of Vidzeme rural areas

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Abstract. In 2014-2015 researchers of the Institute of Social, Economic and Humanities Research (HESPI), Vidzeme University of Applied Sciences, have participated in two research projects aimed at rural areas. There is a wide range of research methods used in these research projects, which in combination with the existing scientific experience have led to conclusions regarding methods that produce higher yield, as well as allow to identify factors affecting application of specific methods. This research is based on the available statistical data, as well as work with specific focus groups (municipal employees, employers, NGOs), it includes field studies and extensive surveys of the residents, evaluation of specific cases and success stories. Furthermore, it includes modelling of future development by applying the Delphi method. As a part of this research evaluation of the historical evolution of processes and development, as well as analysis of the relevant administrative structure has been carried out. The main purpose of this paper is to examine and evaluate effectiveness of the methods used in researching rural areas in Vidzeme region of Latvia. In both research projects scientists faced similar problems and challenges that created obstacles in attaining the objectives of the research. The results of the research allow determine what methods are the most effective in researching socioeconomic aspects of modern rural areas, and allow to identify both objective and subjective factors preventing application of several methods, and also offer solutions for improving current research methods.

Key words: Rural area, research methods, Vidzeme region.

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Development possibilities of rural area in Vidzeme region: comparison to other regions of Latvia and analysis

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Abstract. The main purpose of this paper is to investigate situation in Latvia's rural areas, analyse situation in Vidzeme region and develop proposals for fostering smart, inclusive and sustainable growth of Vidzeme rural area. In this research the following complimentary quantitative and qualitative methods of work and gathering of information were used: analysis of data and documents, publications in data bases and surveying of residents, and focus groups. The obtained results indicate a direct link between the situation in Latvia's rural areas and in the nearest major city. Taking into account tendencies of rapid urbanisation, the authors have concluded that the development of Vidzeme rural area should be fostered through advancement of Valmiera city.

Key words: municipalities, Riga region, sustainable growth, urbanisation.

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The construct of value in knowledge-intensive business service from customer's perspective. An example of a long-term training activity

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Abstract. Value is considered to be the driver, as well as the main purpose, of relationships between customers and service providers. Despite the topicality of the subject, service marketing literature provides little information about the process of value creation. The question of how is value formed is topical for a broad scope of services, from healthcare to beauty services, but it is especially relevant for knowledge-intensive business services (KIBS). KIBS are complex offerings that aim to solve customer's problem by applying competence of service provider (for example consultancies and training services). It happens quite often that those types of services fail to meet the expectations of the customer regarding service value. This mismatch between service value and price charged might come from a broad variety of reasons. This ambiguity of value creation process leads to the research question of the current article: how do clients identify, what the service is actually worth? The current article presents the results of longitudinal qualitative research on service value formation from the customer's perspective. It aims to provide insights both for researchers as well as practitioners on elements of service, based on which client forms the perception of the value of KIBS and also illustrated the dynamics.

Key words: service value, customer value, value creation, co-creation, value-in-experience, KIBS.

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Fertilizer use efficiency impact on GHG emissions in the Latvian crop sector

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Abstract. Within increasing production activity Latvian agricultural sector has become one of the main sources of greenhouse gas emissions (GHG) in Latvia. In 2013, agricultural sector contributed 21.0% of the total GHG emissions originated in Latvia (2310.1 Gg CO₂eq). Analysis of agricultural GHG emissions by sources shows that direct N₂O emissions from agricultural soils through the usage of synthetic fertilizers are one of the most significant GHG source in Latvia. The usage of synthetic fertilizers is one of the most common widespread agricultural practices in Latvian cropping systems and according to statistical data usage of synthetic fertilizers is constantly increasing, for example, in 2013 it increased by 6.9% if compared with 2012. Taking into account that over-fertilization can lead to negative economic and environmental consequences, such as high production costs, depletion of energy resources, and increased GHG emissions, this research aims to estimate how effective usage of synthetic fertilizers are in Latvian crop farms. In order to achieve the set aim an N fertilizer usage were estimated in four crop farms by giving insight into N balance and N use efficiency (NUE) rate in these farms. Research results suggest that improved N efficiency can be selected as GHG mitigation measure as it reduces N surpluses and the use and production of mineral fertiliser while maintaining yield levels. It was also concluded that improved N efficiency reduces direct N₂O emissions from fertilized soils and indirect N₂O emissions that occur by the release of NH₃.

Key words: GHG, emissions, nitrogen use efficiency, Latvia.

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Ethics audit as a marketing instrument and its potential for organic farming

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Abstract. Demand for organic foods is growing quickly but remains to be a relatively small segment of the food market. In order to increase the market share there is important role in an effective and smart marketing communication. According to many researches consumers are mostly interested in additional ethical attributes in organic food producing. Organic food farmers' ability to earn profit from experience marketing according ethical values in organic food production is rather weak. At the same time organic farming faces many significant ethical risks from unregulated area of organic food-production. Consumer trust in environmentally friendly or organic products is often being undermined by business scandals, unsubstantiated 'organic' claims and assessment practices. The current paper aims to improve ethics audit framework as a marketing instrument for organic farming companies in order to increase the trust between producers and consumers. This paper draws upon previous researches and adds new approach based on the needs of organic farming.

Key words: ethical values, organic producing, marketing communication, risk assessment.

Quality labels in Estonian food market. Do the labels matter?

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Abstract. The current study investigates the consumers' perception of quality labels for Estonian food. Based on empirical findings from a representative population survey, this paper analyzes and discusses consumers' attitudes and the behavioural consequences towards two quality labels and related campaigns: *the best Estonian foodstuff and the sign of national flag*. The representative survey was fielded annually, at first in 2009 following in the years 2011–2015. Every wave comprises the answers of 1,000 Estonian inhabitants. Employing the same methodology over the time the current study achieves an understanding of development in consumer awareness the quality labels and the impact of those labels on the purchasing behaviour. The paper enables to estimate the effectiveness of launching quality labels for foodstuffs and concludes that the labels serve their purposes.

Key words: quality food labels, consumer behaviour, hierarchy-of-effects (HOE), consumer decision-making.

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Performance trends as a prerequisite for smart growth in the rural territories of Latvia

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Abstract. Any country is interested in economic growth regardless of its development level at the current period; yet, an increasingly important role in defining growth is played by the term smart growth. The EU development strategy until 2020 defines smart growth as a strategic objective (EC. Europe 2020). For this reason, economic performance trends towards smart growth and smart specialisation have become an urgent task in project No.5.2.3 'Rural and Regional Development Processes and Opportunities in Latvia in the Context of Knowledge Economy' in National Research Programme 5.2. 'Economic Transformation, Smart Growth, Governance and Legal Framework for the State and Society for Sustainable Development - a New Approach to the Creation of a Sustainable Learning Community: EKOSOC-LV'.

The research performed by the authors gives insight into the socio-economic performance trends towards smart growth in Latvia's regions and particularly municipalities, which are typical local administrative units in the country. The research employed Lursoft, Central Statistical Bureau and RDIM (Regional Development Indicator Module) databases for the period 2009-2013, examining the information acquired and performing horizontal and vertical analyses and data grouping, in order to identify the accumulation of positive/innovative changes. For a detailed examination of the mentioned phenomena, Zemgale region was selected as an average development level territory in Latvia. The research led to a conclusion that an increase of the proportion of knowledge-based goods (produced by high-tech and medium high-tech enterprises) and knowledge-intensive services in the overall increase of output in Zemgale region was greater than an increase in the total number of enterprises. Growth was observed both in 'accessible' territories and in 'remote' territories at different population decline rates etc. The latter allows considering that smart growth is determined not only by objective circumstances but also by local authorities, the activity of various public institutions and the readiness of residents to act under the guidance of the mentioned structures, which have to be taken into consideration when working on a territorial development strategy and achieving the objectives set in the strategy.

Key words: performance, smart growth, municipalities.

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III BIOENERGY

Biogas potential from animal waste of Marmara Region-Turkey

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Abstract. The purpose of this study was to determine the biogas production capacity from animal wastes in Marmara region of Turkey for the years 2005–2014. The wastes from the cattle and hen in the region were considered the resource for biogas production taking the number of animals and the collectability of the wastes into the account. Three scenarios were evaluated to estimate the biogas capacity by assuming that 100% (theoretical potential), 50%, and 25% of the total animal waste could be used for biogas production in the region. For theoretical biogas production from cattle wastes, the greatest potential in the year 2014 was calculated for Balıkesir province with 145.53 Mm³, followed by Çanakkale, Bursa, Sakarya, and other seven provinces. Balıkesir had the highest biogas potential in 2014 from the poultry waste, too, followed by Sakarya, Kocaeli, Bursa, and other seven provinces. Biogas potential (100%) of Marmara region increased by 15% from 2005 to 2014 with 1,242.17 Mm³ in 2014. The heat and electrical energy equivalents of the biogas were found to be 7,453.02 GWh and 2,608.56 GWh_e, respectively. In the other two scenarios, depending on the utilization rate of theoretical biogas potential: biogas amount, heat and electric power values were determined proportionally.

Key words: Renewable energy, biogas, animal waste, Marmara region.

Material waste paper recycling for the production of substrates and briquettes

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Abstract. This Article is focusing on recycling waste paper, which became one of the main collecting commodities for its widespread use in many economic regions. The introduction provides an overview of the development of a segment of waste paper in the EU. The article presents information about product options, new materials from processed waste and waste paper. The first part of the article describes the situation in the Central Bohemia region both in terms of production and in terms of processing capacities. The next part of the article contains the practical information and value gained from the process of production of briquettes from waste paper and the description and analysis of technologies as well as description and analysis of achieved physical characteristics of manufactured briquettes. Another mentioned option for using waste paper is the application in substrate production technology as an input material with excellent physical properties, which could become an indispensable component in the production of high-quality substrates. The resulting values indicate a higher absorption capacity of fluids that are substrates of biodegradable materials. In both technologies there are present variations of the different samples and their ratios used to manufacture the final products and are shown in the resulting comparison.

Key words: biodegradable municipal waste, material recycling, composting, production of briquettes.

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Potential use of macroalgae *Fucus vesiculosus* for bioenergy production in Latvia: A review

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Abstract. Washed ashore brown algae *Fucus vesiculosus* biomass is causing recreational problems for local inhabitants and tourists. Biofuel produced from plants, animals or algae products can offer an alternative to reduce our dependency on fossil fuel and assist to maintain healthy global environment. Increasing biomass demand for biofuel production is challenging because of limited land and freshwater resources. Previous studies of potential use of *Fucus vesiculosus* shown that, due to high levels of heavy metals in seaweed, it is not recommended to use *F. vesiculosus* in food and pharmacy and was suggested to use as a feedstock for biofuel. High levels of structural polysaccharides and low lignin contents make seaweed attractive feedstocks for production of liquid biofuels via fermentation and biogas production via anaerobic digestion. This review discusses biofuel and bioenergy production from *Fucus vesiculosus* and investigates opportunities, problems, advantages, disadvantages and other issues of this emerging industry. Biomethane, biodiesel and bioethanol was considered as potentially best types of biofuels. Literature studies shown that brown algae is not suitable for biodiesel due to low level of triglycerides and neither for bioethanol because of lack of easily fermentable sugars. Best use is to use it as a feedstock for anaerobic digestion conversion processes.

The properties of wheat straw combustion and use of fly ash as a soil amendment

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Abstract. Agriculture is one of possible producers of by-products suitable for energy purposes, such as rapeseed and wheat straw. But on the other hand, not only thanks to the support of energy from biomass grown specifically for this purpose, arable land is exposed to intense cultivation of wide-row crops indirectly supporting soil erosion and nutrient elution. The issue of recycling ash from biomass combustion on agricultural and forest land is very important to resolve. Experience with this problem is found in countries in Northern Europe such as Finland or Sweden, as well as in North America. Due to ash characteristics, it is considered a valuable soil component and a potential replacement for conventional fertilizers.

Elemental analyses of samples from wheat straw pellets were followed by combustion and emission measurements. The effects of temperature and volume of air in the combustion of wheat straw was analysed, focusing on emission concentrations and the ash content. Effect of excess air coefficient on the composition of end products after combustion was assessed in three modes (small, optimum and high coefficient of excess air). During the measurements, the excess air coefficient ranged between the values from 3.95 to 14.89. The average net calorific value of the wheat straw samples was 15.55 MJ kg⁻¹ in the original state. Mineral composition analysis of solid combustion products, necessary for using these residues as a fertilizer or soil component, was performed as well.

Key words: wheat straw, elemental analysis, ash, soil amendment, excess air coefficient.

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Mechanical durability of briquettes from digestate in different storage conditions

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Abstract. A present research was conducted to determine mechanical durability of digestate briquettes and potential influence of different storage condition. Experiments were performed on briquette samples produced from digestate feedstock with moisture content of 8.2%, ash content of 10.9% and gross calorific value of 17.15MJ kg⁻¹ by hydraulic piston press with working pressure of 18 MPa with external diameter 50 mm and length 40–60 mm. Briquette samples were divided into two groups and stored inside and outside building. Both groups were subjected to five experimental testing during specific time period from May until late November 2014. Mechanical durability of each briquette was measured after every testing, subsequently overall mechanical durability of specific groups was calculated. Results showed the lowest mechanical durability after first measurement: 98.85% for Group 1 and 98.95% for Group 2. The biggest change in mechanical durability was observed between first and second testing, values of following measurements were approximately equal. The highest mechanical durability was achieved after fifth testing: 99.65% for Group 1 and 99.63% for Group 2. It implied mechanical durability equal to 99.44% for Group 1 and 99.45% for Group 2 in average. Research proved very high mechanical durability which corresponds to the highest category of this quality indicator given by standard EN ISO 17225-1. Difference between mechanical durability of groups stored in different conditions was considered as minor. Thereby briquettes made from digestate are not only secondary product of proper waste management, effectively modified fertilizer but as was found by results of this research it is also suitable fuel with outstanding mechanical properties.

Key words: biomass, densification, biofuel, abrasion resistance, renewable energy, quality control.

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Applying simultaneously encapsulation/ dehydration and cryopreservation method for long-term storage of cyanobacteria

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Abstract. Cryopreservation at ultra-low temperatures in liquid nitrogen (LN at $-196\text{ }^{\circ}\text{C}$) is the method of choice for the long-term conservation of microalgae. It has significant advantages; protection from any genetic drift and storage under suitable conditions, minimum risk of contamination by other microorganisms. Cryopreservation method has been successfully implemented for many microalgae so far, however, microalgae and cyanobacteria constitute a highly diverse group and there are many types, which can not survive when the cryopreservation method is applied alone. Ice crystals formed during freezing of the water in the cells of cyanobacteria causes degradation by damaging cell integrity. Another storage method, encapsulation/ dehydration with alginat beads, can be applied with cryopresevation for long time storage of cyanobacteria. The alginat beads protect cyanobacteria cells from mechanical effects of ice crystals which occurs during the freezing and oxidative stress. This study investigates the applicability of encapsulation/dehydration, a vitrification-based cryoprotective strategy for cyanobacteria in Ege Microalgae Culture Collection (EGEMACC). Encapsulation/dehydration was applied to cryopreserve for 10 cyanobacteria species. Cyanobacteria spesices were incubated in 100 ml flask containing 50 ml of BG-11 medium at $22\text{ }^{\circ}\text{C}$ under $20\text{ }\mu\text{mol photons m}^{-2}\text{s}^{-1}$ for 15 days. Liquid cultures were concenrated and the supernatant was decanted. 5% (w/v) sodium alginate (SigmaR A-2158) prepared in BG-11 medium was added into the cell suspension with the ratio of 1:1(v/v). The alginate/cell mixture was dispensed drop-wise into 100 mM CaCl_2 solution and beads equilibrated and allowed to polymerize for 30-60 min. Then dried beads were transferred to cryovials (~ 10 beads per cryovials) containing % 0-5-10 DMSO in BG-11 medium and cryopreserved in LN at $-196\text{ }^{\circ}\text{C}$ for 30 days. Viability of the cyanobacteria cells were determined with *fluorescein diacetate (FDA)* staining and pour plate technique.

Along with this work, the versatility of the encapsulation/dehydration method to cryopreserve cyanobacteria was demonstrated and it can be said that encapsulation/dehydration is feasible alternative to controlled rate cooling for preserving cyanobacteria held in EGEMACC.

Key words: culture collectsiön, cryopreservation, encapsulation, cyanobacteria.

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The effects of cryopreservation on the fatty acid production of microalgae

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Abstract. Theoretically, microalgae can be stored without alteration for an unlimited period of time at ultra-low temperature. In fact, this is not the case. The concept of genetic stability after cryopreservation is untested. The cryopreservation process itself may induce various stresses on the organism via intracellular ice formation, cryoprotectant toxicity, and osmotic shock. During freezing, cryoprotectants and oxidative stress may cause the formation of free radicals, which may potentially lead to genetic alterations and morphological modifications. During the TUBITAK (The Scientific and Technological Research Council of *Turkey*) project 113Z202 'Determination and Optimization of Appropriate Cryopreservation Methods of Microalgae and Cyanobacteria' it has been found that cryopreservation causes morphological changes in microalgae. For example, frozen down microalgae cells by a cryoprotectant could be used as carbon source by microalgae and were getting smaller, while cells could not divide by freezing down with more toxic cryoprotectant, such as dimethyl sulfoxide (DMSO). Also it was seen that, fatty acids profile of cryopreserved cell can be changed depending on the cryoprotectant type and concentration.

In this study, the effect of cryopreservation on the fatty acid production of microalgae was examined. Two different axenic freshwater microalgae species (*Neochloris texensis*, *Chlorella vulgaris*) in EGEMACC (<http://www.egemacc.com/>) were incubated in 100 ml flask containing 50 ml of medium at 22 °C under 20 $\mu\text{mol photons m}^{-2}\text{s}^{-1}$ for 15 days. Liquid cultures were centrifuged and the supernatant was decanted. Microalgae cell were resuspended with fresh medium and adjusted to 10^6 cell/ml concentration. Cells were incubated with glycerol, dimethyl sulfoxide and methanol (5-10%) for 30 min at -20 °C, -80 °C for an overnight and then placed into liquid nitrogen (-196 °C) for 30 days. Fatty acid profile of the cryopreserved and non-cryopreserved microalgae were determined comparatively with Bligh and Dyer method.

The rapid decrease in temperature and type of cryoprotectant can influence the fatty acid production of microalgae.

Key words: Microalgae, cryopreservation, cryoprotectant, fatty acid.

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Diatom cultivation and lipid productivity for non-cryopreserved and cryopreserved cells

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Abstract. Many freshwater and marine algae can be cryopreserved, but typically with lower post-thaw viability levels. However, most of the algae groups (dinoflagellates, cryptophytes, synurophytes, and raphidophytes) cannot be successfully cryopreserved in these days. Marine diatoms can be cryopreserved and frequently have shown great viability. The aim of this study is to compare the cultivation and lipid productivity for non-cryopreserved and cryopreserved marine diatom cells. Diatoms preserved in the EGEMACC (Ege University Microalgae Culture Collection) are usually maintained by serial sub-culturing. In this study, the cryopreservation of marine diatom algae (*Amphora cf. capitellata*, *Cylindrotheca closterium*, *Nanofrustulum shiloi*) using the passive freezing system procedure was studied. Investigation into the cause of the freezing injury at the cellular level was made at different salt concentrations. Passive freezing method used in sea salts liquid media at the percentage of 1%, 2% and 3% containing cryoprotectant of 10% Me₂SO for six months in liquid nitrogen. *C. closterium* was obtained with the highest viability however *N. shiloi* was revival extended period of time. All of the diatom cells were grown in 1 L sterile bottle containing 900 mL of F/2 medium under the light intensity of 20 μmol photons m⁻² s⁻¹ at 22 ± 2 °C with the air flow rate of 1 L min⁻¹ for 15 days. The growth rate and biomass productivity were determined at the end of the batch production process. Also, lipid content of *A. capitellata* was obtained at the highest concentration compared to that of the other diatoms.

Key words: *Cylindrotheca closterium*, *Amphora cf. capitellata*, *Nanofrustulum shiloi*, cryopreservation, growth rate, lipid content.

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Biogas production from sugar rich waste

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Abstract. 56 biogas plants are working today in Latvia. There is need to investigate the suitability of various biomasses for energy production. Sweets production factories by-products are organic waste and wastewater featuring a high sugar content. Wastewater have a high chemical oxygen demand (COD) level and requires special treatment that results in additional input of energy and financial resources.

This article shows the results of two studies evaluating sugar-containing biomass suitability for the production of biogas.

The anaerobic digestion process of damaged jam and sweets factory wastewater was investigated for biogas production in 0.75 L digesters, operated in batch mode at temperature 38 ± 0.1 °C. The average biogas yield per unit of organic dry matter (ODM) from digestion of damaged jam was $1.114 \text{ L g}^{-1}_{\text{ODM}}$ and methane yield was $0.716 \text{ L g}^{-1}_{\text{ODM}}$. Average biogas yield from digestion of sweets production factory wastewater was $1.058 \text{ L g}^{-1}_{\text{ODM}}$ and methane yield was $0.663 \text{ L g}^{-1}_{\text{ODM}}$. All investigated sugar rich wastes can be utilised for biogas production successfully thus providing an environmental solution for wastewater problem of sweets production factories.

Key words: anaerobic digestion, sugar rich wastes, biogas, methane.

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Microalgae for biomethane production

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Abstract. Competition for arable land between food and energy producers has begun in Latvia. Biogas producers are seeking to use the hitherto unused land. There is a need to investigate the suitability of various biomasses for energy production. Maize is the dominating crop for biogas production in Latvia, but it is expensive to grow. The cultivation of more varied biomass with good economics and low environmental impact is thus desirable. Microalgae can be grown in pipes, basins and also in open ponds. This paper shows the results from the anaerobic digestion of microalgae *Chlorella vulgaris*, cultivated with fertilizer Varicon in open pond and harvested on 27 October and centrifuged (Study 1). The anaerobic digestion process was investigated for biogas production in sixteen 0.75 l digesters, operated in batch mode at temperature 38 ± 1.0 °C. The average methane yield per unit of dry organic matter added (DOM) from digestion of *Chlorella vulgaris* was $0.331 \text{ l g}_{\text{DOM}}^{-1}$. The second investigation (Study 2) used fresh biomass of *Chlorella vulgaris* harvested on 10–15 June with low dry matter content, as it was obtained from 4 m deep open pond without centrifugation. Anaerobic digestion process was provided in 4 digesters with volume of 5 l each. Average methane yield from the digestion of *Chlorella vulgaris* was $0.290 \text{ l g}_{\text{DOM}}^{-1}$, which is comparable to methane yield obtainable from maize silage or other energy crop silages. Microalgae *Chlorella vulgaris* can be successfully cultivated for biogas production from May to October or at least 170–180 days in a year under the agro-ecological conditions in Latvia.

Key words: anaerobic digestion, *Chlorella vulgaris*, biogas, methane yield.

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Identification of kinetics parameters of wheat straw and sugar beet pulp hydrolysis with sulphurous acid

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Abstract. The mathematical modeling of the conversion of hemicelluloses of wheat straw and sugar beet pulp into monosaccharides using diluted sulphurous acid (0.59 and 1.18% wt) at high temperatures was performed. Kinetic equation, activation energy, pre-exponential factor and reaction order of the acid catalyst were determined. It was shown that agreement between the experimental data and kinetic model is good. It was proved that the process proceeds in the kinetic region and the entire array of measurements of the yield of monosaccharides satisfactorily described by the model with the minimum number of steps. The model predicts a decrease of duration of the process and increase of monosaccharides concentration in hydrolysates of lignocellulosic feedstock with temperature increase.

Key words: dilute acid hydrolysis, hemicelluloses, sulphurous acid, kinetic parameters.

Model-based estimation of market potential for Bio-SNG in the German biomethane market until 2030 within a system dynamics approach

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Abstract. One option for energy provision from renewables is the production and grid injection of synthetic natural gas from lignin-rich biomass like wood and straw. Bio-SNG (biological produced synthetic/substitute natural gas) is the product of the thermochemical production of methane via gasification and methanation of lignin-rich biomass. The first commercial bio-SNG plant went successfully into operation in the end of 2014, in Gothenburg (Sweden). Regarding the huge potential of lignin-rich biomass bio-SNG is expected to have a high potential for a sustainable and greenhouse gas reducing contribution in power, heat and fuel markets. Being a future technology with great advantages like storability and transportability within a gas grid but recently too high prices for market implementation, possible future market shares are uncertain because bio-SNG has to compete with anaerobic biomethane as well as fossil alternatives. With the combination of an extensive techno-economic evaluation for present and future costs of bio-SNG depending on the feedstock supply chain and economy of scale, Delphi-Survey and a quantitative market simulation we determined future market shares for biomethane and bio-SNG for Germany under varying scenarios like incentive schemes, economy of scale and feedstock prices. Results indicate that substantial governmental support in terms of either R&D effort to lower bio-SNG prices or direct subsidies for a further capacity development is necessary to achieve significant market shares for biogenic methane.

Key words: bio-SNG, System Dynamics, Bioenergy markets, biomethane.

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Effect of cryopreserved *Haematococcus* cells on astaxanthin production in airlift photobioreactor

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Abstract. Astaxanthin is used as a pigment in aquaculture and food industries and has applications in pharmaceuticals and nutraceuticals because of its higher antioxidant activity than β -carotene and vitamin E. *Haematococcus pluvialis* is considered the most promising microalgae, as it accumulates the 3S,3'S-isomer of astaxanthin, mostly in its mono or di-ester form. The advantages of cryopreservation method (storage at ultra-low temperatures in liquid nitrogen for the long-term period) are the protection from any genetic drift and storage under suitable conditions for a long time, minimum risk of contamination by other microorganisms. The aim of this study was to investigate the effects non-cryopreserved and cryopreserved *Haematococcus* cells for astaxanthin production in airlift photobioreactor.

The cells were incubated in air lift photobioreactor containing 1.8 L BG11 medium for 30 days. The green stage of production was taken 15 days for cell growth and the red stage of production was taken 15 days for astaxanthin accumulation. A 2 L plexiglass internal loop air-lift PBR was equipped with an on-line controller (Biosis, Pikolab, Turkey), consisting of a combined temperature-dissolved oxygen probe and pH probe. The working volume was 1.8 L, the height and internal diameter was 55 and 6.4 cm, respectively. The height of the draft tube of the airlift PBR was 35 cm with an internal diameter of 2.4 cm. The pH was maintained at 8.0 by the automatic addition of 1 N HCl. The temperature was kept constant at 22 ± 2 °C in the temperature-controlled incubator. Air was supplied to the culture by air pump continuously and air flow rate was adjusted to 2 L min^{-1} (1.1 vvm) with flow meter (RST electronic Ltd. Sti, LZM-6T, Turkey). Illumination was provided by LED downlight lamps (Cata 10 W CT-5254) from the top of the PBR with a 16:8 h light:dark cycle photoperiod with the light intensity of $100 \mu\text{Em}^{-2}\text{s}^{-1}$. These investigations were carried out by the measurements of the absorbance values, cell counting, chlorophyll-a and chlorophyll-b, total carotenoid and astaxanthin amount.

After 15 days of green stage of production, the maximum specific growth rate of 0.148 day^{-1} , which correspond to the doubling time of 4.67 day was obtained for cryopreserved *Haematococcus* cells. It was found that cryopreserved *Haematococcus* cells shown much better performance than non-cryopreserved cells for the growth. On the other hand, the results for red stage of production will be presented in the congress.

Key words: Astaxanthin, *Haematococcus pluvialis*, air-lift photobioreactor, cryopreservation.

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Influence of lammas shoots on height of young Scots pines in Latvia

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Abstract. Scots pine is a commercially important tree species in northern Europe. Climate changes in combination with genetics cause differences in the tree growth rhythm, including the formation of lammas shoots. The aim of the study was to assess the relation between the occurrence of lammas shoots and the height of young Scots pines and its implications in tree breeding. Tree height was repeatedly measured, and the presence of lammas shoots was assessed at the end of the 4th through 8th growing seasons in two open-pollinated progeny trials (Daugmale and Norupe, both including the same 61 families) in the central part of Latvia. The proportion of trees with lammas shoots (max. 23%) decreased over the observation years. In both trials, at the age of 7 years, trees that had formed lammas shoot during at least one of the observed years were significantly ($P < 0.001$) higher than trees with no lammas shoots: 226 ± 3.5 cm vs 213 ± 3.3 cm in Norupe and 146 ± 3.9 cm vs 121 ± 1.9 cm in Daugmale, respectively. When only dominant trees ($1,000 \text{ ha}^{-1}$) were considered, the height superiority of trees with lammas shoots remained in Daugmale (trial with highest proportion of trees with lammas shoots), but not in Norupe. The earliest formed lammas shoots (assessed in the 4th growing season) had the strongest effect on the tree height. A correlation between the mean height and the proportion of trees with lammas shoots in the particular family was not found ($P > 0.05$).

Key words: second flushing, dominant trees, height superiority, open-pollinated family.

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Biomass gasification thermodynamic model including tar and char

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Abstract. Biomass gasification is a thermochemical process in which feedstock is heated to high temperatures in a condition of absence of oxygen. As a result, biomass is converted into the combustible syngas, which typically consists of carbon monoxide (CO), carbon dioxide (CO₂), hydrogen (H₂), methane (CH₄), nitrogen (N₂) and water vapour (H₂O). Biomass gasification process simulation plays an important role in gasification process comprehension and optimization. Typically, gasification models have only one output flow in the process mass balance, which represents the amount of the produced syngas. Tar and char also are significant products of gasification process. This study presents a thermodynamic biomass gasification model. The fundamental distinction of the proposed model, comparing to other available models, is that tar and char also are taken into account in developed model. Gasification process is affected by many factors. Similarly, the amount of produced tar and char can significantly vary depending on gasifier operation conditions. Literature review on the previous studies is done to determinate the most critical factors which affect tar and char formation. Results show that temperature in the gasifier, equivalence ratio and fuel properties have dominant effect on the products yield. Two regression models are elaborated to present the amount of the produced tar and char depending on independent variables. The achieved mathematical equations are added to the developed thermodynamic model of the gasification process. Biomass gasification process is simulated with different values of fuel moisture and equivalence ratio. The results show that produced syngas amount, calorific value and biomass energy conversion efficiency are more realistic after tar and char including in the model.

Key words: biomass gasification, syngas, tar, char, mathematical model.

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The early growth and fall frost damage of poplar clones in Latvia

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Abstract. The early growth and frost damage of *Populus* spp. was studied in two sites. The height of 23 five-year-old poplar clones was measured in the central part of Latvia; and the early-fall frost damage of 19 one-year-old and two-year-old poplar clones were assessed in the eastern part of Latvia. The relation between the height growth and frost damage of 16 clones, which were common for both sites, was assessed. The phenologically dormant stage was denoted for three clones, among which two are collected across Latvia (the origin un-known; introduced in 1960s). All the other clones had trees with damaged leaves and two clones had stem damage. The height of the clones ranged from 273.3 ± 60.2 to 711.0 ± 32.0 cm. The 3 most productive clones (LV3, LV1 and LV4) significantly ($P < 0.01$) exceeded others, by 34 and 65% for height and biomass, respectively. The mean height of these clones was 649.0 ± 21.5 cm and stem biomass varied from 33.7 ± 4.2 to 55.0 ± 6.4 t_{fresh}·ha⁻¹ (planting density 6,500 trees·ha⁻¹). The clone had significant ($P < 0.01$) effect on the phenological stage, leaf and stem frost damage, as well as on the height and stem biomass. No relation ($P > 0.05$) between the frost damage of leaves and both tree height and stem biomass was found. The results suggest that fast-growing frost-tolerant clones might be selected.

Key words: height growth, height increment, biomass, frost damage, frost tolerance, short rotation coppice.

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Long-term effect of spruce bark ash fertilization on soil properties and tree biomass increment in a mixed scots pine-Norway spruce stand on drained organic soil

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Abstract. Ash contains all plant nutrients, except N, and is often used to facilitate forest growth and to prevent nutrient depletion potentially caused by harvesting. In this paper, we report effects of a large dose of spruce bark ash on soil properties and tree biomass increment in a mixed Scots pine-Norway spruce stand on drained organic soil in central Latvia, 12 years after ash application. Significant positive growth response after wood ash fertilization was recorded only for overstorey spruce. During the 12 years after fertilization the additional volume increment was $8.3 \text{ m}^3 \text{ ha}^{-1}$ or $0.7 \text{ m}^3 \text{ ha}^{-1}$ annually. The effect of wood ash application is long-term. Also 12 years after treatment fertilized overstorey spruces demonstrated $0.6 \text{ m}^3 \text{ ha}^{-1}$ additional annual volume increment compared to the controls. Additional diameter increment increased during the first 10 years after treatment but started to decrease in 2012. Results demonstrate that ash fertilization did not change N availability in the soil, and additional growth can be explained with improved supply of P, Ca, Mg and other nutrients. Ash application did not significantly influence the chemical composition of the O layer.

Key words: Ash Fertilization, Biomass Increment, Scots Pine, Norway Spruce, Soil Properties, Drained Organic Soil.

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Mechanical durability and water absorption of pellets made from different tree species - a case study

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Abstract. Seven different tree species (coniferous and broad leaved) were selected for small scale pelletizing tests: birch (*Betula sp.*), aspen (*Populus tremula L.*), grey alder (*Alnus incana L.*), poplar (*Populus sp.*), European larch (*Larix decidua* Miil.), pine (*Pinus sylvestris*) and lodgepole pine (*Pinus contorta*). Tree species were mixed in different combinations and proportions. Wood mixture from one tree specie (several tree species were tested as base material during study) was used as base material with volume share in the mix at least 70% and mixtures from other tree species were used as additives. In total 49 different tree mixes were tested in pellet production where mechanical durability and water absorption was later measured for each sample. Mechanical durability where grey alder was mixed with pine was 98.8% (fulfils ENplus quality class). Poplar also showed high results and in some mixes meet the criteria for mechanical durability with best result 99% in mixes with European larch and lodgepole pine (proportions 80:10:10). From 9 different poplar mixes 7 of them showed mechanical durability higher than 97.5%. In tests where no additives was added (100% poplar), poplar pellets mechanical durability was 98.8%. Other mixes with birch, aspen and grey alder when they were taken as base material for pellet production (base material wood volume share in the mixture at least 70%, where remaining 30% consists of other tree specie mixtures) didn't meet the mechanical durability limit for ENplus quality classes and it was lower than 97.5%. Also in samples where birch and grey alder were used without adding other tree species durability was under 97.5%. European larch was the only one from coniferous trees was tested as base material and the best results in mechanical durability showed in mixes with lodgepole pine (proportion 70:30). From 9 different European larch mixes 7 of them showed mechanical durability higher than 97.5%, which is suitable for ENplus certification. Water absorption in pellets with different tree species composition does not change significantly and ranges from 0.70 to 0.73 ml g⁻¹ when in commercially available litter material it is 0.75–0.8 ml g⁻¹. Water absorption tests leads to a conclusion that if pellets mechanical durability is not sufficient to sell it as combustion material in could be sold as litter material for animals.

Key words: pellets, coniferous pellets, deciduous pellets, poplar pellets.

ACKNOWLEDGEMENTS. Research were done by implementation of European Regional Development Fund projects No 2013/0049/2DP/2.1.1.1.0/13/APIA/VIAA/031.

Combustion of briquettes from oversize fraction of compost from wood waste and other biomass residues

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Abstract. This article aims to determine experimentally the energy potential of samples from oversize compost fraction formed into briquettes. Theoretical combustion characteristics of the briquettes are determined and are compared with a reference fuel. Elemental analysis and stoichiometric calculations were performed for the samples. Classical grate combustion device with manual fuel supply was chosen for combustion tests. Flue gas temperature and emission parameters, such as the emission levels of carbon monoxide, carbon dioxide and nitrogen oxides, were monitored by a multi-purpose flue gas analyzer Madur GA-60. Dependence of these parameters on air input was followed.

Elemental analyses and stoichiometric calculations of individual samples indicate favourable properties of the energy compost for further energy utilisation, namely the gross calorific value of 16.42 MJ kg^{-1} . Excess air was causing high losses through heat of the flue gas during the experiments on combustion device. This fact occurred in a situation when the temperature of flue gas leaving the chimney reached high levels. The excess air coefficient also significantly influenced emissions of carbon dioxide and monoxide and nitrogen oxides in the flue gas. The trends are analysed statistically and are expressed by regression equations. The results can serve in practice for optimization of combustion processes in grate boilers with manual feed of the fuel.

Key words: biomass, combustion device, calorific value, combustion gases, heat loss.

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Influence of Mechanical Pre-treatment on Fermentable Sugar Production from Lignocellulosic Biomass

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Abstract. Mechanical pre-treatment of lignocellulosic biomass has been extensively applied in biofuel production despite its high energy requirements. To balance the consumed energy with the energy produced, careful selection and evaluation of pre-treatment parameters, equipment and desired outcome is needed. The study aims to determine optimal hay and barley straw biomass particle size in view of sugar yields, energy consumption and treatment time. The results show that there is no significant difference ($p > 0.05$) in sugar yields from hay biomass with particle sizes 0.25 mm, 1 mm and 10 mm. Energy requirements for the production of 1 kg of sugar from hay range from 1.8–10.7 MJ. At the same time barley straw proved to be inappropriate for sugar extraction due to low sugar yields (below 40 mg g⁻¹ dry mass) and high energy consumption (18.5–76.2 MJ to produce 1 kg sugar). Thus, after the careful selection of biomass, mechanical pre-treatment followed by enzymatic hydrolysis can be an effective technique in biofuel production from biomass.

Key words: lignocellulosic biomass, pre-treatment, fermentable sugars, milling.

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Intra-annual dynamics of height growth of Norway spruce in Latvia

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Abstract. Norway spruce (*Picea abies* (L.) Karst.) is a tree species with the highest economic importance in northern Europe. Therefore, it is important to improve knowledge of the potential effects of climatic changes on the growth of this tree species. An essential part of the information is the tree's intra-annual growth cycle. There are comprehensive studies describing the formation of radial increments of coniferous trees; however, information on height growth in hemiboreal forests is scarce. The aim of our study was to characterize the intra-annual height growth of Norway spruce in Latvia. The data was collected from two Norway spruce trials located in in former arable and forest land in the central part of Latvia, including 89 and 68 open-pollinated families (respectively) of plus-trees. Weekly height increment measurements of 20 trees per family were carried out during the 9th growing season. Growth intensity culminated in 10 ± 0.2 mm day⁻¹, following similar trend, but resulting consistently in significantly different values between the trials; the higher growth intensity was observed in higher trees and families, which also showed higher frequency of lammas shoots, boosting their height superiority even further. Significant family effect on all coefficients of shoot elongation curves, described by Gompertz model, was found. Both tree height and height increment at family mean level was strongly correlated with the asymptote parameter ($r_{fam} = 0.93$, $P < 0.01$) and the growth rate parameter ($r_{fam} = -0.70$, $P < 0.01$).

Key words: *Picea abies* (L.) Karst, height growth, shoot elongation, growth intensity, open-pollinated family.

ACKNOWLEDGEMENTS. Study was funded by Latvian Council of Science project 'Adaptive capacity of forest trees and possibilities to improve it' (No 454/2012).

Washed-out marine brown macroalgae *Fucus vesiculosus* as substrate for anaerobic digestion: biological methane potential batch tests

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Abstract. The article focuses on finding the optimal pre-treatment method for biogas production from washed ashore algae (mainly consisting of *Fucus Vesiculosus*). Mechanical pre-treatment methods are tested. It includes resizing of algal substrate (cutting by blade vs cutting combined with use of pestle) and the use of microwave on substrate. Batch tests are carried out at 37 °C, in batches with working volume of 60 ml. As inoculum waste water treatment sludge before and after digestion was used. Incubation time 30 days.

Key words: anaerobic digestion, macroalgae, biogas, BMP.

ACKNOWLEDGEMENTS. The work has been supported by the National Research Program 'Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)'.

Efficient use of arable land for energy: Comparison of cropping natural fibre plants and energy plants

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Abstract. With focus on renewable energy from agriculture governments can either support the growing production of energy crops or it can invest in technology or measures to reduce the energy consumption. But what is more efficient with regard to the use of the limited resource arable land: to insulate a building with fibre material grown on arable land to reduce the heating demand or to use such land for growing energy plants for the sustainable energy supply of a building? To answer this question, a long term balance calculation under consideration of numerous framework parameters is necessary.

Based on traditional fibre plants like hemp, flax, and woody fibre crops (e.g. poplar), these agricultural plants and their processing to insulation material were examined. Based on available data for the typical building structure of detached and semi-detached houses in Germany, models of buildings were developed and the accessible potentials for heating energy savings by using suitable insulation measures with natural fibre materials were determined. As a comparable system for the supply of renewable energy, bio-methane from silage maize was chosen, since it can be used efficiently in conventional gas boilers for heat generation. The different levels of consideration allow the following interpretations of results: in a balance calculation period of 30 years, the required acreage for heating supply with methane can be reduced by approx. 20%, when at the beginning of the use period fibre plants for the insulation of the houses are grown on the arable acreage. Contrariwise, to compensate only the existing loss in heating energy due to inadequate insulation of older detached and semi-detached houses (build prior to 1979) an annual acreage of approx. 3 million ha silage maize for bio-methane would be required in Germany. Therefore, from the land use perspective the production of biogas plants in agriculture for heating should be accompanied by the production of fibre plants for a reasonable improvement of the heat insulation of houses.

Key words: natural fibre plants, fibre, bioenergy, biogas, heat insulation, heating.

New constructs for ethanol production via cyanobacteria

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Abstract. Alternatives to fossil fuels must be developed due to several already known reasons. Bioethanol can be an attractive energy concept. Bioethanol gasoline hybrid fuel can be used by most internal combustion engines. First and second generation bioethanol production is already available – here agricultural crops or residues are utilised. There are controversial discussions about these bioethanol production methods – the food versus fuel debate, cost and energy efficiency. Alternative advanced bioethanol production must be established with competitive production costs. Photosynthetic prokaryotes like cyanobacteria are attractive organisms for this purpose – these prokaryotes are fast growing organisms and utilize solar energy and CO₂. But these prokaryotes must be genetically manipulated for ethanol production. In this study transformation was performed using homologous recombination to introduce the pyruvate decarboxylase (*pdh*) and alcohol dehydrogenase B (*adhB*) genes of *Zymomonas mobilis* into the photosynthetic prokaryote *Synechococcus elongatus* PCC 7942 genome. These cyanobacteria grow in fresh water and seawater or even in wastewater. Both genes were expressed under the control of the strong constitutive promoter of *psbA1* gene (encoding photosystem II protein D1). Various cloning strategies were done. Each construct was transformed successful in *Synechococcus elongatus* PCC 7942 and the potential bioethanol production was determined with HPLC. Only one construct produces bioethanol at detectable level. Diverse reactors and scale up steps were done to increase the bioethanol production. Anyhow further cloning strategies must be implemented to improve the production rate to achieve an effective bioethanol production from *Synechococcus elongatus* PCC 7942.

Key words: bioethanol, third generation, cyanobacteria, genetic manipulation.

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Ground flora in plantations of three years old short rotation willow coppice

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Abstract. Short rotation willow coppice plantations are widely used for biomass production over the world. However, their effect on local biodiversity has not been fully elucidated. Ground flora cover of willow plantations are functionally diverse and contains high richness of plant species. The vegetation structure depends on soil type, previous land use, management practices (for example herbicide and fertilizer use) and frequency of harvesting. Investigation of ground vegetation and soil analyze were conducted in seven willow SRC plantations in Central Latvia, Skrīveri municipality. The objective of this study was to evaluate the influence of light availability, plantation age, and soil properties on ground vegetation species composition in three years old short rotation willow coppice. Plantations consist of various willow clones, planted in rows. Weed control was carried out during the first year of plantation establishment.

The qualitative and quantitative proportion of species, including species percentage cover and the mean Ellenberg indicator values were calculated. In total, 64 vascular plant species and two tree species were found in the willow coppice ground vegetation layer. Perennial plants dominate in ground vegetation (constitutes 81% of the identified species). For most species, percentage cover was 10–20% within each plot, but percentage cover of *Achillea millefolium* L., *Elytrigia repens* (L.) Nevski and *Agrostis gigantea* Roth was more than 40% in some plots.

Key words: Ellenberg indicator values, ground flora, weed species, willows, plantations.

The evaluation of biomass yield and quality of *Phalaris arundinacea* and *Festulolium* fertilised with bio-energy waste products

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Abstract. Tall growing perennial grasses such as *Phalaris arundinacea* and *Festulolium* can be used as an alternative source for bioenergy production in northern latitudes as they can be grown in less cultivated areas and can be potentially used as a dual purpose crop (bioenergy and forage). The aim of studies was to investigate the effectiveness of using bioenergy waste products – fermentation residues (digestate) and wood ash as fertilisers for perennial grasses. The field experiment was conducted in the central part of Latvia (56°42' N and 25°08' E) from 2013 to 2015. For all fertiliser treatments (wood ash, digestate once per season; digestate twice per season and mineral fertilisers) the same amount of plant nutrients (N, P, K) was applied annually: N (100), P₂O₅ (80), K₂O (160); and the missing quantities of elements in ash and digestate were compensated by mineral fertilisers. Dry matter yield (DMY) in two harvest regimes (single cut and two cut) and chemical composition (ash content; total C and N) of grass biomass partitioning among tillers, leaves and panicles were estimated.

Biomass yield in the three years of use varied considerably depending on the fertiliser, harvest regime and species, ranging up to 10.0 Mg ha⁻¹ for RCG and 7.73 Mg ha⁻¹ for festulolium. All fertilisers provided a significant increase of DMY, however, better results for both species were obtained using wood ash and mineral fertilisers. The harvest regime and species affected directly the quality of biomass, single cut of RCG contained significantly less ash and more carbon. There were significant differences between sward fractions – culms in comparison with leaves contained less ash and nitrogen, and more carbon, what are desirable features for solid fuel.

Key words: perennial grasses, dry matter yield, chemical composition, fermentation residues, wood ash.

Explosive decompression pretreatment: nitrogen vs. compressed air

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Abstract. Lignocellulosic material is the most promising feedstock for the bioethanol production however, due to complicated physico-chemical characteristics of biomasses, it is necessary to pretreat the biomass before the bioethanol production. The goal of the pretreatment is to open the biomass structure for enzymatic hydrolysis to gain higher sugar and ethanol yields in further processes. In this paper a novel explosive decompression pretreatment is studied where two gases – nitrogen and compressed air are utilized for pressure generation. For this, traditional three-step bioethanol production process was used, where explosive decompression pretreatment with N₂ gas or compressed air was applied for biomass pretreatment. Glucose and ethanol concentrations were measured during the process. Glucose and ethanol yields and process efficiencies were used to evaluate the effect of explosive decompression pretreatment and its suitability for biomass pretreatment in bioethanol production process. Results show that the highest glucose yield was gained when nitrogen gas was used, while difference in glucose yield compared to that of autohydrolysis was negligible when compressed air was applied.

Key words: lignocellulose, explosive decompression, bioethanol, pretreatment.

Small- and medium-scale biogas plants in Sri Lanka: Case study on flue gas analysis of biogas cookers

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Abstract. Biogas technology has received attention in Sri Lanka already from the initial days of the energy crisis in 1973. Biogas production by anaerobic fermentation is a promising method of producing energy while achieving multiple environmental benefits. The study was carried out in the different areas of Sri Lanka at the level of biogas plants owners ($n = 51$) and local consultants ($n = 4$) in August 2014. Methods of data collection included semi-structured personal interviews and questionnaire survey. Further, at 51 biogas plants flue gas analysis was done through the portable device TESTO 330-2, which is capable of capturing the gas concentration of CO and NO; consequently by recalculating the concentration of CO₂ and NO₂. Surprisingly, the quite high concentration of CO was detected $c(\text{CO}) = 1,008.92 \text{ mg m}^{-3}$, which might be caused by one and/or various combinations of the following factors such as insufficient burning, inappropriate biogas cookers and inappropriate maintenance. The concentration of NO is under the value of 0.046 mg m^{-3} , which is under the permissible exposure limit of nitric oxide. Average temperature of flue gas is within the typical flue gas exit temperature for burning in biogas cookers ($TS = 449.16 \text{ }^\circ\text{C}$) and flue gas excess air (4.0%), however the air/gas efficiency (54.0%) was recognized at lower value than the optimal one for small- and medium-scale biogas plants. Easy energy access is a trigger for development, especially in terms of human, social and economic development and biogas plants represents a boon for farmers and rural people to meet their energy needs. However, further factors must be also examined and evaluated, such as exploration of gas composition and its microbiological content, emission analysis exploring particle size distribution, emission rates and potential harmful exposures.

Key words: biogas technology, biogas cookers, Sri Lanka, flue gas analysis.

ACKNOWLEDGEMENTS. This research was conducted with the People in Need project: ‘*Promoting Renewable Energy as a Driver for Sustainable Development and Mitigation of Climate Change in Sri Lanka*’ (funded by European Commission), also thanks belong to all PIN Sri Lanka team. Further support was provided by the Internal Grant Agency of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, projects number [2015511307] and [20165006] and Internal Grant Agency of the Czech University Life Sciences Prague [20165003].

The effect of sulphur content on B20 fuel stability

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Abstract. The aim of this study was to investigate if a high amount of sulphur is favourable for the fuel blends' storage stability. The parameters that correlate with the storage stability of the fuel blends were compared with two B20 fuel samples consisting of 20 vol% biodiesel and 80 vol% fossil diesel. The studied parameters were the oxidation stability (OSI), acid number and kinematic viscosity. The measurements were carried out straight after mixing the blends, and again after 4 and 9 weeks. One of the B20 samples was prepared from rapeseed methyl ester (RME) and fossil diesel fuel containing 6.6 mg kg⁻¹ sulphur and the other from the same RME but the fossil diesel fuel contained 186 mg kg⁻¹ of sulphur. According to the results of this study, the fuel containing less sulphur had slightly better quality during the entire study. Though, the OSI of the fuel containing more sulphur decreased less in percentages than it did for the fuel containing less sulphur. As a conclusion, the study gives a reason to assume that the sulphur may be favourable to fuel blends' storage stability but it should be studied for a longer time to confirm this statement.

Key words: FAME, fuel blends, B20, diesel fuel, storage stability, sulphur.

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Impact of browsing damages on growth and quality of silver birch plantations in Latvia

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Abstract. Silver birch is widely used both in forest regeneration and afforestation of abandoned agricultural lands, since it has high productivity and phenotypic plasticity and is relatively seldom damaged by biotic or abiotic factors. In Baltic States significant browsing damage of this tree species had not been noted in contrast to other countries with notably higher ungulate population densities. Therefore the aim of our study was to evaluate the impact of browsing damages on tree and stand parameters as a basis for further recommendations for stand protection. Data for the analysis were collected in central Latvia (56°22'N, 23°7'E) in a large plantation with areas of different browsing intensity. At the age of 16 years, tree height and diameter was measured and traits characterising damages were assessed. Browsing had caused a significant decrease in survival: from 87% survival in areas with light browsing to 56% survival in areas with heavy browsing. Browsing had caused a reduction of tree growth: mean tree height in areas with slight browsing was 13 ± 0.4 m, but only 2 ± 0.3 m (i.e. reaching height of red deer and moose) in areas with heavy browsing. Heavy browsing had created irreversible loss of productivity: even if browsing would not continue, it would take double as much time for the birches in these areas to reach target diameter for cutting (27 cm) than in slightly browsed areas. Frequency of spike knots and crooked stems was statistically significantly higher for trees with browsing damage.

Key words: browsing, ungulates, spike knots, stem straightness, rotation period, *Betula pendula*.

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Investigations of fibre plants preparation and utilization of solid biofuels

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Abstract. Presented research results of technological-technical means and operations for solid biofuel preparation: chopping, milling, pelleting and burning of fibre plants – 3 sorts of fibre hemp (Beniko, Bialobrzeskie and Epsilon 68) and fibre nettle (sown in 60 x 60 cm). These fibre plants were grown in the experimental fields of Lithuanian Research Centre for Agriculture and Forestry, Upytė Experimental Station, and in Aleksandras Stulginskis University were investigated the technical means of these plants preparation and usage for energy purposes. It was used the standard methodology for solid biofuel preparation of fibre plants, and was investigated the technique for plant chopping, milling and pelleting. There were determined fibre plant mill fractional composition while usage the hummer miller prepared mill. There were determined the fibre plant pellet quality indicators – moisture content and bulk density. The fibre plant pellet moisture content ranged from 6.4% to 8.8%, and pellet density reached 1,082.7–1,186.2 kg m⁻³ DM (dry matter). Pellet elemental composition, ash content and calorific value were determined at the Lithuanian Energy Institute. The ash content after the burning of fibre plant pellet was not high and varied from 3.6 to 5.9%. Determined net calorific value of fibre hemp and fibre nettle dry mass was relatively high 17.2–17.5 MJ kg⁻¹, it was close to calorific value of some wood species.

Key words: Fibre hemp, fibre nettle, pellets, elemental composition, ash content, calorific value.

Application of conventional HPLC RI technique for sugar analysis in hydrolysed hay

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Abstract. To determine the potential biofuel yield and necessary technological parameters a known concentration and type of fermentable sugars should be produced during chemical or biological extraction from lignocellulose. The most popular method for sugar interpretation and quantification is liquid chromatography (HPLC) using refractive index (RI) detector. The aim of this research was to show the applicability of the high–performance liquid chromatography using refractive index (HPLC RI) technique for sugar interpretation in hydrolysed hay and possible solutions for optimisation of this method. Analysis of hydrolysed hay with standard additive showed low recovery of sugar concentrations and inconsistencies with dinitrosalicylic acid (DNS) method, which was mostly due to low separation of peaks of these sugars on the chromatograms. As result HPLC RI method was useful for qualitative analysis of sugars only, not for its quantification.

Key words: lignocellulosic biomass, sugar determination, DNS method, HPLC RI.

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Mass and energetic yields of hydrochar from brewer's spent grain

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Abstract. Brewer's spent grain (BSG) was hydrothermally carbonized at combinations of three temperatures (180 °C, 215 °C, 250 °C) and three reaction times (2 h, 5 h, 12 h). For comparison, the corresponding barley malt was also tested at the same conditions. Elemental composition, volatile matter, ash and heating values were determined for original biomasses as well as resulting hydrochars. The mass yield of dry BSG hydrochar ranged from 45 to 73%. The energetic yield defined as retention of total lower heating value in the hydrochar on dry basis ranged from 66 to 85%. Specific lower heating value of dry material rose from 20.6 MJ kg⁻¹ to 30.3 MJ kg⁻¹ at the most severe conditions. Nitrogen and sulphur content in hydrochar were not strongly dependent on reaction conditions.

Key words: hydrothermal carbonization, malt, calorific value, heating value, biochar, elemental composition.

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IV ERGONOMICS & ERGODESIGN

Telework as a possibility to prevent psychosocial stress from ICT use

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Abstract. Telework has become a natural part of regular work life of employees who use the information communication technology (ICT). By enabling working without significant need for commuting, it can be regarded as an option for employees to postpone their retirement. In the situation where stakeholders are concerned about ageing catastrophe, resulting from a continuous increase of a life span, the retirement age is hardly about to enhance. The objective of this research is to find out interactions between senior employees' telework and work stress. The main research question is - if telework can reduce the work stress. A secondary research question is - to find out if ICT usage differs by age. In the study, a survey method was used where work stress was measured with the Kiva method and several questions about telework and information communication usage were asked. The results showed that telework as a less stressful work form is exaggerated to some extent. However, telework can be neither underestimated nor taken as interchangeable with regular work in a traditional workplace. Therefore, it is necessary to pay attention to telework as a different way of working.

Key words: telework, ageing workforce, computer use skills.

The impact of information technologies upon the social interaction culture among employees in Latvian enterprises

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Abstract. The purpose of this paper is to explore the impact of information technologies upon the social interaction culture among employees in Latvian enterprises. To transform the available data and information into a valuable form for decision-making and subsequent actions, organisations have to provide an efficient communication circulation system, which is directly affected by each company's social interaction culture. Based on previous study results in Latvia the problem of the research is to reveal and assess how to increase mutual confidence among colleagues and encourage to share of information. Tasks of the study were to research the basis of the review of scientific sources and to study the organisational and individual factors affecting employees' perceptions regarding the role of information technologies in the information sharing process in Latvian organisations. The research showed that in organisations with positive social interaction culture, employees and supervisors socialize, interact and share information much more frequently in a verbal form, which promotes a sense of adherence to the organisation; information technologies, for their part, are used for creation of database and distribution of formal instructions.

Key words: social interaction culture, information sharing.

Workers' representation in OHS activities: Example of Estonian industrial sector

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Abstract. The safety level in 11 Estonian enterprises was investigated. Some of them have implemented OHSAS 18001 or belong to foreign corporations. These enterprises have generally good or very good safety level. The larger the enterprise is, the better are the possibilities to give regular training for the work environment representative (WER) in occupational health and safety. The study includes quantitative and qualitative study. The MISHA method is used as the tool for quantitative study. The parts from the interviews with the enterprises representatives' (management and employees) concerning the role of the WER in the safety performance (qualitative study) are included. The clarification and appropriate application of the WER's role and position are the key elements to raise the safety level at enterprises. Two hypothesis: 1) on the connections between the real and formal safety elements concerning WERs and 2) OHSAS 18001 implementation effectiveness on safety activities (including WERs' role improvement) were proved with statistics: Factor analysis were carried out with *KMO and Barlett's test, ANOVA and T-square test with Wilks' Lambda row*. Additionally, knowledge management in safety may enhance the activities among WERs and thus, increase the safety performance in enterprises.

Key words: work environment, safety and health management, management responsibilities in safety and health, work environment representative, safety activities at small and medium-sized enterprises.

Presentation title: ability to handle unfamiliar systems in passenger cars according to driver skills

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Abstract. This paper addresses the ability of drivers to intuitively control special passenger car systems that they have as yet not encountered in the course of their driving practice and therefore have no experience of them. The study described in this paper was conducted on a sample group of drivers without any prior experience of the tested model or of any other model of the same brand, and the functions and systems selected for testing were unique for the brand and model in question. The reason for conduction of this study was the endeavour to recreate the common situation in which a driver is forced to drive a car with whose controls he/she has not yet had the opportunity to become acquainted. Based on statistical evaluation of the obtained data, it proved that the initial hypothesis claiming the existence of a correlation between driver parameters such as age, gender or length and quality of driver experience and his/her ability to adapt to completely unknown car control systems could be confirmed. The results in this paper may be applied in the cabin and car control system design process, thereby enhancing the user-friendliness of passenger car controls, thereby also indirectly increasing road traffic safety.

Key words: Ergonomics, Experience, Evaluating, Vehicle, Information systems, Safety.

Comparative study of the noise levels: impact of renovation

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Abstract. Health effects from different noise exposures have been studied by many researchers. According to the frequency of the noise, the complaints induced differ. Some studies have shown that low frequency noise may have serious health effects from annoyance to sleeping disturbances. Using a sound analyser with 1/3 octave band sound spectrum analysis capability, measurements were conducted on a scientific research vessel. Measurements were carried out in cabins, mess hall and engine room. The results were then compared to the Estonian and International Maritime Organization's recommendations on noise as well as results from a previous study on the same vessel (previous study was conducted before the renovations to modernise both the engine and the cabins was conducted). The renovations did not have the desired effect on the overall noise levels of the vessel as a working environment; the noise values obtained after the renovations do not agree with the normative values during sailing. The situation has improved in several cabins on the vessel but the improvement is rather insignificant.

Key words: Noise, noise reduction, frequency analysis, vessel, occupational hazards.

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Dust pollution in the sport facilities

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Abstract. The aim of this paper is to present the results of microclimatic research focused on the dust pollution in several buildings and different rooms used for sport activities at the University. The attention is paid mainly to the problems of dimensions of space, capacity and activity of sportsmen, and influence of space ventilation. In the frame of this research the concentration of air dust was measured by the exact instrument DustTRAK II Model 8530 aerosol monitor. Using the special impactors the PM_1 , $PM_{2.5}$, PM_4 , PM_{10} size fractions were also measured. Obtained results of measurements were evaluated and concentrations of different size of dust particles were analysed. Results of different indoor conditions were generalized. Based on the results of measurements practical recommendations for the design, use and ventilation of these types of buildings were summarised in the conclusions.

Key words: air, dust fractions, gyms, indoor environment, swimming pool, ventilation.

Ventilation and microclimatic conditions in the laboratory of adhesive bonding

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Abstract. The aim of this paper is to present the results of the research focused on the ventilation and microclimatic conditions in the laboratory of adhesive bonding. This special large underground laboratory is used for the research and teaching purposes during the whole year. The experiments provided in the laboratory require the use of different chemicals, adhesives and glues for the preparation of specimens for the testing various methods of adhesive bonding of metals and wood. There are intensively released chemical pollutants into the indoor environment of the laboratory during those processes. If there are taking place in the lab at the same time the classes with students (maximum 26 persons) there are also produced in that space products of the metabolism. To ensure the hygienic conditions for researchers and students, the laboratory must be adequately ventilated, but it is also necessary to ensure the desired thermal state of the environment. The results of measurements of indoor microclimate in this laboratory during the adhesive bonding processes are also presented in this paper. The experience and new knowledge useful for the future research and practical designs are summarized in the conclusions of this paper.

Key words: chemicals, contamination, dust, temperature.

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Integrating ergonomics principles and workplace health protection and promotion to improve safety and health at work - evidence from Estonia

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Abstract. Previous scientific literature indicates that organisations manage workplace health promotion (WHP) in different ways. Despite conceptual and empirical justification, researchers have not consistently included concepts of WHP in ergonomics and safety studies.

The objective of the study is to explore workplace health protection and promotion activities available in Estonian organisations and to assess how ergonomic principles are integrated with workplace health protection and promotion within an organisation.

The current study adopted a multi-method approach. The WHP activities were evaluated using the questionnaire of 36 items administrated to all members (organisations) of the Estonian Human Resource Management Association. A qualitative approach includes eight case studies (organisations, with the best practices of WHP and ergonomic interventions), semi-structured interviews with human resource personnel.

The data reveal key issues in WHP management in Estonian organisations. A statistical analysis of WHP questionnaires shows many organisations with outstanding programs and positive employers' perceptions towards WHP. However, qualitative data indicate some important aspects of WHP and drawing attention to contextual variables in the development of safety management systems and improving the integration of ergonomics programs with WHP. The main contribution of the study is providing the conceptual clarification on incorporated WHP, how it complements a safety management system and showing its possible effect on employees' health, safety behaviour and on knowledge exchange. It is essential for the established WHP program to have a fully integrated part of safety management system in the organisation and employees' health and healthy behaviour must be recognised, acknowledged and be managed.

Key words: health protection, healthy workplace, ergonomics, health behaviour, health promotion.

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Drivers' mental strain evaluation when using automatic guidance systems in agriculture

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Abstract. Guidance systems in agricultural machinery are a common feature of modern farming. These systems bring together many advantages including possible reduction of fatigue to the operator and reduction of the operator's general workload influencing his work quality during agriculture machinery utilization. The article evaluates the level of mental strain, stress, difficulty of driving and operating machinery sets in fields by means of heart rate measurements. A group of different drivers with different machine sets were chosen and evaluated doing different field jobs, mainly soil cultivation and seeding. The exact position of the machine was monitored by GPS receiver and the heart rate was measured by means of a chest belt equipped with a heart rate sensor. The data from the sensors was collected during manual steering of the tractor-implement set and also during the complete automatic guidance steering without any intervention of a driver using DGPS guidance signal. The data was processed with special software compatible with the heart rate sensor and further statistically evaluated. The trials were performed at different farms in the Czech Republic in 2014. The outcomes showed a statistically significant difference between both experimental variants and proved a great benefit to guidance systems for drivers concerning mental strain and workload relief.

Key words: heart rate, guidance systems in agriculture, mental strain, driver's stress, machinery operation.

Shifting to proactive risk management: risk communication using the RAMP tool

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Abstract. Ergonomic risk factors are major contributors to work-related musculoskeletal disorders and quality deficiencies in the manufacturing industry. Due to lack of tools or systems that can support a systematic risk management of these production and health related factors, a new risk management tool (RAMP) was developed. In this paper, the risk communication system (the Results module) of this tool is presented along with a description of its development. An example of how it can be used, based on assessments performed in industry, is given. An evaluation of its usability, which included twenty practitioners active in the industry, gives support to the notion that the system is usable both for risk communication and as a decision base.

Key words: Risk assessment, risk reduction, manual handling, ergonomics.

CONFLICTS OF INTEREST. The authors declare no conflicts of interest.

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Software development for Qualimetical ergonomics of a workplace

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Abstract. Ergonomics is the science investigating the person and the activity within the process management aiming at improvements of labor conditions and labor process at workplace. The microelement analysis as part of ergonomics allows in quantitative measures estimate time that is expended and to analyse effective use of time, as one of the major indicators. Along with an indicator of time it is necessary to consider and other indicators influencing man during commission of labor process which can be presented in the quantitative form, using science a qualimetry. The aim of the research is to analyze scientific literature on qualimetical ergonomics of a workplace and develop software for practical evaluation of qualimetical ergonomics. At the crossroads of a qualimetry and ergonomics the system of the microelement analysis was discovered. The research provides approach in software development for the microelement norm-fixing at the beginning of process automation.

Key words: ergonomics, qualimetry, microelement analysis, workplaces.

Predictors and prevalence of musculoskeletal disorders among sewing machine operators

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Abstract. Musculoskeletal disorders (MSD) are a common and most often disabling problem among sewing machine operators and associated to work related factors. The aim of study was to determine work related and individual risk factors and the prevalence of MSDs among sewing machine operators and describe relationships between risk factors and MSDs. The data were collected in random sample method, using parts of a standardized CUPID (Cultural and Psychosocial Influences on Disability) questionnaire. The questions were focused on occurrence of MSDs in different body regions, in the past year and past month. The respondents assessed pain in the neck, lower back, and both on the right and left side of shoulders, elbows, wrists/hands and knees. The questions about individual, physiological and psychological risk factors and health behaviour were included.

The response rate was 43.9%, from 130 sewing machine operators fifty seven of them responded to the questionnaire. They all were women, in mean age 44.4 ± 8.6 years and with average body mass index (BMI) 26.8 ± 6.6 kg m⁻². The majority had work experience more than 5 years. Sewing work is monotonous, in steady sitting position, with repetitive movements in elbow, wrist and fingers during a whole workday. The most of respondents (93%) have reported poor autonomy to decide over the working schedule and 75.4% had low decision latitude over what and how to do work. The majority of sewing machine operators get support from the colleagues and management.

Musculoskeletal pain at least in one body site was measured in 91.2% of cases in the past 12 months and among 82.5% of respondents in the past month. More than half of participants reported pain in three or more body sites. The most often pain regions were lower back (66.7%), neck (61.4%), wrist/hand (50.9%) and shoulders (42.1%) in the past year, and neck (45.6%) in the past month. Pearson correlation analysis showed positive relationships between lower back pain and poor autonomy ($p = 0.02$) and BMI ($p = 0.05$) and repetitive elbow bending was related to neck and wrist/hand pain ($p = 0.05$, in both). Regular smoking was related to wrist/hand pain ($p = 0.003$). In conclusion, high prevalence of MSDs among the sewing machine operators has observed, whereas lower back, neck, wrist and shoulders were the most often reported pain regions. Lower back pain correlated positively with BMI and autonomy, smoking with wrist/hand pain and repeated upper limb movements with neck and elbow pain.

Key words: sewing machine operator, musculoskeletal disorders, risk factors.

ACKNOWLEDGEMENTS. The research team is much obliged to the sewing company management for help and guidelines in carrying out the study among the sewing machine operators.

Pulse-video method for determining the workload and energy expenditure for assessing of work environment

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Abstract. Examining the humans work load and energy consumption allows us to identify the energy used for working postures and techniques and thereby create solutions how to make work technology and work environment better and altogether improve an employees work ability. There are several methods in which human energy consumption is determined by working postures, type of work and handling of loads, they all take account only the physical load factors ignoring mental or microclimate factors in the work environment. In recent times there are also used the mathematical models, in which the energy consumption is determined on the basis of puls frequency. The methods are complicated to realize them in the work situation because they do not allow to determine the dynamics of the work load in the work process. The aim of this research was to develop a method that enables to use a computer to determine and analyse the work process on screen at real time and that shows the employee's heart rate, work load and energy consumption momentary load values as well as their dynamics. The method is based on continuous measuring the employees pulse rate in the working process without disturbing him and at the same time also filming work process to make a video to demonstrate the results. We introduce the methodology how to measure an employees pulse rate, work load and energy consumption dynamics to make a compiled video. There are shown the fragments of research results about a farmer's and glassblower's work.

Key words: physical work, workload, energy expenditure, pulse-video, pigfarmer, glassblower.

Comparison of reliability of monocriterial and multi-criteria of biometric identification systems

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Abstract. Biometric user identification is a highly topical theme these days. The most widespread areas are identification of a person on the basis of fingerprints and identification on the basis of facial features. Testing was conducted on two scanners only for fingerprints, and on two systems that recognize users via their fingerprints and also through a facial image. The conclusions from the measurements were that reliability was mainly affected by the characteristics of the scanners, in particular whether the scanner identifies only based on the fingerprint or in combination with another biometric method. Due to the fact that with combined systems manufacturers focus only on one identification circuit – usually the most modern - and not the potentially safest, i.e. a fingerprint, the results show that it is much easier to sabotage dual biometric identification devices than those that identify solely on the basis of a fingerprint.

Key words: fingerprint, false rejection rates, false acceptance rates, user, sabotage.

Group 0 to 0+ infant car seat use in Estonia

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Abstract. The purpose of this research is to describe knowledge of choosing and using the group 0 to 0+ infant restraint systems (children with up to 13kg weight). Three sample groups were studied to find out respondents' knowledge and skills. Sample groups were expecting parents, new parents and parents who are already using 0 to 0+ infant car seats. Expecting parents were surveyed in internet through connect.ee website and obtained 108 participants. New parents were surveyed in the maternity ward of the Hospital of Southern Estonia and obtained 28 participants. 12 participants who are already using infant restraint seats were interviewed and observed in parking places of shopping centres, NGO Õnnemaa family centre and found through personal connections. Results were used to find out the theoretical knowledge and practical skills of using infant restraint systems. Theoretical knowledge about child safety seats was good but in using restraint system there were several flaws and misconceptions. During winter the most common mistake was using infant restraint system with thick winter clothing what will lead to incorrect use of safety belts. For choosing restraint systems, parents found information mainly from internet and from friends and family. More than half of the people in the survey were planning to use child seats also outside of their vehicles. That poses additional risks of suffocation, overheating and falling from higher surfaces. The study revealed that the parents expect more reliable information than it is available now. Pregnant women expect more information from their doctors and midwives, and more hands-on training already before the child's birthdate.

Key words: 0 group child restraint system, 0+ group child restraint system, infant restraint system, infant car seats

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Comparison of MSDs development of Estonian office and garment workers

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Abstract. The aim of the paper was to investigate the structure of the factors influencing on the development of the work-related musculoskeletal disorders (MSDs) of two different employees groups: office and garment industry workers. The work conditions in these two workplaces are different. The first group is mostly exposed to psychological distress and less to physiological risk factors. The second group is more affected by non-ergonomics factors. Several different search methods were used in the study: the work conditions were assessed using flexible risk assessment method; the ergonomic risks were assessed with ART-tool; the workers' musculoskeletal complaints were assessed using the Nordic Questionnaire; the intensity of pain was assessed by the Visual Analogue Scale (VAS). The number of investigated workers was: 54 people from office and 49 from garment industry. As a result, the garment workers' group had significantly more musculoskeletal complaints. Self-reported muscle pain and discomfort complaints showed that the office workers' left hand was less strained than the right. It was confirmed in the studies determining the risk level by the ART tool at the workplace. The garment workers both hands are usually strained thereabout in the same level, only in the extreme conditions where the right hand is fulfilling special operations, the operating (right) hand is strained more. The results of the study give the possibility to work out the means for prevention and rehabilitation from the work-related musculoskeletal disorders.

Key words: work-related musculoskeletal disorders (WRMSD), garment industrial and office workers, self-reported musculoskeletal disorders.

Ergonomics risk analysis in construction operations

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Abstract. The research focuses on analysis of ergonomics risks among construction workers in different operations at work. The aim of the research is to carry out ergonomics risk analysis in various construction operations and to prove that physically hard manual work and application of force in manual work operations affect muscular fatigue, using objective and subjective risk assessment methods, including extended version of Nordic musculoskeletal questionnaire, myotonometric measurements, muscle's force determination with dynamometer. During the research it was proved that the combination of objective and subjective ergonomics risk analysis methods provides holistic approach and reliable ergonomics risk analysis results.

Key words: Ergonomics, construction, risk, hand grip.

Safety climate in Estonian nursing homes: a nationwide survey using the NOSACQ-50 questionnaire

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Abstract. The health care sector is one of the largest employers where it is possible to find a high risk of fatal and nonfatal occupational injuries, illness and absences from work. In the light of the above arguments, the present nationwide study is the first step in assessment of safety climate and relevant factors, which contribute to the safety of care workers and to the healthier workplace in Estonian nursing homes. The objective of the study is to assess the influence of different dimensions of the safety climate on (a) levels of safety among nursing homes, (b) workers' psychosocial and physical health, (c) patient safety and examine variations among national nursing homes.

Participants (n = 233) in the study represent 15 nursing homes in different regions of Estonia. The Nordic Safety Climate Questionnaire (NOSACQ-50) was used in order to explore care workers' shared perceptions and opinions towards safety related policies, procedures and practices in nursing home as well as their perceptions on their health.

The study results reveal, that management safety priority, commitment and ability has impact on six dimensions of safety climate. The stronger correlations were found between 'management safety priority and ability' and 'management safety empowerment'. Workers assess the dimensions of safety climate with high scores, however majority of respondents complain about physical pain, especially low back pain, and work-related stress. The current study reveals the main obstacles by assessing quantitatively safety climate in nursing homes.

Key words: health care, safety climate, psychosocial health, physical health, workplace safety.

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Changes in Air Ions Concentration depending on Indoor Plants Activity

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Abstract. Lack of negative ions in the air can cause deterioration of the health which is described in many scientific articles. At the same time, an air saturated with negative ions can improve the state of health and provide a comfortable indoor environment. In addition, there are considerable evidences that drowsiness, apathy, headache etc. get even worse indoors, and these health problems may be effectively eliminated with a help of moderate concentrations of negative ions.

Literature sources and earlier researches state that plants may be able to produce a variety of air ions, including negative light ions. The most plants emit different types of volatile organic compounds, and the indoor plants can improve the air quality: they effectively remove organic pollution and reduce the number of microorganisms in the air by releasing phytoncides. In this article, the regularity of influence of plants on the number of ions in the room is being proved, basing on a series of experiments performed with the following plants: *Spathiphyllum*, *Pinus mugo*, *Aloe arborescens*, *Chlorophytum comosum*, *Cactaceae opuntia*.

Key words: air ions, plants, microclimate.

***Toxoplasma gondii*, an overlooked parasite in the agricultural setting in Estonia**

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Abstract. Agricultural setting appears to be a good habitat for the zoonotic parasite *Toxoplasma gondii* because it offers hosts and suitable environmental conditions. The results of our seroepidemiological *T. gondii* studies on cattle and sheep show that the parasite is common in farm animals in Estonia, which indicates the presence of parasite in this agricultural environment. On numerous cattle and sheep farms in Estonia, the current biosafety measures have not stopped the spread of this parasite in the environment and to animals.

As herbivores, cattle and sheep likely encounter *T. gondii* through the fecal-oral route. That is, by ingestion of oocysts that have been shed by the definitive hosts Felids, mainly domestic cats, that have acquired the infection. Finding hundreds of *T. gondii* seropositive animals on the farms thus illustrates that there is an unhampered fecal-oral infection route - an infection route that is also used by other pathogens. Moreover, finding seropositive herbivorous hosts indicates that the farm environment is contaminated with *T. gondii* oocysts, which poses a risk also to other hosts working or living on the same farm. Furthermore, it suggests that prevention of *T. gondii* infections of domestic cats and the proper disposal of their feces has failed.

Farm animals are relevant hosts in the epidemiology of *T. gondii* because they may also serve as source of infection to other hosts, including humans. After the infection, the parasite multiplies in the host and can be found in the tissues and body fluids. Informing consumers that undercooked meat and unpasteurized milk may contain pathogens such as *T. gondii* should be emphasized. In addition, the infections are an animal welfare issue because they can cause clinical signs and even deaths. The parasite is well known for causing abortions, especially in sheep, which causes economical losses to the farmers.

Toxoplasma gondii is important from the point views of animal health and welfare, public health, occupational health, and food hygiene. Toxoplasmosis is a relevant and costly zoonosis, but prevention of *T. gondii* infections has received little attention in Estonia.

Electromagnetic fields' exposure to head, torso and limbs in office workplaces

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Abstract. The aim of this research was to investigate the electromagnetic fields in the modern office environment. Both low frequency and the high frequency electromagnetic fields were studied. The sources of elevated electromagnetic fields and the conditions under which they occur were identified. Measurements were performed by following a 14-point human body model, which characterizes the overall exposure of the sitting person. The measurements analysis revealed the most typical sources of exposure to be loosely spread power wires and extension cables, but also power cables close to the worker's body on the floor or beneath the table. Standard office devices were also rising the exposure levels when situated in close proximity to the worker.

Key words: electromagnetic fields, radiofrequency, extremely low frequency, occupational exposure, office.

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Transport route segments and stress effect on drivers

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Abstract. Drivers are expected to drive safely whilst carrying out a variety of complex tasks using physical, sensor, cognitive and psychomotor skills. In this paper, the authors examine the influence of road characteristics and microclimate influence in driver's cabin, on different drivers' performance while accomplishing their daily duties. The authors gave prior emphasis on transport route profiles like pedestrian crossing, road junctions, round about; pulling in and out of each bus stop and other unexpected incidences on driver's attention. The research was held on different drivers on the same transport route and segment of articulation. Work experiences, unfamiliarity of the routes were among the key factors for increasing stress and decreasing drivers' attention. This paper analyse stress factors on drivers during the summer period of driving performance. The core data on microclimate situation in the driver's cabin and the heart rate are preserved through careful measurements on all route segments. The drivers' heart rates are carefully recorded at specific parts in the road to examine how the road characteristics affect driver's behaviour. The influence of route characteristics, the microclimate influence in the drivers cabin, and other complications in transport route on heart rate variations of different drivers is the output of the research findings.

Key words: crossroad; downhill drive; roundabout; transport route; uphill drive.

ACKNOWLEDGEMENTS. The authors are extremely grateful and would like to express thanks to the management, drivers and all of the staff members of Prague City Urban Public Transport, who allowed us to carry out the data collection for our research.

V LIVESTOCK TECHNOLOGY

Determination of spatial distribution of ammonia levels in broiler houses

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Abstract. Ammonia concentration plays a significant role in broiler performance. High concentration of ammonia impairs the immune system and increases cases of respiratory disease in birds. Ammonia concentration can be reduced using various chemical additives such as zeolite. In the present study, spatial variability of ammonia concentration was investigated and analysed in two broiler houses. In House 1 (H1) sawdust only was used as litter material whilst sawdust used together with zeolite was used in House 2 (H2). Ammonia concentration measurements were taken from 21 points in each of the broiler houses. The readings were recorded at on a weekly basis using birds' height as height measurement bases. In order to create spatial distribution maps, Inverse Distance Weighted (IDW) and Radial Basis Functions (RBF) methods were used and analysed. The performances of these techniques were assessed by using validation test methods (root mean square error (RMSE) and mean absolute error (MAE)) with the best performing method (lowest RMSE and MAE) being selected for creating ammonia spatial distribution maps. The results indicated that spatial ammonia distribution is more uniform in H2 compared to H1. It was also observed that ammonia levels were lower in H2 than H1. The presence of zeolite as a litter addition can be attributed to study findings positively affected the broiler performance. It was considered that using zeolite with sawdust as litter material significantly reduced ammonia concentration. In H1, higher ammonia concentrations of greater than 25 ppm were recorded near ventilation fans and at the centre of the house. Because of this it is recommended to install additional fans at middle of the house for remove harmful ammonia.

Key words: Ammonia concentration, Interpolation, Litter, Zeolite.

Effect of cow traffic system and herd size on cow performance and automatic milking systems capacity

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Abstract. The objective of the current study was to investigate automatic milking systems (AMS) to find relationships between cow traffic system and efficiency of the AMS use. Milking records of cows from 11 Estonian dairy farms (46 AMS units) as well as data coming from four Latvian (7 AMS units) and two Polish (4 AMS units) dairy farms were analyzed to determine the system capacity. The highest capacity (milk yield per AMS unit per day) for Feed First cow traffic system (mean \pm SD) $1,817 \pm 276$ kg was indicated in Estonian dairy farms. 142 and 255 kg more milk was obtained, respectively, compared with Milk First and Free cow traffic systems. Overall, average milk yield per cow per day was the highest with Milk First cow traffic system – 31.4 kg. It was 3.3 kg higher than with Feed First and 3.5 kg than Free cow traffic systems. The average machine-on time for milking was highest with Feed First traffic system, i.e. $85.3 \pm 6.1\%$. However, the lower percentage of machine-on time for milking was observed for Free and Milk First cow traffic systems ($76.4 \pm 10.1\%$ and $73.3 \pm 7.2\%$, respectively).

Key words: AMS capacity, milk production, cow traffic system, Feed First, Milk First, Free cow traffic.

Method to monitor sand level changes in free-stall lying area for dairy cows

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Abstract. Understanding sand properties and proper sand management is critical to the selection and successful use of sand as a dairy bedding material. Use of sand as a bedding material is an alternative solution at many dairy farms instead of straw and other organic materials. In order to successfully use and manage sand as a bedding material for cows, it is necessary to consider monitoring of the sand amount in order to create the highest possible level of lying comfort for animals. The objective of the study was to investigate a modified approach to sand level measurements to find changes in the amount of sand covering the lying area in a barn with the free-stall keeping system. The method to measure sand level changes included use of a timber board (put on the neighbouring partitions at each lying stall) to determine the distance to the bedding surface in two zones of lying stalls. Results of the investigated method of monitoring sand level changes were discussed against the background of other results presented in the specialist literature. The discussion included the problem of measurement accuracy as well as simplicity of the proposed measuring method for practical use by farmers.

Key words: bedding, cow, dairy farm, free-stall, keeping system, management, sand.

An approach for determination of quality in hay bale and haylage

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Abstract. In this study, a new approach for faster determination of quality in hay bale and haylage was aimed. To this end, the relationships between bale densities, dry matter (DM), pH content and penetrometer values in hay bale and haylage were investigated. The mixture of caramba (*Lolium multifiform cv Caramba*) and berseem clover (*Trifolium alexandrinum* L) was used as forage material. It was harvested by using two different harvesting methods and stored as dry hay and haylage. The penetrometer values were measured at four different points on bales. It was obtained that the pH content decreased with increase in bale density ($R^2 = 0.86$) and with decrease in DM content ($R^2 = 0.86$). The values measured at vertical-middle point gave higher correlation with density and pH contents.

Key words: Forage quality, bale density, pH, dry matter content.

Microclimatic conditions in the poultry houses

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Abstract. The aim of this paper is to present the results of microclimatic research focused on the indoor conditions in several agricultural buildings used for fattening of chicken broilers. The attention is paid mainly to the construction of the building and its position in the farm area, which together with technological equipment of the building, floor covering, and system of ventilation, can influence the microclimatic conditions inside the halls. In the frame of this research main parameters of internal and external properties of climate were measured and evaluated. The measurement results of the air temperature, humidity, globe temperature, concentration of CO₂, dust pollution and surface temperatures show rather important role of the overall layout of buildings, influence of the wind and solar radiation together with surroundings. The research results show that to the improvement of internal microclimate can contribute significantly the use of principles of passive air conditioning. The acquired new knowledge can be useful not only to improve the current situation on the farm, but mainly for the improvement of the building constructions in similar new farms.

Key words: air temperature, air pollution, solar radiation, passive air conditioning.

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Research in farm management technologies using the expert method

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Abstract. The task of the research was to state the most popular peculiarities of farm management technologies depending on the size of the herd in order to use the research results in calculations of greenhouse gas emissions. The research was performed applying the expert methods based on the farm management technologies as they are closely related to the size of the herd and the kind of the obtained farm manure. The expert method can be applied for research in farm management technologies of different animal species and groups, but in the present article only milk cow management technologies will be discussed as they produce the biggest amount of greenhouse gas emissions. The practice shows that on small farms the cows are tied, on medium farms – either tied or loose, but on large farms – only loose. On the farms where the cows are tied solid litter manure is obtained, but where the cows are handled loose – liquid manure is obtained. Besides, on the farms with a small herd the cows are pastured in summer and in this period manure spread in the pastures is produced. Stating the maximal size of the herd that is pastured and the length of the pasture period as well as the marginal size at which the transition from tied to loose handling takes place and additionally using the statistical data on the total number of cows in the country and the proportion of animals according to the size of the herd, it is possible to state from which proportion of milk cows solid litter is produced and from which – liquid manure. Therefore, the experts were given the task to name the marginal values of the above mentioned technology parameters based on the value intervals stated in advance. Thereupon that the experts had to state only one chosen value, it was not possible to apply the traditional expert evaluation methods and this method had to be adapted in accordance to the existing situation. The research results showed that in Latvia the critical size of the milk cow herd at which the transition from tied to loose handling takes place is 85 cows, the herds that are not larger than 90 cows are pastured but the pasture period lasts in average for 165 days.

Key words: farm management technologies, size of the herd, farm manure management, the expert method.

The efficient management of straw-bedding solid manure

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Abstract. The aim of this particular article is to define, firstly the technical standard of the manure removing systems in straw-bedded cowsheds and secondly the validity of the given patent. For these purposes, a literature overview, their suitability and permanent parts will be provided. Innovative solution for working tool will be given.

Key words: first solid manure, manure press, technology level, state of the art.

Use of automatic system for pig feed consumption control

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Abstract. The aim of this study was to analyse average daily gain and feed conversion ratio, and to estimate daily gain and feed conversion ratio during the pig fattening period. 100 pigs from the same herd were housed in pens of around 10–15 animals and fed ad libitum with one single-place electronic feeder. Average on-test weight and off-test weight were 34.8 kg and 119 kg, respectively. Average daily gain, average daily feed intake and feed conversion ratio were computed. During investigation the average daily gain was 0.788 kg, the daily feed intake was 2.25 kg and feed conversion ratio was 2.86 kg. The differences in investigated traits between male and female pigs were significant. Generally, male pigs had greater off-test weight (+7.3 kg, $p < 0.05$), average daily gain (+0.037 kg, $p < 0.1$) and feed conversion ratio (+0.13 kg) in the fattening period. Average daily gain and feed conversion ratio were also calculated based on 100 kg off-test weight. If pigs will be fattening till 100 kg, than daily feed conversion ratio decreased and is 2.25 kg, but average daily gain increased and is 0.840 kg. The average fattening duration when pig has 100 kg off-test weight was 154.8 days. Phenotypic correlations between production and feeding traits were calculated. Correlation between average daily gain and feed conversion ratio was moderate negative ($r = -0.542$), pigs with higher average daily gain had better feed conversion ratio.

Key words: growth traits, feed intake, FCR, pigs.

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The human factor impact on the process of milking

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Abstract. This article deals with the results of measurements that monitor human impact on the process of milking. Milk is an animal product that is intended for direct consumption, but also for further processing. After obtaining the milk from the mammary glands of dairy cows, the milk is treated so that it can be distributed to the customer in many forms. The customer chooses from a wide range of dairy products, which include not only the milk, but cream, cheese, yogurt, etc. To the satisfaction of consumers there is needed large quantities of quality milk, from that in following steps are manufactured the other products. The quantity and quality of the cow milk is important for both consumer and producer. In this article realized measurements, focussed to the effort to improve the preparation of the cows before milking. This is the most important operations to ensure that the best and fastest way of milking. On the basis of the professional literature was proposed procedure for the preparation of the udder and then measurements were taken in the building with herringbone parlor. After evaluation the intervals of milking have been determinate to long times because of in insufficient preparation before milking. The carried out measurement showed, when the udder had been prepared in recommended way, the entire milking process showed significantly better results (shorter times of milking). In this way human factor is the milkers' behaviour towards the animals. It affects the welfare of dairy cows it must not in dangerous.

The suggested process for preparing the udder is therefore recommended to be for practice.

Key words: herringbone parlor, milking equipment, mammary gland, the teat cups, milking procedure, milking preparation.

Choosing and evaluation of milking parlours for dairy farms in Estonia

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Abstract. The aim of this paper is to present the main criteria, which could be used for the choosing, optimization and evaluation of a milking parlour in two large capacity Estonian dairy farms. The choosing and evaluation of milking parlours parameters is based on the available information and results of previous research in dairy farms in the Estonia, using the mathematical model created in the Czech Republic. Time for milking and final specific direct costs are main parameters which enable evaluation and choosing of suitable milking parlour for the dairy farm. Calculation of the first farm with a capacity of 300 cows showed that in the case of rotary milking parlour with 32 milking stalls total specific direct costs per milking per cow and year would be by 25% higher than in the case of Side by Side milking parlour 2 x 12, but the time for milking would be reduced by about 25%. The second farm with capacity of 1,850 cows is equipped with a rotary milking parlour with 70 milking stalls. There are three milkers. Six milkers would bring shortening of one milking from 6.3 h to 3.3 h while preserving approximately the same total specific direct costs per milking per cow and per year. This milking parlour could be used also for the planned increase in capacity at farm to 3,300 cows. Time of one milking would be 5.6 hours, but total specific direct costs per milking per cow and per year would be reduced by 18%.

Key words: Costs, cows, equipment, farm, milking process.

Determination of current location of animal Barns and establishment of a data base by GIS: study case for Akçalar Village in Bursa

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Abstract. Animal husbandry provides an extensive contribution for the economics of Turkey by supplying raw material to industry and food sectors, and also giving occupation opportunities to population who lives rural areas. In Turkey, demand of animal products is increasing each passing day depending on growing population. Most of the countries in the world take advantage of new technologies to protect their present condition and to increase their productivity in sector. Using Geographic Information Systems in animal husbandry can be demonstrated as an example for this. GIS technology is used efficiently in determination of existing animal populations, the distribution of species in this population, controlling and monitoring animal disease and creation of database. Land slope, direction of the wind, climatic conditions play an important role in site selection of animal barns. The barns used in this study were commercial barns registered Dairy Cattle and Sheep Breeding Association in Akçalar-Bursa. While Akçalar was on the track of the Silk Road in the past, it is one of the most important places for animal husbandry for today. There are abundant livestock buildings (dairy cattle barns, sheep barns etc.) in this area.

In this study, a database associated with animal species in this region was established by determination of the current locations of animal barns in Bursa-Akçalar. Spatial and graphical information for mentioned geographical region were transferred into computer via GIS. 108 dairy cattle barns and 48 sheep barns was determined in Akçalar region. Location of these barns was shown on map of Akçalar and a database which belongs to these barns was formed. Thus, database management, analysis, obtaining results has become easier. Moreover, this study will be a database for future studies and researches associated with animal barns in Akçalar village. If this sample information system is expanded and practiced in Bursa and even in whole country, researchers studying on animal husbandry would benefit from these kinds of efforts.

Key words: Animal barns, region, Akçalar, spatial, database.

Determination of the physical properties of different types of milk claws and air leaks in the claw according to rotameter-milk bucket methods

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Abstract. In this study, physical properties (internal volumes, weight and the diameters of the hole in the milk and pulse tubes) of eighteen different types of milk claws which are one of the significant components of milking machine and the amount of air leaks in the claws were examined according to the flow meter (rotameter) and milk bucket experiment methods. 'L' type milking claw was 70 ml in volume which was lower than the standard minimum volume of 80 ml, however, others were higher. Five of the claws ('C', 'D', 'E', 'H' and 'Q' types of claws) were lower than 500 g, the minimum recommended standard for weight. Internal diameters of the short milk tube of the claws were between 5.5 and 10.8 mm. Internal diameters of all but one of the claws' main milk output tubes (with a diameter of 11.9 mm in 'L' type) were under the minimum diameter (12.5 mm).

In experiments conducted with rotameter, the values of the leaking of the claw tap were between 0.0 and 11.0 l min⁻¹. Air leakages of twelve claws ('A', 'C', 'E', 'F', 'H', 'I', 'J', 'K', 'L', 'N', 'P' and 'R' types of claws) were below the standard maximum level of 2 l min⁻¹. The amounts of leaks in the tap of claws were between 0.0 and +14 l min⁻¹. Ten milk claws in here ('A', 'B', 'C', 'D', 'F', 'G', 'M', 'O', 'P' and 'R' types of claws) did not meet the minimum and maximum flow rates. The total amounts of air leak in the claws in the experiments performed with a milk bucket were between 4.1 and 33.9 l min⁻¹. Although the calculated amount of total air leak in all the claws was above the recommended minimum amount (4 l min⁻¹), eight claws ('B', 'C', 'D', 'E', 'H', 'J', 'K', and 'O' types of claws) exceeded the maximum limit (12 l min⁻¹).

Key words: Milking machine, milk claw, claw physical properties, rotameter, milk bucket, claw air leak, free air intake hole leakage.

Aquaculture: problems and modern perspective on topical solution

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Abstract. In this article describes the current problems of aquaculture. As a new material for feeding fish pond serves biocomposite based on protein hydrolysates and natural polymers. Also disclosed is a method of forming the proposed mother. Studies have been conducted biocomposite molecular weight and amino acid composition of the initial protein products.

Key words: fish feed, biocomposition, protein hydrolysate, aquaculture.

The impact of differently solved machine lines and work procedures of feeding and bedding on dust concentration in stables for dairy cows

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Abstract. The measurements were aimed at the impact of differently solved feeding and bedding systems on dust concentration in stables for dairy cows. Dust particles can be found in the environment in which the animals are housed and can affect their welfare and health, and can also negatively affect equipment in livestock buildings. Measurements of dust aerosol on 7 different farms for dairy cows in 9 stables in total were carried out. We focused on the impact of differently solved machine lines and work procedures of feeding and bedding, especially feeding with a mixer feeder wagon, bedding with a bedding wagon (equipped with a floor conveyor, a milling cylinder and a transversal conveyor), bedding with a straw blower, laying of deep litter with a wagon equipped with a hydraulic arm and manual distribution. Technical systems are especially affected by the presence of dust particles larger than 10 μm , which fall down very quickly and easily settle on the animals and surfaces in the stable. So, we measured the concentration of dust aerosol with an aerosol monitor by means of a 10 μm filter.

The results of the measurements show that feeding with a mixer feeder wagon increases the concentration of dust particles in the stables by the least amount. Straw bedding increases the concentration of dust particles in the stables by several times. This increase, however, is short in duration, and dustiness in the stables quickly returns to the state before bedding. There is a clear, substantive difference between the differently solved bedding systems.

Key words: dairy farm, feeding and bedding operations, dust concentration.

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VI PRECISION AGRICULTURE

Comparison of different chlorophylls determination methods for leafy vegetables

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Abstract. Modern agricultural farming requires precise, quick and nondestructive methods for determination of basic plant physiological parameters. One of the widely used and informative parameters is chlorophyll content in plant leaves. Determination of chlorophyll content by nondestructive methods is well elaborated for main field crops, but these methods are not widely used for chlorophyll content determination in leafy vegetables. The aim of the study was to compare two nondestructive methods with a classic biochemical chlorophylls determination method. Pigment content was expressed regarding to the leaf weight and leaf area. For nondestructive chlorophyll determination were used: a low cost handheld chlorophyll meter atLEAF+ and Miniature Leaf Spectrometer CI-710 (CID- Bio-Science). Chlorophylls content was determined using one of the 21 indices incorporated in CI-710. For comparison of methods four different plant species (lettuce, leaf mustard, radish and cabbage) were used. Plants were grown at four illumination conditions – natural light, illumination supplemented with red, blue and mixed red/blue LED light. Results showed that at the majority of the investigated wavelengths, readings of the chlorophyll meter atLEAF+ and indices used for calculation are more sensitive to chlorophyll a content calculated per unit area. The maximum sensitivity of reflectance to variation with pigment content is found at 605 nm and 696 nm and in the near infrared region (740–930 nm). Higher correlation between non-destructive methods and biochemical analyses was observed in radish and leaf mustard leaves. The highest correlation coefficient was obtained with Difference Vegetation Reflectance index (NDVI) and Simple Ratio Pigment Index (SRPI). Nondestructive chlorophyll determination with chlorophyll meter atLEAF+ and Miniature Leaf Spectrometer CI-710 can completely replace biochemical analyses.

Key words: chlorophyll, atLEAF+, CI-710, non- destructive determination.

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Optimization of the filtrate generated from acidogenic fermentation of poultry manure for polyhydroxyalkanoate production through struvite precipitation

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Abstract. Anaerobic digestion for the production of biogas is used diversely in the world for resource recovery process that combines stabilization of agro-industrial organic matter or wastewater treatment with the production of a valuable end-product. But, since the economic added value of the biogas produced is limited, arising storage and transportation problems and the requirement of the relatively longer retention times for methanogenic activity which increases the initial investment cost, efforts are being made worldwide for the development of alternative processes that yield higher-value end-products through generating high yield volatile fatty acids (VFAs). Among which, polyhydroxyalkanoates (PHA) as one of the most studied biodegradable and biocompatible polymers can be synthesized by microorganisms using renewable resources such as VFAs. Using waste derived low-cost substrates for PHA production gets lots of attention from the scientific community due to the fact that PHA production cost is much higher than the synthetic plastics because of the expensive carbon sources which corresponds to about 31% of the total operating cost. But prior to using fermented VFA rich waste for PHA production, it is required to regulate the ammonium and phosphorus content, since excessive nutrients will favor growth of microorganism rather than converting VFAs to PHA.

The current study, as the initial part of an ongoing project, evaluates for the first time the nutrient regulation of the carbon-rich filtrate obtained from acidogenic fermentation of the real poultry manure through struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) precipitation in order to propagate PHA production. Struvite is a naturally occurring crystal, when the concentrations of Mg^{2+} , NH_4^+ and PO_4^{3-} (molar ratio; 1:1:1) exceed its solubility limit especially at alkaline pHs. As struvite has a low solubility constant pK_s between 12.60 and 13.26, its insoluble form can be easily formed and simply separated from fermented supernatant which results in generating a substrate with reduced nutrients content to further use in microbial PHA production. On the other hand, struvite is a well known low-releasing fertilizer which could be used for agricultural purposes, thus it minimises the operational cost of the entire process. Acidogenic fermentation of PM was realized using through fed-batch experiments with a CSTR-type reactor with a working volume of 6 L at a relatively high organic loading rate (OLR) of 4,0 g VS/L/d and at a HRT of 6 days. On average, 83.06% of initial volatile solid (VS) fed to bioreactor was converted. Thanks to the relatively high HRT. The obtained fermentation filtrate yielded 4.47g TVFA/L (as acetic acid equivalent and consist of acetate, propionate, butyrate valerate and isovalerate). The chemical oxygen demand (COD), dissolved organic carbon (DOC), ammonia nitrogen ($\text{NH}_3\text{-N}$) and ortho-phosphate ($\text{PO}_4\text{-P}$) content of the filtrate were 5.12 g L^{-1} , 4.31 g L^{-1} , 1.85 g L^{-1} and 0.042 g L^{-1} , respectively. The subsequent flask based experiments was conducted to optimize the nutrient (mainly nitrogen) removal conditions. Since fermentate includes much more nitrogen than phosphorus and magnesium, additional phosphorus and magnesium was introduced to medium as $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ and $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ to have the appropriate molar ratio (1:1:1). The results obtained at pH of 9.50, 10.00 and 10.50 showed close nitrogen removal rates. But best nitrogen removal (94%) was obtained at pH 10.00 with a residual amount of phosphorus and minimal carbon loss. The results of the ongoing study suggest that, optimized filtrate (to have imbalanced nutritional conditions) generated from acidogenic fermentation of poultry manure could be used as an alternative and cheap way to produce PHAs.

Key words: acidogenic fermentation, struvite, poultry manure, volatile fatty acids (VFAs), polyhydroxyalkanoates (PHAs).

The influence of basic soil tillage methods and weather conditions on the yield of spring barley in forest-steppe conditions

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Abstract. The research on the effect the main methods of soil treatment have on its hydrophysical properties was carried out as a stationary experiment at the National Scientific Centre, Institute of Agriculture NAAS. It included a grain crop rotation with the subsequent crop sequencing: winter wheat/grain maize/barley. In 2013–2015, the spring barley variety ‘Solntsedar’ was sown. Throughout the three years of research, the consistency of the effect of the main soil treatment methods on the overall yield stayed more or less the same. Reduction in barley grain yield against the backdrop of long-term disking at the depth of 10–12 cm is explained by the thickening of the 10–30 cm layer of soil to the critical level of 1.57 g cm⁻³, moisture deficiency, as a result of the over-compaction of the root layer, and an increase in the amount of sterile spikelets. As the result of our research, we have come to a conclusion that for barley, soil disking at the depth of 10–12 cm is as good as ploughing if it is used as a part of differential treatment system, which includes ploughing at the depth of 28–30 cm or chisel tilling at 43–45 cm for its preceding crops. If disking was used for all crops of the grain crop rotation, a deterioration of hydrophysical properties was observed in the barley field, which can lead to a considerable reduction in the barley yield, especially in a dry cultivation year.

Key words: soil treatment, yield, barley, weather conditions, moisture accumulation, crop rotation, water consumption coefficient, vegetation period.

Technical and software solutions for autonomous unmanned aerial vehicle (UAV) navigation in case of unavailable GPS signal

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Abstract. The article presents autonomous navigation for Unmanned Aerial Vehicles (UAV) without GPS support flying in extremely low altitudes (1.5 m – 2.5 m). Solution via visual navigation as an alternative to missing GPS position was proposed. MSER (Maximally stable extremal regions) was used as a navigation algorithm for detection of navigations objects. While GPS is useful for waypoints specification there are scenarios where GPS has unreliable signal (orchards) or is not available at all (indoor machinery halls or greenhouses). For that reason existing installed camera which is already needed for the task of inspection was used. The navigation algorithm was tested in two scenarios. The first experiment was done with dashed line marked on the floor of the hall. 8-loop testing track was created approximately 10 meters long so it was possible to fly it several times. Then outdoor experiments were performed on the university campus and park roads.

One of the discoveries was that MSER algorithm, proposed for finding correspondences between images, is possible to run in real-time. High reliability of the navigation algorithm was found during the indoor testing. The incorrect detection of the dashed line was found only in 1% of cases and those failures did not cause failure of navigation.

Although outdoor road recognition is difficult in general due to various surfaces and smoothness, MSER was able to find suitable candidates. When the UAV was fed with the parameter of road width it could verify that information with estimated distance and camera pose to accept or reject the detected pattern. The road was successfully recognized in 40% cases. Similar to the indoor algorithm in the case of navigation failure navigation along the absolute trajectory (line) was used.

Key words: robot, machine vision, maximally stable extremal regions, algorithm.

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Influence of nitrogen fertilizer on Cd and Zn accumulation in rapeseed (*Brassica napus* L.) biomass

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Abstract. Diffuse soil contamination with heavy metals and Cd in particular is a matter of serious concern. Application of conventional remediation methods usually is not feasible due to the large territories and relatively low heavy metal content. Thus, phytoremediation is seen as an alternative. Rapeseed was grown on Cd and Zn contaminated as well as clean soil under the greenhouse conditions. Solid and liquid nitrogen fertilizers were applied during the pot experiment in order to test their influence on heavy metal accumulation in plant tissues. Vegetative parameters were measured four times during the pot experiment and it was concluded, that the elevated concentrations of Cd and Zn in the soil did not disrupt the development of rapeseed plants. Furthermore, plants from contaminated soil produced significantly bigger seeds in comparison to plants from uncontaminated soil. Calculated Bioconcentration factors for rapeseed grown on Cd and Zn contaminated soil in all cases were below unity, thus possibility to use this plant species for phytoextraction purposes is limited, but it can be successfully grown on contaminated land as an energy crop. Application of nitrogen fertilizers had a significant effect on heavy metal accumulation and decreased Cd and Zn concentrations in rapeseed roots and stems with leaves were recorded. Accumulation differences between the liquid and solid fertilizer applications were negligible.

Key words: cadmium, zinc, contaminated soil, phytoremediation, nitrogen fertilizer.

Awareness and adoption of precision agriculture in the Cukurova region of Turkey

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Abstract. Adoption of precision agriculture (PA) technologies has an increasing trend in developed countries. However, it is not well known in developing countries including Turkey. No study was reported on the awareness of PA in Turkey before. The objectives of this study were to assess the awareness of PA in the Cukurova region of Turkey using an interview survey study and also to briefly inform each survey participant about these technologies. The study was conducted with 164 participants that were agricultural engineers, farm equipment dealers and farmers. 90.2% of all participants reported that they followed new trends in agriculture. However, 51.8% of all participants indicated that they did not hear the term 'PA' before. Only 29.3% of the participants who heard the term 'PA' knew its concept. Internet was the most important means to gather information on new technologies. Most three well-known technologies by all participants were satellite positioning (GPS) (81.7%), geographical information systems (GIS) (69.5%) and remote sensing (61.0%) as the least known two ones were variable rate application (33.5%) and soil sampling and mapping (34.8%). In addition, a training brochure was handed out to each participant and the PA technologies were explained. 97.6% of the participants expressed that these technologies would be somehow beneficial for agriculture in Turkey. 88.4% of the participants wanted to get more detailed training on these technologies. Also, information on recent developments in the adoption of PA technologies is included in the paper.

Key words: Precision agriculture (PA), awareness, adoption, survey, Cukurova Region, Turkey.

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Soil weed seed bank and factors influencing the number of weeds at the end of conversion period to organic production

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Abstract. In 2008 an experiment was set up on the field in Eerika experimental station (Estonian University of Life Sciences) as a 5-field crop rotation: red clover, winter wheat, pea, potato and barley undersown with red clover. The objective of the study was to measure the content of weed seeds in the soil and to evaluate the diversity of the species at the end of the period of converting to organic production. In conventional farming systems without fertilizer (Conv I) and conventional farming with mineral fertilizer (Conv II) herbicides were used for weed control. All the crops in Conv II system received P 25 kg ha⁻¹ and K 95 kg ha⁻¹, but the application rates of mineral nitrogen fertilizer differed. In organic systems (Org I – organic farming based on winter cover crop and Org II - organic farming based on winter cover crop and manure), the winter cover crops (ryegrass after winter wheat, winter oilseed rape after pea, winter rye after potato) were sown after the harvest and were ploughed into the soil as green manure in spring. The content of annual weed seeds was the lowest in red clover that had 17.7% less weed seeds in the soil of Org II system compared to control (Conv I). In winter wheat the content of winter annual weed seeds was 50–76% higher compared to other crops. By the end of 2009 the content of organic carbon (Corg %) in the soil had increased significantly in both organic systems which results in higher activity of organisms that decrease the viability of weed seeds.

Key words: organic farming, soil, weed seeds, seed bank, crop rotation, winter cover crops.

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Application of artificial neural networks for Honey Bee Swarming identification

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Abstract. Artificial neural networks have shown their capabilities for problem solving in various sectors. They have been used for tasks related to robotics, classification problems, system control, pattern recognition, biological system monitoring and other.

In the field of beekeeping it is also possible to use neural networks for different colony state identification. One of the important bee colony states is swarming, that can lead to significant economic losses for the beekeepers. Swarming is natural reproduction process of the bee colony that usually happens in summer period. During swarming, a significant amount of bees leave the hive usually temporary settling down near the hive before going to other place. This gives the beekeeper some time to catch the swarm before they leave permanently. Thus, it is essential for beekeeper to know, when the swarming will occur or have on-time information about already swarmed colony.

Within the ERA-NET ICT-Agri project ITAPIC (Application of Information Technologies in Precision Apiculture) honey bee colonies were constantly monitored for identification of different states. Hives were equipped with one temperature sensor (DS18S20) per hive. Measurements were stored in a remote database with one minute interval. Authors propose temperature pattern recognition during swarming, using artificial neural networks. Temperature data during swarming events that were confirmed by the beekeeper on-site were then inspected and a neural network was developed for the bee colony swarming detection.

Segmented capacitance sensor and first tests of inverse problem solution

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Abstract. The segmented capacitance sensor (SCS) is developed for the purpose of material throughput measurement. SCS can be used in precise agriculture (e.g. yield maps creation) or for controlling of mass flow in stationary lines. This sensor is a compromise between simple capacitance throughput sensor which has been developed at the Department of Agricultural Machines Faculty of Engineering of Czech University of Life Sciences Prague and electrical capacitance tomography sensor. The SCS consists of the bottom plate (bottom electrode) and several upper electrodes which are placed parallel above the bottom plate. The upper electrodes are sometimes called segments of an upper plate. The bottom plate is undivided and it is assumed that it will be stored under measured material. During the measurement process the electric capacitance between one upper electrode and the bottom plate is measured every time. The sensor should be able to determine the distribution of material between upper electrodes and the bottom plate. This paper presents the algorithm of inverse problem solution. The algorithm was tested in two phases. The testing during the first phase was done via mathematical model which was presented in previous papers. Results show that the presented algorithm can be used for the inverse problem solution. For the purpose of the second testing phase a simple SCS was made. Electrical capacitances were measured by precise LCR meter. In the second testing phase, the inverse problem algorithm was tested using the actually measured data.

Key words: finite element method, inverse problem, electrical capacitance tomography, electrical field.

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Bacterial endophytes of grapevine (*Vitis vinifera* L.): isolation, characterization and detection in treated plants

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Abstract. As a result of organized expeditions comprehensive collection of plant samples, consisting of samples of seeds and vegetative parts of grape has been created. As a result from the vegetative parts of grape plants (5 varieties) 28 isolates of endophytic bacteria have been isolated. All isolates, selected from grapes, belong to gram-positive spore-forming bacteria of the genus *Bacillus*.

Defined bactericidal and fungicidal activity of the investigated strains of endophytic bacteria. Strains having both fungicidal and bactericidal activity have been selected. The ability of the studied strains of endophytic bacteria to produce auxins has been studied and selected strain No. 11 which is the only one of the studied strains capable of producing IAA. On the seedlings of cress salad studied the growth-stimulating activity of the investigated strains of endophytic bacteria. It is shown that the strains №№ 6, 11, 12, 16, 20 demonstrated strong growth-stimulating properties.

Thus, it is established that:

- 1) The best phytoprotectors (for plant protection from phytopathogens) are strains No. 2–6, 8, 16, 18–28 (*B. amyloliquefaciens*), 14 (*B. atrophaeus*), selected on the basis of the results of the analysis of bactericidal and fungicidal activity;
- 2) Growth promoting properties demonstrate strains No. 6, 16, 20, (*B. amyloliquefaciens*), 11 (*B. thuringiensis/B. cereus*), 12 (*B. pumilus*). Strain No. 11 (*B. thuringiensis/B. cereus*) was a good producer of auxin;
- 3) The best phosphat mobilizers were strains No. 9, 10, 12 (*B. pumilus*), 11 (*B. thuringiensis/B. cereus*);
- 4) All kind of enzymatic activity possessed strains No. 13, 14, (*B. atrophaeus*), 15 (*B. subtilis*);
- 5) Under aerobic conditions weak growth on nitrogen-free medium was observed for strains No. 1 (*B. subtilis*), 9 (*B. pumilus*), 11 (*B. thuringiensis/B. cereus*).

The work was supported by the Russian Scientific Fund (project no. 14-16-00146).

Distribution of mating types, metalaxyl sensitivity and virulence races of *Phytophthora infestans* in Estonia

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Abstract. Potato late blight, caused by the oomycete *Phytophthora infestans*, is a destructive potato disease, causing considerable crop loss worldwide. As the late blight pathogen population is diverse and variable in Estonia, changes in the population should be monitored regularly. In this study, the Estonian population of *P. infestans* was characterised with mating type, sensitivity to metalaxyl and virulence on potato R-gene differentials. During the growing season 2013, 110 isolates were collected from nine potato fields. The frequency of A2 mating type was on average 29%, and varied significantly between different fields from 7% to 78% ($p = 0.001$). On all studied potato fields, both mating types were recorded, suggesting continuous sexual reproduction of *P. infestans* and possible risk of oospore production and early attacks of late blight in Estonian potato fields. The prevalence of metalaxyl sensitive isolates in the population (64%) differed from results from previous research. Thus changes have occurred in the *P. infestans* Estonian population. There were no significant differences in metalaxyl sensitivity between studied fields ($p = 0.073$). The Estonian race structure was highly diverse and complex, on average 7.2 virulence factors per isolate, but varied between fields from 5.6 to 9.0. 42 virulence races were found; the four most common were 1.2.3.4.5.6.7.8.10.11, 1.2.3.4.6.7.8.10.11, 1.2.3.4.7.10.11 and 1.2.3.4.7.8.10.11, which comprised 46% of the population. The overall normalized Shannon's diversity index was 0.69, confirming the high diversity of the population. Continuous pathogen population studies describing the contemporary *P. infestans* population are essential in order to advise potato breeders and growers accordingly.

Key words: mating type, metalaxyl, *Phytophthora infestans*, population variation, potato late blight, virulence testing.

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Microbial communities in the rhizosphere of chickpea (*Cicer arietinum* L.): methagenome analysis

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Abstract. Background and Aims. Chickpea (*Cicer arietinum* L.), a valuable legume crop, is an essential component of diet in many Asian, African, European and American countries. A major role in increasing its adaptive potential, quality and quantity of the yield is played by symbiotic and associative bacteria. The main aim - study the taxonomic diversity of microorganisms in the chickpea rhizosphere, the activity of plant colonization by introduced bacterial strains.

Methods. Next-generation sequencing techniques used for the analysis of rhizosphere communities provided an insight into the true scale of the natural genetic diversity of microorganisms in the chickpea rhizosphere.

Results. In particular, the results of our study revealed the influence of treatment with Mo solutions on the taxonomic composition of the microbial community in the rhizosphere. We used earlier constructed primers on the basis of 16S-rRNA gene sequences of both bacteria and archaea. Therefore, we could perform a complex analysis of the prokaryotic community. However, during analysis of the obtained datasets (the number of sequences in each probe was 1-2 thousand) the emphasis was made on the taxonomic groups of interest, in particular, the phyla *Alphaproteobacteria*, where all rhizobia found so far belong. We hypothesized that the influence of the pre-sowing treatment of seeds with *Mesorhizobium* and Mo would be most pronounced in this taxonomic unit, and our analysis confirmed this hypothesis.

Analysis of bacterial communities at the level of phyla and class did not reveal any considerable differences in their composition in the rhizosphere soil of chickpea plants across experimental variants. On the whole, the dominant position at the level of phyla was occupied by representatives of *Proteobacteria* (ca. 30-35% of the total numbers) and *Actinobacteria* (up to 30%). The numbers of bacteria from the phyla *Firmicutes*, *Planctomycetes*, *Bacteroidetes*, *Acidobacteria*, *Verrucomicrobia* were considerably lower (from 1 to 5%). The minor phyla were represented by poorly studied *Nitrospirae*, *Armatimonadetes*, *Gemmatimonadetes* and some other groups, their total numbers being less than 1%. The symbiotic effectiveness of *M. ciceri* strain ST282 was further improved by coinoculation with *B. subtilis* and Mo. In the variant with treatment with Mo, the number of genetic sequences belonging to the order *Rhizobiales* was 90, which was similar to the variant with the inoculation with *Mesorhizobium ciceri* ST282. However, the diversity within the order was greater: all the major associative and symbiotic nitrogen-fixing bacteria from the families *Beijerinckiaceae*, *Bradyrhizobiaceae*, *Rhizobiaceae* were activated. This effect was especially expressed when Mo was used in a concentration of 1 mg l⁻¹. The greatest effect on the abundance and diversity of microorganisms in the chickpea rhizosphere was observed when nodule bacteria *Mesorhizobium ciceri* ST282 and Mo were used together. The total number of DNA sequences of representatives of the order *Rhizobiales* was 109 (when Mo concentration was 1 mg l⁻¹) and 111 (when Mo concentration was 10 mg/l). Genetic sequences of *Mesorhizobium* (5 sequences), *Bradyrhizobiaceae* (6), *Rhizobiaceae* (8), non-classified *Rhizobiales* (58) and some other bacteria were found. Noteworthy, the presence of *Azospirillum*, an important nitrogen-fixing component, was recorded in this experimental variant. Thus, a self-sufficient legume-rhizobium symbiosis improved the physiological status of the plant, increasing structural diversity of the microbial community of the rhizosphere, and paved the way for the development of the most effective associative microorganisms.

The work of A.V. Shcherbakov and V.K. Chebotar was supported by the Russian Scientific Fund (project no. 14-16-00146). This study was partially financially supported by the Government of the Russian Federation, grant 074-U01, and performed using the equipment of the Centre for Collective Use 'Genomic Technologies and Cell Biology' (ARRIAM).

Bacterial endophytes of grapevine (*Vitis vinifera L.*) as promising objects for agriculture: isolation, characterization and detection in treated plants

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Abstract. In this work we isolated the culturable strains of bacteria inhabiting the endosphere of grapevine cuttings of four cultivars, identified and characterized their physiological and beneficial properties and study the colonization process and localization sites of introduced dsRed-labeled strain in the endosphere of grapevine. The taxonomic diversity of microorganisms isolated from the inner tissues of grapevine (four cultivars) was identified at the molecular genetic level based on the analysis of the 16S rRNA gene fragments. A characteristic feature of bacterial populations of grapevine of different cultivars and different geographical origin was the presence of the genus *Bacillus*. As a result of transformation of several promising strains of endophytic bacteria, DsRED+ phenotypes were obtained. Its introduction into the vegetative parts of grapevine plants made it possible to reveal its endophytic localization in the vascular tissue of the plants.

Key words: grapevine (*Vitis vinifera L.*), bacterial endophytes, 16S rRNA gene, colonization activity, dsRed-labeling, CSLM.

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The effect of fertilizer and growing season on tuber dry matter and nitrate content in potato

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Abstract. Field trials with two potato varieties were undertaken at the Estonian Research Institute of Agriculture in 2005 and 2006. Year 2005 was generally optimal for potato growth but year 2006 was dry and very warm, hence, it was adverse for growth. The effect of fertilizing on two main traits of potato, i. e. tuber dry matter (DM) and nitrate content was examined. Five rates of compound fertilizer were applied, N₅₀P₂₀K₈₅, N₇₀P₂₈K₁₁₉, N₉₀P₃₆K₁₅₃, N₁₁₀P₄₄K₁₈₇ and N₁₃₀P₅₂K₂₂₁. Results indicated that DM content was largely determined by variety but it also depended on fertilizer amounts and particular environmental conditions of a year. Nitrate content of tubers was quite clearly dependent upon variety, but growing season had significant effect on final nitrate content in tubers. Water stress during early and main bulking periods resulted in high tuber nitrate levels. In order to gain tuber yield fit for intended use, it is necessary to manage nutrient acquisition based on expected yield and nutrient supply from soils.

Key words: potato, fertilization, environmental conditions, dry matter content, nitrate content.

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Mapping of some soil properties due to precision irrigation in agriculture

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Abstract. Precision Agriculture (PA) is a whole-farm management approach using information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering. These technologies have the goal of optimizing returns on inputs whilst potentially reducing environmental impacts. This study was conducted out to determine the acidity, salinity, field capacity, permanent wilting point and water holding capacity in precision agriculture by analyzing soil samples taken from the field in 32 points. Maps were drawn by obtaining data from the field. The purpose of this research is to use the geographic information system for comparing the obtained data from soil more quickly and easily than before and also the water amount in order to make precise decisions for agriculture progress and applying the appropriate inputs which is related to water. The present results also indicated that water holding capacity maps. These maps are usage for the irrigation management and the information from different points of the field. These data obtained the field has an important role in the management of precision agriculture.

Key words: Precision Agriculture, Precision Irrigation, Field capacity, Wilting point.

Precision Apiculture approach for improving bee colony management

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Abstract. Beekeeping is a very old and traditional branch of agriculture, where information and communication technologies also can be used to improve and ease the bee colony monitoring and management. Recently Precision Apiculture (Precision Beekeeping) was introduced and defined as an apiary management strategy based on the monitoring of individual bee colonies to minimise resource consumption and maximise the productivity of bees. Future of the traditional beekeeping is to implement Precision Beekeeping approach and start to use different colony monitoring systems and remote tools for optimised bee colony management. Within the ERA-NET ICT-Agri project 'ITAPIC' various bee colony monitoring and control systems together with its combinations were developed and analysed for application in Precision Apiculture.

Precision beekeeping idea is to introduce IT tools that can be easily implemented into beekeeping practice for helping to identify different important bee colony states, like swarming, brood rearing, broodless and death of the bee colony. To do this different parameters of the bee colony can be monitored, like, temperature, humidity, gas content, sound, vibration etc. As apiaries usually are placed in rural areas, which is outside inhabited areas, important part of the Precision Beekeeping is usage of alternative energy for powering all the monitoring and control devices. Together with hardware part it is also needed to develop software products and application for remote data analysis. Mainly it should be Web system or applications for smartphones. Some advanced data analysis system together with decision support functionality and with additional option for informing the beekeepers about changes in the state of the bee colonies could be developed as well for implementation of the Precision Beekeeping.

**VII PRODUCTION ENGINEERING
&
AUTOMATION TECHNOLOGY**

Determination of chemical content of soil particle for abrasive wear test

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Abstract. Soil is an extremely abrasive environment that causes a change in the part dimension of agricultural tools like as chisels or ploughshares. Dry rubber wheel test according to ASTM G65 is one of standard to wear testing. For this test is used Ottawa sand (SiO₂ particles) which have a spherical shape. The actual soil contains sand, but also particles of other minerals with higher or lower abrasion than sand. This article is focuses on identifying the abrasive particles in the soil by electron microscopy with EDS analysis. The results should be used for mixing the abrasive particles to the rubber wheel test, but also to identify the mineral composition of the soil profile. The aim of the research is closer to the real test of wear on the field and laboratory tests on the device with a rubber disc. Results shown that the soil contents alumina oxide particles with high hardness or silumina complex chemical composition with sharp shape. The ratio of amount these abrasive particles in the soil is influenced by geological position in earth and this ratio of particle amount influence wear rate in actual soil.

Key words: abrasives, soil particle, EDS analysis, electron microscope, rubber wheel test.

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Supply and processing of novel whole-crop raw materials for reinforced composites

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Abstract. The application of natural fibres from agricultural or forest origin as reinforcing ingredient for plastic components is resulting from their particular properties in combination with economical and ecological advantages in the total life cycle. A multitude of technologies for the processing of natural fibres to composites were continuously developed, so far focused on optimising material and process parameters of existing technological solutions in plastics-processing industries. Certainly, complex applications e.g. in the automotive industry require an integrated consideration of the total value added chain from material supply to manufacturing of semi-finished products up to component development and production. In this regard novel fibre reinforcements made from whole plant materials represent a potential for considerably higher material and cost efficiency compared to conventional natural fibre raw materials.

With the paper selected results of a comprehensive national network activity are presented. It is related to new integrated value chains for natural fibre reinforced composites by using raw materials made of the whole plant.

Development of a system for locating of persons by triangulation

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Abstract. Systems that monitor movement of persons are closely linked to ensuring the security of the entire monitored complex. The security of the buildings is mediated via different types of systems such as I&HAS, CCTV, EFS, and others. These systems are combined with each other in order to achieve more optimal security of the guarded building. Patrol, attendance and other surveillance systems that do not provide the exact location of a person via coordinates are also used to monitor specific groups of people. For this reason, our goal is to design a system that is able to locate the monitored person (employee) in the building with minimal deviation.

Key words: triangulation, security, employees, monitoring.

Intrusion and hold-up alarm systems and their reliability glass break detection

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Abstract. The problem of detecting glass break affects a large proportion of intrusion and hold-up alarm systems (I&HAS). In a time of increasing property crime, it is highly important for glass break detector (GB) to be able to detect glass break within the guarded area reliably and free of error. In the case of installation of glass break detectors it is naturally important not only to ensure correct installation, to gauge the external influences impacting upon the detector and ensure proper maintenance, but also to guarantee their capability of detection under more arduous conditions. The tests which have been conducted examine both the normal operation of the glass break detectors and the operation of these detectors under extreme conditions (different ways of breaking glass, foils on glass etc.). These tests are important both from an informative perspective and due to the possibilities of development of potential counter-measures which could lead to their improvement and an enhancement of their level of security.

Key words: security risks, sabotage, intrusion and hold-up alarm systems, glass break detector.

New security elements in biometric systems and systems I&HAS

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Abstract. New security features or upgrades to existing features in biometric and security alarm systems and emergency formed at the Czech University of Life Sciences Prague, mainly due to the teaching of subjects with similar themes. When developing new technologies also help us grants, personal experience with a real installation, cooperation with manufacturers (or with distributors) security systems and a testing ground for current security features.

Key words: development, innovation, biometric systems, intrusion and hold-up alarm system, detector.

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Mechanical properties of polymer matrix composites filled with *Jatropha Curcas* L.

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Abstract. Polymers and their composites are widely used for their specific properties. This paper deals with composite materials based on *Jatropha* oil cake. Seeds of *Jatropha Curcas* L. plant are pressed for gaining oil. A cake is a by-product.

A polymer composite was a subject of performed experiments. A continuous phase was in a form of a two-component epoxy adhesive and *Jatropha* oil cakes were a discontinuous phase (reinforcing particles).

Using *Jatropha* oil cake as the by-product after the mechanical extraction of the oil decreases a price of the composite system. *Jatropha* oil cake is the waste which is not further utilized.

The research was focused on various weight concentrations from 5 to 30%. The volume energy, the strength characteristics and the impact resistance were tested at these composite materials. Results were evaluated by means of the statistical program ANOVA. The filler moisture was $4.59 \pm 0.22\%$ WB. Mechanical properties were not changed using of the filler.

The negative influence of the filler was ascertained at the tensile strength. The positive influence was ascertained at the impact strength until 20 wt% of the filler concentration.

Owing to the high complexity of the failing process of the composite material the grid electron microscopy in the area of the fracture surface was used.

Key words: Adhesive, seeds, *Jatropha* oil cake, statistica.

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Analysis of rapid temperature changes

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Abstract. The analysis of rapid temperature changes in the dynamic system is described in the paper. Temperature changes are in range of tens of milliseconds. The sensor we used has a significant influence on the dynamic system. In these cases we need to use thermocouples that have appropriate transfer characteristics and can be manufactured with a low time constant. The time constant directly corresponds with weight and size of the sensor. The quality factor is usually in a range between 0.98 and 0.995. Information about the temperature course is particularly important in the field of dynamic systems, e.g. agricultural machines where the switching components are overloaded by pulse switching of technology systems. For the object analysis we use the thermocouples with diameter 0.012 mm with non-encapsulated finish and 0.12 mm with suppression of interference impact and comparative temperature fluctuation. For the analysis of dynamic temperature changes we conduct a measurement with a load factor change, which is the mean value of power change, expressed as ratio of the pulse duration to the delay between pulses, this way we will affect the measurement conditions. As a solution we use measurement methods for a steady state, an impulse test and a method of local measurement of temperature. Compared to a real principle of a component we do not increase temperature of the environment during experiments. The results of measurement can be applied for design and implementation of switching systems for electronic circuits with signal modulation and power load.

Key words: temperature, thermocouple, measurement, sensor, load factor.

Mechanical and physical properties of thermally modified wood flour reinforced polypropylene composites

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Abstract. Heat treatment of wood helps to lower the hydrophilicity and polarity of wood fibres used in wood-plastic composites. By means of heat treatment it is possible to reduce the access to wood hydroxyl (OH) group, which causes hydrophilic and polarity of wood fibres. Therefore improving compatibility between the wood and polymer matrix. In this research, the effect of wood flour (WF) heat treatment and chemical modification with 3-aminopropyltriethoxysilane (APTES) were investigated. WPC test samples were prepared using alder (*Alnus incana*) WF with mesh size of 0.05 mm as a filler material and polypropylene (PP) as the matrix material. WF was chemically modified with NaOH and APTES to increase the adhesion and compatibility of WF to polymer matrix. The composites were manufactured using a twin-screw extruder and the test samples were made by injection molding. The composites mechanical properties were tested using three-point flexural test and Charpy impact test. The composite physical properties were investigated with Fourier transform infrared spectroscopy (FTIR). The effect of silane (APTES) and NaOH modification on thermally treated and untreated WF was examined with contact angle measurement. Comparisons were made between the untreated WF and thermally treated WF. Also the effect of NaOH and silane (APTES) modification on the properties of thermally modified and unmodified WF composite were investigated. Using WF as a filler material increased flexural strength, while impact strength decreased thus making the material more rigid and brittle. The test results revealed that there was no significant difference in the mechanical properties between thermally treated and untreated composites. However, chemical modification improved the mechanical properties of the composites.

Key words: wood-plastic composite, wood flour, chemical modification, thermal treatment.

Determination of the heat flux of steel for the heat treatment model of agricultural tools

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Abstract. Chisels and tines for agricultural machinery are mechanically worn. Mechanical wear depends on the microstructure of the material. The desired microstructure of the material, specifically steel is obtained by heat treatment. Microstructure after heat treatment can be determined in two ways. The first one is the experimental determination, which is time-consuming and not economically efficient. The second is to build the thermal model during the heat treatment. Microstructure is affected during the heat flux during heat treatment. This research was focused on the boundary conditions of the model heat flux during quenching. The heat flux was measured during quenching with solid cylindrical samples ($\phi 25\text{--}50$ mm) by means of two thermocouples. The first temperature was measured in the axis of the sample and the second temperature was measured near the sample surface. The results of the heat flux were appointed to the model and experimentally verified. In this way it is possible to construct a model of tines and chisels for agricultural machine, which shows the progress of the heat flux during quenching.

Key word: quenching, FEM, tool steel, heat flux.

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Electromagnetic shielding properties of ceramic spheres coated with paramagnetic metal

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Abstract. This study utilized a setup of radiofrequency generating and metering instruments to measure the reflective and pass-through properties of the innovative material of paramagnetic metal coated ceramic hollow spheres (MCS). The dimensions of the spherical articles reside around 50–250 μm , the thickness of metal (Cu) coating is 0.5–1.3 μm . The radiofrequency field was of 2.4 GigaHertz (GHz) frequency and radiated towards the material via a waveguide-horn antenna at 100 mWt power output. Two additional waveguide-horn antennas connected to a radiofrequency analyzer measured the reflection and pass-through characteristics of the material. Reflection and pass-through coefficients (from 0 to 1) were calculated to each tested sample. The material was tested at different thicknesses: from single – to multi (up to 5) mono-layers and 5 mm layer in bulk condition of MCS.

The measurement results show insignificant shielding characteristics for 1 to 5 layer thickness samples: pass-through coefficient from 0.96 to 0.92. Noteworthy shielding characteristics were starting to show in case of MCS mixed with graphite emulsion: transmission coefficient dropped to 0.16.

The latter sample demonstrates the prospective shielding characteristics of the material, since most of the radiofrequency radiation was not allowed to pass through the material neither to be reflected, but absorbed within the structure of the material.

Key words: electromagnetic fields, microwaves, shielding, absorption, cenospheres.

Improving fretting resistance of heavily loaded friction machine parts using a modified polymer composition

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Abstract. The application of coatings based on fluorocarbon polymer composition, friction-mechanical brass, fullerene C₆₀ and surface treatment of vibrorolling with the regular roughness for the protection of heavily loaded mating parts of machines, working in conditions of fretting-corrosion. Studied the mechanisms of friction of coating, which will considerably reduce the fretting-wear mechanisms of friction in engineering products. It is established that in all studied for the protection of heavily loaded mating parts of machines is a single mechanism of increasing wear resistance when fretting in the area of the contact layer of the fine particles through the use of thin-layer coatings. Their presence may be due to either structural self-organization material, or forming of composite structures with small wear particles when using the polymeric composition. At that the protective coating virtually eliminates component corrosion mechanism of fretting – wear.

Key words: fretting corrosion, fluorocarbon polymeric composition, friction-mechanical brass, vibrorolling, fullerene C₆₀.

Influence of dust pollution in the laboratory on the strength of adhesive bond

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Abstract. The main aim of this paper is to evaluate the influence of microclimate conditions on the bond strength in the research laboratory in the Faculty of Engineering at the Czech University of Life Sciences Prague. The main attention is paid especially to the contamination of the working environment with dust particles. In the frame of this research the concentration and size of dust particles in the air was measured by the aerosol monitor DustTRAK II Model 8530 with impactors for measurement of size fractions PM₁, PM_{2.5}, PM₄ and PM₁₀. The adhesive bonds were created according to the ISO standards from Duralumin material specimens with different type of two-component epoxy adhesives under different conditions of ventilation (0%, 50% and 100% of ventilation rate). The tensile strength of created specimens was measured by universal testing machine for tensile strength measurement – LABTest 5.50ST. The results of measurement were evaluated by statistical methods and summarized in the conclusions. There is no significant difference in the strength of the bond when applied various performance of ventilation.

Key words: adhesive bond, contamination, dust, ventilation.

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Natural vibrations of stepped arches with cracks

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Abstract. Natural vibrations of elastic circular arches are studied. The arches are assumed to be of constant width and piece wise constant height. It is assumed that at the re-entrant corners of steps stable surface cracks are located. The aim of the paper is to assess the sensitivity of the eigenfrequencies on the geometrical and physical parameters of the arch including the length and location of each crack.

Key words: elasticity, arch, natural vibrations, crack, eigenfrequency.

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Utilisation of industrial steel wastes in polymer composite design and its agricultural applications

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Abstract. A constant development of agricultural activities is linked inherently to generation of significant amount of chemically aggressive organic wastes. This paper outlines a synergistic opportunity for industrial metalworking and plastic wastes recovery and re-use, with clear final product – composite steel-polymer material. Experimentally obtained composite polypropylene-perforated steel material is characterized by structural strength and stiffness provided by perforated steel tapes, and corrosion resistance assured by polypropylene layers, which protect steel from aggressive environment. Authors suppose that waste-based composite material could be applied for certain agricultural constructions, and namely, for boundary construction of farm animal feed lines and storage facilities for organic wastes and minerals.

Key words: perforated steel material, industrial wastes, polymer composites, cellular structures, feed lines, waste storage.

Effect of porosity on the performance of cutting ceramics

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Abstract. The article examines the forecasting performance of the cutting tool equipped with interchangeable plates of carbide oxide ceramics (A_2 – mixed ceramic), by definition porous ceramic tool material affecting its cutting properties. Set correlation of porosity ceramic tools from electrical resistivity removable ceramic plates. Cutting tools having larger electrical resistivity values and, respectively, smaller porosity percentages should be used for machining the most precise components of machine part blanks, since their performance will be better than that of the tools whose ceramic bits have small electrical resistivity values. Based on the established correlation selects ceramic plates for the required machining conditions.

Key words: cutting ceramics, strength, porosity of the material, operation tools, electrical resistivity.

Cellular tubular structures from perforated metallic tape and its application

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Abstract. The objectives of performed research were the following: 1) check out the possibility of effective formation of the tubular and planar structures from the perforated steel tapes, which were obtained as a waste during stamping of fine-sized details, by cutting and bending; 2) testing of achieved tubular and annular structures for fixing up of the electrical cables and as electromagnetic shielding solutions; 3) analysis of achieved results and elaboration of the recommendations for using of lightweight tubular shields for the electrical cables. The actuality of research is connected with the re-using of metallic wastes and shielding solutions against electromagnetic fields. All objectives were reached successfully using bending for formation of the tubular structures. The bending strength of achieved structures and the shielding efficiency in a controlled environment was examined. The measurement results have shown that perforated steel will exhibit noticeable shielding properties against both the electric and magnetic field. Such results open up wide possible application of the planar and cellular tubular structures from perforated metallic tapes.

Key words: perforated metallic waste, tubular structures, electromagnetic fields, shielding.

Production of crumb rubber – iron powder mixture for perspective synthesis of carbon-iron powder sorbent

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Abstract. A sustainable technique for conversion of end-of-life tyres (ELTs) to products with added value is of a great importance for resource-efficient circular economy. However, obtaining products with added value often requires multi-stage procedures, which include traditional and emerging technological approaches. In current paper, the authors suggest an efficient approach for recycling of ELT tyres, obtaining products which can be subsequently used for environmental applications. This approach introduces a synthesis path for new materials by transformation of industrial wastes i.e. ELT rubber wastes to crumb rubber and further mixing with iron powder. Particular attention is driven to perspective processing of obtained crumb rubber-iron powder mixture by means of microwave pyrolysis for synthesis of carbon-iron powder mixture and its use as a composite absorbent material along with emerging application for electromagnetic and microwave irradiation protection.

Key words: crumb rubber, iron powder, high pressure grinding rolls, disintegrator, microwave pyrolysis.

Relaxation and creep behaviour of false banana's fibre (*Ensete ventricosum*)

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Abstract. This study was focused on the analysis of viscoelastic behaviour of fibres of false banana (*Ensete ventricosum*). The aim of the experiment was to describe the short term creep and relaxation behaviour under tension loading. The fibers of *Ensete ventricosum*, originally from Ethiopian region Hawasa, were used in this experiment. Moisture content $Mc = 8.40 \pm 0.67\%$ (d. b.) and true density $\rho_t = 668 \pm 44 \text{ kg m}^{-3}$ of the samples were determined. The specimens had initial gauge length of $L_0 = 100 \pm 1 \text{ mm}$ and the average yarn breaking load (YBL) after 20 tests was $\sigma_r = 14.3 \pm 1.7 \text{ N}$. To determine the relationship between tension force and deformation, tension device (Labortech, MPTest 5.050, Czech Republic) was used to record the course of deformation function. All tests were performed using a constant rate $\alpha = 3.1 \text{ N s}^{-1}$. The short term creep tests were performed using constant loads of 30%, 60% and 90% of the average YBL. The short term relaxation tests were performed using constant strain of 30%, 60% and 90% of maximal strain. Measured data were analysed by computer software Mathcad 14. Experimental creep and stress relaxation curves at different load levels were determined. Experimental creep lifetimes t_c for different load levels: $24,311 \pm 7,489 \text{ s}$ (30% YBL), $1,831 \pm 462 \text{ s}$ (60% YBL) and $17.6 \pm 5.5 \text{ s}$ (90% YBL) were determined. Initial modulus of elasticity, finite modulus of elasticity and initial energy of stress relaxation and creep of *Ensete* fibres were determined.

Key words: agriculture, initial modulus, tensile test.

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Impact strength behaviour of structural adhesives

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Abstract. A cohesive force at an adhesive bond is one of the limit for a strength of an adhesive bonding. This study is focused on an impact force of an adhesive. Samples without a notch were cast in the casting mould at a laboratory temperature with a normal pressure. The instrumentation microcharpy test equipment was used for the evaluation of the impact force. The samples were tempered at a laboratory temperature, 40 °C and 60 °C. Results showed that the temperature of the specimens influenced the impact strength, the toughness and the maximum deformation of the adhesives. Higher temperature decreased the impact force but it increased the toughness. The hardness Shore D of commercial filled two-component epoxies is comparable. A non-homogeneity of adhesives distinguished for a porosity was found by the investigation of a fracture surface.

Keyword: Deformation, hardness, impact force, impact energy, microcharpy test, temperature.

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Electrical field based detection of fruits and vegetables for robotized horticulture

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Abstract. In this research authors study possibilities of using transmitting-type electric field based sensors for recognition of fruits and vegetables. The main idea is to detect distortions of electrical field between electrodes of sensors by measuring capacitance changes for these electrodes. Electrical field is strongly affected by relative permittivity of medium, which is several times larger for fruits and vegetables consisting mainly of water than for surrounding air, leaves and other low-mass non-conductive objects. This could help to develop electrical field sensing device with number of electrodes for detection of fruits or vegetables and determining their position thus serving as additional sensor in multi sensor system with optical camera or as stand alone device. The research covers both theoretical aspect of proposed approach and experimental evaluation of prototype device based on mixed signal controller MGC3130 originally intended for electrical field based gesture sensing periphery for consumer electronics.

Main results show that in worst condition when an electrode is fully covered with a physical model of leaf 43% of signal value in comparison to sensor output without obstacle is still usable. Thus this type of sensors potentially can be an integral part of complex fruit or vegetable recognition system in robotized horticulture applications.

Key words: electrical field, sensor, horticulture, fruit and vegetable recognition.

Use of spiral conveyor in the processing of granular waste materials

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Abstract. The work presents a construction solution, verification of operation function and evaluation of the efficiency of a spiral separator in processing of agricultural, food industry and other granular waste. The common method of processing waste is based on crushing and subsequent sorting by various physical and mechanical properties. Crushing waste results in a heterogeneous mix of particles with a substantial size and weight difference and major share of dangerous powder particles. Thus, specific requirements are put on the conveying and manipulation of the mixture. The solution is using pneumatic conveying and closed sub-pressure separators. Under laboratory pilot conditions a sub-pressure spiral separator was designed and tested. The separator is designed as an immobile drum sieve in which a rotating axis-free helix is inserted. The inside space of the drum sieve is linked axially to the sub-pressure pipe of the combined conveyor. A light aspiration proportion (dust particles) are carried by the air flow while the granular particles with big specific weight and specified size make the sieve fraction. The particles larger than the separation apertures of the sieve are carried mechanically by the helix. The separating efficiency was observed on a mix of granular materials at same operation conditions. The contents of the mix of granular materials varied in size, specific weight and in the proportion of dust particles. Evaluation of the separating possibilities of the spiral separator verified the operation applicability of the system for separation and conveying of various agricultural, food and other granular materials.

Key words: pneumatic conveying, mechanical conveying, granular waste, separation, combined transport materials.

Development of belt sorters smoothly adjustable belt drums

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Abstract. Belt sorters are used to sort different type of objects according by their size. Making belt sorter easily and quickly adjustable in desired range has positive influence on it's functionality and productivity. One solution for that is to use one or more adjustable belt drums. This option allows to change the distance between belts evenly and through this change the mesh size so to speak. Greater benefits will be obtained if belt drum is smoothly adjustable. The aim of this research paper is to compare technical peculiarities of two patented technical solutions for smoothly adjustable drum and identify if the newer has benefits compared with the older one. In this study comparative tests are performed using real prototypes. Both prototypes have key structure that determine the range of their adjustability. Prototype with older technical solution contains CNC milled key structure and prototype with improved solution contains 3D printed key structure. Prototype's mechanical parameters like belt pulleys backlash relative to the fixing point, backlash between two neighboring belt pulleys and required torque to regulate slot width between belt pulleys are studied. Also, it is considered how both technical solutions influence the sorting quality. During this study different measuring instruments are used included laser scanner. Obtained results are used to develop better and more reliable technical solution for belt sorters that can be used in berry processing lines.

Key words: agricultural engineering, post-harvest treatment, berry sorter, blueberry, product development.

Study on impact strength of sisal fibers reinforced epoxy composites using experimental methods

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Abstract. Among the advantages of composite materials is their ability to exploit the properties of partial phases that creates the composite. Common materials used as matrix materials include polymeric composites. The properties of these matrices can be optimized by using synthetic or also natural fibers. Natural fibers are inexpensive, ranks among renewable resources and when respecting their biological nature, they can replace synthetic fibers in many applications. This paper describes the impact strength of epoxy resins filled with unordered short sisal fibers with a length of 2–6 mm. From the experimental results it is evident that the presence of fibers of sisal examined as epoxy resins, increases the impact strength, up to 143%. SEM (scanning electron microscopy) was used to assess the failure of mechanism of these composites.

Key words: Agave Sisalana, fiber composite, mechanical properties, porosity.

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Effect of conductive ink on transfer characteristics of pressure into electric signal for tactile sensors

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Abstract. The article deals with tactile sensors with circular electrodes in which conductive ink was used as a converter converting pressure into an electric signal. The article briefly describes theoretical background of this issue and presents several appropriate converters, from which the tested ink was selected. The measurement process is described in detail, and subsequently the dependence of resistivity on the thickness of the deposited ink layer is studied and the properties of various setups were compared. Finally, the results are summarized and the main issues are pointed out.

Key words: Conductive elastomer, conductive ink, tactile sensors and transducers.

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Production and characterization of Ni-Co (WC) composites materials

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Abstract. Ceramic-Metal Composite such as NiWC, CoWC are among advanced technology materials that have outstanding mechanical and physical properties for high temperature applications. Especially low density and high hardness properties stand out in such ceramic-metal composite. The microstructure, mechanical properties of %60Ni, %20Co and %20WC powders have been sintered by using tube furnace at 1,000–1,100–1,200–1,300–1,400 °C temperature. Mechanical properties and metallographic analysis were investigated after sintering. NiCo phases observed after metallographic analysis. XRD, SEM (Scanning Electron Microscope) results showed us best microhardness of composites 174.16 HV, 8,563 g cm⁻³ density were obtained at 1,400 °C sintering temperature.

Key words: ceramic-metal composite, powder metallurgy, sintering and high temperature.

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Low-cyclic fatigue test of adhesive bond reinforced with glass fibre fabric

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Abstract. Epoxy resins are widely used polymers, which are popular due to their workability, high tensile strength and a chemical resistance. The glass fibre fabric interlayer was used for improving the tensile and the quasi-static lap shear strength of joints bonded with an epoxy adhesive.

The aim of the experiment is to clarify a fatigue behaviour (low-cyclic tests of the fatigue) of structural two-component epoxy adhesive applied to a constructional steel S235J0. The fabric was composed from type E glass fibres in a plain weave. For optimization of properties of the composite bond it was used various weights in grams of the fabric in the extent of 80, 110, 160 g m⁻² for the fabric treated by a wax, where this treatment is determined for better spinning of fibres at the production of the fabric, and weights of grams of 80, 110, 163 g m⁻² at the fabric with a chemical dressing determined for improving the adhesion between the fibres and the epoxy resin. The specimens for quasi-static and lap shear strength tests were made in accordance with EN 1465:2009. The difference of the saturation of the various types of fabrics with the epoxy adhesive was observed with SEM (Scanning Electron Microscopy). It is obvious from the experiment results that it came to the improvement of the quasi-static loading at all adhesive bonds reinforced with glass fibres. The adhesive bonds specimens A110, A160, B110 and B160 resisted to required 200 cycles at 80% loading. The test specimens without the fabric showed worse properties.

Key words: adhesive bond, low-cycle fatigue, lap-shear strength, two-component epoxy adhesive.

Hybrid aspen clone wood mechanical properties

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Abstract. The hybrid aspen is believed to be a suitable alternative to the European aspen for raw material supply, but information on its wood properties and their variations among clones is lacking. Nevertheless, its fast growth is associated with a decrease of wood density and mechanical strength. The aim of the study was to assess wood mechanical properties of the hybrid aspen clones and their relationship with growth traits. The tree height and diameter at breast height (DBH), basic wood density, compressive strength, modulus of rupture (MOR), and modulus of elasticity (MOE) were measured for three sample trees from 22 hybrid aspen clones and one common aspen clone. Significant (all $P < 0.001$) differences of assessed wood properties and growth traits were found among the hybrid aspen clones. At the clone mean level, compressive strength ranged from 26.6 ± 1.3 to 36.7 ± 0.8 N mm⁻² and MOR and MOE were from 57.9 to 74.5 N mm⁻² and from 7338.5 to 9734.6 N mm⁻², respectively. The mean wood density was 383 ± 3.1 kg cm⁻². It correlated significantly ($P < 0.001$) with MOR ($r = 0.66$), MOE ($r = 0.63$), and compressive strength ($r = 0.71$) at the individual tree level. All mechanical properties of the wood showed non-significant (all $P > 0.05$) correlation with growth traits. Therefore, selection of fast-growing clones will not interfere with the mechanical quality of wood. However, the suitability for structural applications should be cautiously tested due to the clonal variations.

Key words: *P. tremula* × *P. tremuloides*, basic wood density, bending strength, compressive strength.

ACKNOWLEDGEMENTS. This study was funded by the Latvian Council of Science project 'Adaptive capacity of forest trees and possibilities to improve it' (No 454/2012).

**VIII RENEWABLE ENERGY
&
POWER ENGINEERING**

Practical usage of additional heat from biogas plant

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Abstract. Biogas plants are one of the most stable and cost-effective energy sources. The better volume of produced biogas is used for parallel electricity and heat production in CHP gas engines. The heat from the engine is conveniently used for heating the digester but the additional amount causes lot of problems and is wasted despite its large potential. The inefficiency in energy use is a bottleneck in current biogas production, causing macroeconomic and microeconomic losses and challenges in the context of increasing land use competition. As a major output of the biogas management process research provide by authors, this article was elaborated in order to introduce the results of theoretical heating system analysis.

Key words: biogas, heat balance, CHP.

Operation reliability of induction motors at egg processing plant ‘Balticovo’

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Abstract. In hen houses air quality plays an important role in egg production volume. However, failure of fan induction motors often occurs and it is important to improve reliability of these. A motor reliability study was conducted in the egg processing plant ‘Balticovo’ in Iecava. Results show that 86% of failed number from 2010–2015 occur in hen houses and more than 50% of them were failures of motors which drive the fan. Annual failure rate of fan induction motors each year was increasing and in 2015 it was 6%. Investigations of the faulty motors showed the following defects – stator turn to turn failure of stator winding insulation leadwire and stator winding insulation thermal stress and mechanical damage of stator core resulting in the damaged stator winding leading to a short circuit. Results show that conditions that could contribute to such defects are excessive heating and vibrations.

Key words: induction motor, reliability, failure, fan, egg processing plant, hen houses.

Basic theory and methods for managing energy efficiency in consumer systems

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Abstract. In this article, we present a scientifically proven methodology for monitoring and controlling of industrial energy efficiency in consumer power systems (CPS) – an original method of finite relations (MFR), which uses relative energy intensity resulting from energy use in the technology of the enterprise as the main indicator of innovative energy efficiency. The differentiation algorithm and control of energy consumption are based on the effectiveness of energy use in power technology processes which ensure delivery of technologically expected results. The main provisions of the method are confirmed by experiments and tested under production conditions. The research results correspond to the basic principles of the global energy efficiency practices (integrated approach to the design and the principle of sustainable development), but yielded a number of more specific solutions.

Key words: energy saving, power consumption of production, criteria of energy efficiency, consumer power system.

Low degradation of a-Si solar panels of the building integrated PV power plant in Prague historical area

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Abstract. The unique photovoltaic power plant installed in Prague on the roof of the new buildings of National Theatre in Prague has been investigated. As the new buildings are very close to the old historical building of National Theatre designed in late 19th century, the PV power plant has to be totally invisible from the streets of Prague to not disturb historical panorama of the city. Flexible a-Si photovoltaic foils in the nearly horizontal position have been used because the placing is in the urban conservation area in the historical city centre. The operation started in the autumn 2009. The photovoltaic power plant is described in this paper and results of its operation are presented. The energy production data indicate that the degradation of the nearly horizontally installed a-Si panels is below 5% within 5 years period.

Key words: Photovoltaics, thin film a-Si panels; degradation; soiling.

Methodology for determining the mixing ratio of selected solid recovered fuels

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Abstract. Energy recovery is a preferable waste management method for waste that cannot be reused or recycled. For energy recovery, various types of waste with differing properties are being used, e.g. mixed municipal solid waste or end-of-life tires. To achieve a more stable and homogeneous characteristics of the waste derived fuels (RDF, SRF), they can be mixed in a number of ratios. The paper presents a methodology for determining the optimal mixing ratio of three selected waste derived fuels (mixed municipal solid waste, sewage sludge, end-of-life tires) considering environmental and economic aspects. The developed method is based on combining life cycle assessment method, mass balance calculations and multi-criteria analysis (the technique for order of preference by similarity to ideal solution – TOPSIS). The results show that mixing the various waste derived fuels allows obtaining a more sustainable solution than in the case of each separate waste derived fuel.

Key words: Life cycle assessment, end-of-life tires, method integration, multi-criteria analysis, municipal solid waste, sewage sludge.

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Analysis and evaluation of the waste management in the municipality

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Abstract. Objective of this paper was to analyse the waste management on an example of the municipality Nový Bor in the Czech Republic. The analysis is performed on comparison of Municipal Solid Waste (MSW) production in Nový Bor which systematically separates between mixed and sorted waste as commodities with a second life span. It was noted that the average amount of mixed MSW came to approximately 200 kg person⁻¹ year⁻¹ in Nový Bor in 2014 which was 24% below the Czech average value of 263 kg person⁻¹ year⁻¹ from the identical year. Comparison of the sorted waste production in 2014 showed that Nový Bor achieved better results than the Czech average of 39.7 kg person⁻¹ year⁻¹; a common resident of Nový Bor separated 24.4% more waste via recycling containers (= 49.5 kg person⁻¹ year⁻¹) and 11.6% more via Bag Collecting System (BCS) which means 54 kg person⁻¹ year⁻¹ in total. Unfortunately, approximately 80% of MSW from Nový Bor is landfilled so its energy producing utilisation is totally neglected. Generally, the decision how to dispose of waste depends more or less on price: disposal of MSW by landfill costs about 700 CZK t⁻¹, whereas in an incinerator about 2,000 CZK t⁻¹. The personalised, registered BCS clearly ensures a better, diligent waste separation (impurity only max. 10%) compared to the mixture found in 'anonymous' recycling containers placed all over the city where the impurity of sorted waste varies between 20–40%.

Key words: bag collecting system (BCS), municipal solid waste (MSW), mixed waste, sorted waste, waste collection system.

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Correlation between temperatures of air, heat carrier liquid and seabed sediment in renewable low energy network

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Abstract. The low energy network based on renewable seabed sediment heat has been monitored for several years in Vaasa, Finland. In this study the temperatures of air, heat carrier fluid and seabed sediment are compared to each other and correlations between them are investigated. In this study data from one year 2014, was used. Correlations between these subjects clearly exist. The sizing of installed network seems to be correct; no overuse was detected.

Key words: Renewable energy, heat energy, sediment energy, carbon-free, distributed temperature sensing (DTS) method.

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Support scheme for CHP and its sensitivity on heat wasting

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Abstract. This paper describes basic principles of the CHP, advantages and disadvantages, technologies. In first part of article are described principles of CHP from the viewpoint of the energy customer. Second part describes basic Directives by the European Commission on promotion CHP and third part the most important part focus on the sensitivity of primary energy saving (PES) on outputs especially heat wasting.

Key words: Combined heat and power, cogeneration, primary energy savings, primary energy, heat wasting, efficiency, support.

Optimization of a solar power station with LiFePO₄ accumulators

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Abstract. The paper describes the design and construction of an isolated solar power station supplying energy at weekends to a remote location. The system comprises two parts: a photovoltaic system generating electric energy in sunlight, and an accumulator accumulating energy to be permanently available and to be able to supply a peak power of several kW. The design of the system optimized with respect to maximum reliability, ease of operation and minimum purchase costs. The control circuits were therefore constructed by means of simple analog circuits. To use microcomputers, which are nowadays used in battery management systems most often available on the market, is not appropriate. Such a system, compared with a simpler analog system, is less reliable. Power circuits are again designed in order to ensure minimum complexity of the system. The resulting design is absolutely different from conventional designs offered by suppliers of photovoltaic systems. The photovoltaic part of the system is designed for optimum adaptation of the load characteristic of the photovoltaic generator to the charging characteristic of the accumulator. By selecting photovoltaic panels with appropriate parameters and their appropriate interconnection, possibly by an automatic change of their interconnection during the charging cycle, it is possible to achieve more effective utilization of the charging power of the photovoltaic generator than by using charging DC/DC converters. The accumulator used in the system is formed by an assembly of LiFePO₄ accumulators which thanks to their outstanding durability in spite of their high price currently show the lowest cost per accumulated kWh.

Key words: LiFePO₄ accumulator, solar power, photovoltaic panel characteristic.

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Automated measuring station for accumulator testing

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Abstract. The paper describes the design and implementation of the system allowing the testing of the lithium-iron-phosphate (LiFePO₄) cell parameters during long-term loading. Manufacturers and retailers, in particular, accentuate their beneficial properties – the possibility of charging and discharging by high currents, minimum influence of the discharge time on capacity, long durability. At the same time, their operational conditions are a lot more strictly defined than those for other types of accumulators. The proposed testing system enables loading the accumulators, consisting of several cells, by periodic discharging and charging processes with various operating currents and various levels of cell discharging. The charging and discharging process control is fully automated; the measuring of the cell operational state is performed automatically during charging and discharging. The data is recorded, and continuously evaluated for the purposes of process management. The measurements enable the comparison of the catalogue data with the parameters of the real products. The testing system design is based on the application of a digital control block, which is completed with an analog control block. The core of the digital control unit is a control computer equipped with a multifunctional input-output card and an array of logically controlled circuit-breakers. An accumulator management algorithm, implemented as a control program of the computer, ensures the operation of the accumulator in subsequent charging and discharging periods. The actual accumulator control is based on the evaluations of voltage levels at the cell terminals.

Key words: LiFePO₄ accumulator, testing, Ah capacity, limit parameters.

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Water vapour transmission properties of linseed oil paint

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Abstract. Linseed oil paint has been in use in indoor and outdoor decorating for a long period of time. It is not easy to date the first findings but there are signs of using linseed paint at least in V-IX century in some areas of Afghanistan and during the renaissance period in Europe. It is also known as a good preservative material for wood. Indoor finishing materials considerably influence the indoor climate (temperature, RH, ventilation rate) because of their moisture buffering ability. Moisture buffering occurs because of the sorption and diffusion properties of materials (wood, plaster, gypsum board etc.). As paint is a cover for those materials, the knowledge about material water vapour transmission properties is essential for evaluating hygrothermal properties of boards and the co-action of paint and substrate (plaster). There could be products with different properties referred to as 'linseed oil paint'.

In the current study six handmade paints with different recipes including two primers and two commercial paints were under investigation. As for interior works, one layer of paint could be used as well therefore the samples were covered with both – one and two layers of paint. The thickness of paint layers varied from 0.8 and 6.2 μm for one-layer primers, from 11.3 to 26.9 μm for one-layer paints and from 17.8 to 40.7 μm for two-layer paints. Water vapour transmission properties were determined by using EVS-EN ISO 7783 standard.

Water vapour diffusion equivalent air layer thickness s_d was estimated as 0.1 and 0.2 m for 1-layer primers, 0.2 to 0.9 m for 1-layer paints and 0.4 to 0.9 m for 2-layer paints. The information gathered from the experiment enables to get an overview of the different properties of 'the same product' and use the data in hygrothermal calculations.

Key words: linseed oil paint, water vapour transmission, water vapour permeation coefficient, water vapour diffusion equivalent thickness, water vapour resistance factor.

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Thermal properties and reduction of energy consumption of buildings

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Abstract. The aim of this paper is to summarize and present all relations, which are essential in determination of winter heat balance of the buildings, and that enable a reduction of energy consumption or heating costs. These questions should be realized and taken into account already in the proposal of building design. This paper shows the methods of calculation of winter heat balance and results of measurements which verify theoretical conclusions in real conditions. These factors are applied on two existing buildings. There are due to their different shapes and constructions proposed different solutions of improvement. Two different buildings were selected for this research work: a large ground floor building and a high hall. In the case of the first building (the large ground floor building) it appears to be a major problem not sufficient thermal properties of the envelope constructions. The enormous heat losses caused high heating costs. The existing heating method of the second building (the high hall), is not suitable. The temperature distribution in the interior is undesirable, which results in very high energy consumption. The use of radiant ceiling panels could enable to achieve favourable conditions in the working area and considerable energy savings.

Key words: heat balance, high building, radiant heating, thermal insulation.

Feasibility study of a local power supply system for sparsely populated areas in Estonia

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Abstract. The paper analyses the reasonability of using an off-grid hybrid power supply system or in other words a local grid for sparsely populated areas as well as the necessary components selection and price development of such system. Typical consumers are selected and all estimations and calculations are based on them. Consumer profiles are set and analysed as well as different elements of the local power supply grid and the possibility of connecting to the traditional grid. Estonian example is used in this paper as the country lies relatively north and has some remote areas, where local power supply grids can be implemented. All prices in the paper are derived from the Estonian example. Necessity of further study is proposed.

Key words: Distributed generation, PV panels, renewable energy, wind energy.

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Numerical modelling of transient phenomena in a synchronous machine

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Abstract. The present contribution deals with the idea of identification of electromagnetic transient phenomena in a synchronous machine – namely of distant short circuits – by numerical modelling. Phenomena in AC windings of a synchronous machine (stator) have a backswing effect on the phenomena in DC windings – namely the excitation one. Concerned is namely the current stress of the excitation circuit during the transient phenomenon. The computer model is created in the Famulus- vers. 3 – environment. The time behaviour of AC circuit currents in components d, q and the excitation circuit is monitored on the example of a 3-pole distant short circuit in a synchronous machine (via the impedances of connecting elements). The results are compared of models with a simpler structure (one damper circuit in the rotor) with those with a more complicated structure (two damper circuits in the rotor).

Key words: electromagnetic system, synchronous machine, transient phenomena, modelling.

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IX VEHICLES & FUELS

Development and analysis of a driving cycle to identify the effectiveness of the vacuum brake booster

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Abstract. In electric vehicles electric vacuum pumps are used instead of traditional vacuum generation devices – the vacuum pump or the intake manifold that are specific to vehicles with internal combustion engines. A special driving cycle has to be designed to identify the effectiveness of electric vacuum pumps. The initial experiments were carried out on a real road, intensively applying the breaks and exploiting the vacuum generation devices as long and intensively as possible. Basing on these experiments brake test cycle was developed. It consists of three braking regimes that involve smooth and uninterrupted braking, interrupted and repeated braking and multiple activation of the brake pedal. Using this cycle, it is possible to conduct research on the performance of various automobile components during braking.

Key words: vacuum booster, brake system, brake regimes, test cycle, braking time.

Influence of biofuel moisture content on combustion and emission characteristics of stove

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Abstract. The research aim was to study the effect of moisture in solid fuel on combustion in a stove and its emissions. Analysed samples were from spruce woodchips. Four samples were prepared with different moisture contents and furthermore spruce wood was used as a reference sample. Combustion device used was a stove with a fixed fire grate. Studied parameters were ambient temperature, temperature of flue gases, coefficient of excess air, and contents of oxygen and carbon monoxide in flue gases. Laboratory measurement was performed on an analyser of flue gases whose function is based on electro-chemical converters. Measured values were first converted to a referential oxygen content in flue gases. Evaluation of these values was then made by regression analyses. The course of combustion process and its quality can be seen well in functional dependence of carbon monoxide on excess air coefficient. The area of combustion was the smallest with the least moist sample (3.2%) and increases with increasing moisture. A sample with high moisture (31.1%) was already causing the fire to gradually extinguish. Because flue gas temperature is in the same range for all samples, the overall efficiency of the stove decreases sharply with fuel moisture due to specific heat of flue gases. It has been thus confirmed that fuel moisture content has a substantial influence on combustion, especially in the chosen combustion device, which has been verified by comparison with the reference fuel.

Key words: Biomass, combustion, elemental and stoichiometric analyses, emissions, spruce chips.

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Effect of gasoline contamination on the quality of arctic diesel fuel

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Abstract. Fuel quality is affected predominantly during its transport between producer and user as hired transporting companies may use one transport vehicle for more different fuels. Therefore, gasoline from previous transport may cause contamination of diesel fuel in next transport. Many drivers add gasoline as additive to diesel fuel to improve start of engine avoiding difficulties of cold winter temperatures. Therefore, the objective of this article is to assess maximum gasoline content added still compliant with default values of standard EN590 and values certified by producer. Only 2% maximal gasoline content in arctic diesel fuel was found safe for both machine and operator. Distillation curve, kinematic viscosity, density, lubricity and cetane index were influenced unimportantly. Cloud point, CFPP were not changed at all.

Key words: diesel, gasoline, distillation, blend, limits.

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Evaluation of conventional and alternative jet fuel surrogates in a variable compression ratio reciprocating engine

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Abstract. Compression ignition engine development is increasingly performed by engine simulation codes using predictive physics-based combustion models. The use of such codes requires not only the specification of the chemical composition of the fuel, but also a suitable chemical kinetics mechanism to describe the oxidation process. Despite advances in computing speeds, consideration of the large number of chemical compounds present in distillate fuels and the tens of thousands of chemical reactions required to describe their oxidation present challenges to combustion simulations. Such problems are made tractable by the use of simplified mixtures of a small number of pure compounds, known as fuel surrogates, which replicate the behavior of the target fuel in practical combustion systems. Meanwhile, NATO's Single Fuel Policy dictates that jet fuel is to replace diesel fuel in the military alliance's land-based vehicles and equipment with compression ignition engines. Surrogates considering molecular weight, density, heating value, H/C ratio, viscosity, specific heat, volatility and derived cetane number (DCN) have recently been formulated for conventional and alternative jet fuels. However, their experimental validation against target fuels has been limited to a narrow range of conditions. This work will experimentally examine the ignition quality of three jet fuel surrogates mixed from a palette of n-dodecane, n-decane, decalin, toluene, iso-octane and iso-cetane. In an indirect injection, variable compression ratio compression ignition engine and over a range of inlet temperatures, ignition delay of the three surrogates will be compared against their target jet fuels. The target fuels cover a wide range of ignition quality; a coal-sourced iso-paraffinic kerosene (Sasol POSF 5642, DCN=31), a natural-gas sourced synthetic paraffinic kerosene (Syntroleum S-8 POSF 5109, DCN=60) and a conventional petroleum-based jet fuel (JP-8, POSF 10325). The relationship between inlet temperature and compression ratio will be examined.

Effect of different biofuels to particulate matters production

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Abstract. In recent years the European Union has exhibited a significant interest in the reduction of crude oil usage. Biofuels can be used in conventional engines but the biofuels should reduce the emissions produced by internal combustion engines. This article deals with analysis of particulate matters (PM) production in chosen biofuels burned in internal combustion engine Zetor 1505. The conventional emission analysers are capable to detect gaseous emission components but they are not able to classify PM. Analysis of PM was performed with a TSI Engine Exhaust Particle Sizer 3090 which is able to classify particles from 5.6 nm to 560 nm. The device analysed different blends of alcohol-based biofuels tested under NRSC cycle conditions. The given size of PM can be taken as an impact on human organism's cells consequently human health. PM create an ideal medium for polyaromatic hydrocarbons (PAH), their composition and structure. Analysis of PM should become a standard component of every emission parameter assessment.

Key words: biofuels, particulate matters, emissions.

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Speed limits and their impact on emissions production and fuel consumption

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Abstract. The article deals with emissions and fuel consumption of road vehicles in real traffic conditions. The aim of this study was to prove or disprove correctness of the decision of Prague city government to change the speed limits from 70 km h⁻¹ to 50 km h⁻¹ on the parts of one main road leading to/from Prague. For measurements in real traffic conditions was used 2 typical Czech cars Skoda with manual transmission (Fabia 1.2 MPI with petrol engine and Octavia 2.0 TDI with diesel engine). Measurements were performed on both of directions on defined road segment.

At speed 50 km h⁻¹ the measurement was repeated 5 times at 3rd and 5 times on 4th gear. Similarly at speed 70 km h⁻¹ the measurement was repeated 5 times at the 4th and 5th gear. The aim was to operate the vehicle in the normal engine loads.

The results demonstrate the fundamental assumption that at the higher allowed vehicle speed the engine is more loaded and therefore produces a higher amount of emissions, but according to a higher vehicle speed the emissions are produced on the defined segment for the shorter time. A similar trend is evident even in fuel consumption. The results also indicate the depending on the power reserve of specific vehicle. When the vehicle is more powerful, higher permitted speed is preferable.

Key words: speed limit, emission, fuel consumption, on-road measurement, vehicle.

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Vehicle in use tyre characteristics evaluation during winter driving training

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Abstract. After the substantial increase in road traffic accident death numbers with the start of icy 2014-2015 winter conditions in Latvia drivers have been offered complimentary winter driving training. Having numerous drivers with their cars performing the same braking and manoeuvring actions gave a good opportunity for evaluating driver skills and vehicle in use tyre condition. Tyre age and thread depth were measured and driving instructions have been given to more than a thousand participants. Instrumented braking and manoeuvring measurements were made for thirty cars. The equipment included higher accuracy GPS receiver and two axle decelerometer. Measurement results have been compared against physical observations and hints given by professional driving instructors. The comparison indicated that although the suggestions given to drivers by professional instructors clearly contribute to safer driving, the visual evaluation without measuring may lead to various errors in messages conveyed to drivers. The inaccuracies included the influence of the vehicle mass on braking distance, the influence of ABS systems on simultaneous braking and manoeuvring and the influence of driver's decisions and skills on braking and manoeuvring. The investigation did not show essential vehicle mass influence on tyre adhesion and correspondingly on braking characteristics. Tyre thread depth and tyre age effect on braking characteristics demonstrated the relevance of technical requirements for winter tyres. Different approaches to manoeuvring in slippery conditions were observed. The advantage of using public training for winter tyre in use experiments is lower cost for getting tyre samples with various technical condition. The disadvantages are the different skills of car owners, the need for individual instruction, the necessity to adjust to the training format, the limited choice of the testing variables and substandard conditioning of the road surface. The tests gave valuable information for further training sessions and coming winter tyre tests.

Detection and characterization of wear particles of universal tractor oil using a particles size analyzer

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Abstract. Oil contamination is the most common and serious source of machine failure. Therefore, lubrication oil testing and analysis is one of the most important condition monitoring (CM) techniques for machinery maintenance and failure diagnosis. Oil analysis consists of determination of physical-chemical properties, contamination and wear debris analysis (WDA). One of the modern methods how to detect wear particles is LaserNet Fines (LNF). The technology is an extension of effective laboratory microscope analysis and was developed specifically to address the shortfalls of monitors that measure only particle size or elemental concentration. Universal tractor oil (UTTO) is the multipurpose oil for the lubrication of the transmission, rear axle, differential, wet brakes, and hydraulic system fed by the common oil reservoir.

The aim of this work is detection and characterization of friction particles during lifetime of two different universal tractor transmission oils samples with using of laser particle counter LaserNet Fines-C and their comparing, synthetic ester-based UTTO oil and mineral-based UTTO oil.

Key words: contaminants in oil, counting particles, image analysis, oil condition monitoring.

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Link between static radial tire stiffness and the size of its contact surface and contact pressure

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Abstract. The article is devoted to the description of the experimental results regarding the measurement of static radial deformation characteristics of the selected tire and its impact on the size of the contact surface and contact pressure. The given measurement was carried out on the diagonal tire Mitas TS05 10.0/75-15.3 PR10 in the area of the soil test channel. The radial deformation characteristics of the tires in question were determined for inflation pressures of 300 kPa, 220 kPa, 160 kPa and 100 kPa, with a radial stress of the tire varying in the range of 567.9 kg to 1025.09 kg. The prints of the tire's contact surfaces were made at the same time for the corresponding inflation pressure and the corresponding radial stress. The size of these prints was subsequently planimeterized by the digital polar planimeter Koizumi KP-90N. The values of the medium contact pressure on a solid support were subsequently calculated from the tire radial stress values and the obtained contact surfaces. The calculated static radial stiffness values were obtained through the linearization of the measured deformation characteristics according to Jante. The course of the deformation characteristics and the calculation of static radial stiffness imply that static radial stiffness is significantly dependent on the tire inflation pressure. A suppler tire structure at a lower inflation pressure allows for greater values of the contact surfaces and lower values of contact pressures. This feature can be used when selecting appropriate tire inflation pressures when driving off-road to reduce soil degradation and improving the vehicle's passability through the terrain.

Key words: terramechanics, landscape, mobile machines, wheeled chassis.

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Measuring the mobility parameters of tree-length forwarding systems using GPS technology in the Southern Italy forestry

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Abstract. The introduction of modern forwarders to Apennines forest operations must account for the traditional forwarding units used by local logging contractors. They generally use the same machine for extraction and intermediate off-road transportation on mountain trails, inaccessible to heavy road vehicles. Conventional forwarders are not designed for fast transportation on trail and cannot replace conventional. This research set up a long-term follow-up study to determine the use pattern of three conventional tractor-trailer units (Forwarder, forestry trailer and articulated truck). The goal of this study was to gauge the potential of these machines. In particular, the study determined for both machine types: monthly usage, incidence of travelling time over total time, distance covered and travel speed. The null hypothesis was that use pattern, average travel distance and speed distribution did not differ between traditional tractor and trailer units and high-speed forwarders. For this purpose, Global Positioning System/Global System for Mobile Communications data loggers were installed for continuous real-time collection of the main work data, including position, status, speed and fuel consumption. The study showed that new forwarders could actually travel at a speed higher than 24 km h^{-1} , and they performed both extraction and intermediate transportation. They were capable of independent relocation, which made them suitable for small-scale forestry. Both machine types were used intensively, but the annual usage of forwarders was almost twice as large as that of tractor-trailer units. Furthermore, forwarders had a 27% higher hourly productivity and a 50% higher fuel consumption per hour, compared with tractor-trailer units.

Key words: GPS – Track logger, data logger, extraction, precision forestry.

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Energy consumption of commuting of suburban areas

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Abstract. The intensive and sprawling development of the Prague's suburban areas has been often carried out without a construction of adequate transport infrastructures and public facilities. Many factors that characterize suburban land use e.g. density of population (or households, job opportunities), free access to public facilities, accessibility to different transport modes etc., are significantly associated with energy consumption especially within a transport. The cumulative effect of increasing traffic intensities is evident on radially oriented roads (of 2nd. or 3rd. class) to the city centre during last years. The energy consumption (or fuel consumption) determined according to vehicle's homologation does not take into account real conditions that negatively affect a way of drive e.g. slow drive, traffic congestions, road vertical alignment and tortuousness etc. The paper describes and concludes results from conducted traffic surveys that were focused on the energy consumption of vehicles used for commuting from suburban areas to Prague. The results show a difference in unit energy consumption of individual passenger transport and bus transport to the city's core. Furthermore the results show the difference in the energy consumption at peak hours. The obtained results proved the increase of transport energy consumption in time. The conclusions are important and should be used in spatial planning or decision making processes to prevent 'urban sprawl' with all its negative impacts. Suburban development should be made as concurrent processes of the construction of new transport infrastructures and the offer of high quality transit services.

Key words: energy consumption, fuel consumption, transport, suburban settlements.

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Optimization of vehicles' trajectories by means of interpolation and approximation methods

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Abstract. The need to optimize the trajectory of vehicles is still highly topical, regardless whether the means of transport are robots, forklifts or road vehicles. It is not only important the safety by passing obstacles, but also the energy balance, i.e. the energy expended on the movement of the vehicle and on the change of its direction. This paper presents a mathematical approach to solving this problem through interpolation and approximation curves.

Key words: means of transport, trajectory optimization, interpolation curves, approximation curves.

Comparison of methods for fuel consumption measuring of vehicles

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Abstract. Essential task for companies in these days is to reduce operating costs and optimization of workflow processes of machines, in order to increase the competitiveness and productivity. Telematics systems is relatively widespread and utilized for fleet management and enables collecting a wide range of operating parameters. One of the monitored parameters of operating costs is fuel consumption of machines. The collection of data on fuel consumption can be realized using various methods. By default, the fuel consumption data is transmitted from CAN-BUS which does not always coincide with the value of the real fuel consumption. Another possible way of fuel consumption monitoring is realized via installation of capacitance probe mounted directly into the fuel tank. The principle of measurement of these two methods is different, and each method has its own specifics. For instance, a capacitive probe enables detection of non-standard decreases of fuel level in the fuel tank. The aim of this paper is to compare the methods of fuel consumption measuring via the CAN-BUS and utilization of capacitive fuel probe. Measuring unit Gcom was used for collecting data which sends data of fuel consumption to the server in real-time. The purpose of this paper is to prove or disprove the hypothesis that measured fuel consumption is statistically significant between measuring via CAN-BUS compared to capacitance probe.

Key words: Fuel consumption, capacitance probe, CAN-BUS, telematics system.

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The influence of biobutanol on performance parameters of mobile generator

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Abstract. The expansion of biofuel also affects the area of using small internal combustion engines, which are widely used in municipal equipment such as minitractors, chainsaws, mowers and brush cutters. These small engines have their specific operation conditions, especially given by high operating speeds and high loads. Current legislation for fuel BA 95 prescribes the addition of ethanol. The percentage is however very small nearly not affecting the operation of combustion engines. The paper is focused on biobutanol since it is considered as more advanced type of alcohol based fuel than bioethanol. The measurement is focused on a small combustion engine of portable generator with maximum power of 2.5 kW. There is monitored influence of biobutanol on their performance parameters. As the mixing ratios are in the range of 100% fuel BA 95 (without ethanol) to 100% biobutanol.

Key words: combustion engine, bio-fuels, biobutanol, generator, engine parameters, fuel consumption.

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Smoke and NO_x emissions of combustion engine using biofuels

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Abstract. Production of solid particles significantly increases the dangerousness of combustion engines. The excellent sorption characteristics of the solid particles increases their harmful effects and makes them very dangerous component of emissions which causes health problems. Currently there are many design solutions which aim to reduce smoke of combustion engines. One of the most significant solutions suggests increasing the injection pressures up to the limit of 250 MPa and filtering the exhaust gases. The paper compares different fuels and biofuels, whether used alone or in mixtures, and their effect on smoke of supercharged CI engine. The comparison uses the 8-point NRSC (Non-Road Steady Cycle) test during which the following fuels were used: diesel, rapeseed methyl ester, rapeseed oil, Jatropha curcas oil, biobutanol, hydrotreated oil and other blended fuels. The measurement and comparison results show that using biofuels can significantly reduce smoke of combustion engine by up to tens of percent in comparison to diesel.

Key words: Combustion engine, biofuels, harmful emissions, performance.

ACKNOWLEDGEMENTS. The paper was created with the grant support project CULS 2015:31190/1312/3117 – Quality of work and energy intensity of mulcher with vertical axis of rotation using different shapes of cutting tool and within the long-time development project of Research Institute of Agricultural Engineering p.r.i. no. RO0614.

Specialized alcoholfuel powered motor-generator capacity parameters improvement

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HIGHLIGHTS

- Recent concepts, developments and patents of free-piston engines are over viewed.
- Innovative approaches and promising novel technical solutions are highlighted.
- Selected physical and numerical models are critically evaluated.
- Based on critics and compromises a new mechanical model is proposed and presented.

Abstract. Free-piston engines, as power generators for electricity and hydro solutions, have been under research and development over last decade. So far, not seen yet commercially available or production ready compact and stable engine. There are certain technical reasons for not being on the markets currently. This article reviews the recent theoretical investigations and experiments of free-piston engines, from the diesel and gasoline combustion engines up to bio fueled and dual fuel solutions. Innovative and novel features of free-piston engines are mapped and their influence on engine operations and power production are discussed, along with potential pros and cons. This article focuses mainly on open-source available technical and operational data. Overviewed different technical solutions and physical calculations will be broth together and discussed critically. The paper will epitomize discussions above with one possible theoretical technical solution for free-piston engine, as power generator, consuming in combustion process pure alcohol fuel.

Key words: Flat free-piston engine generator, two-stroke IC engine, linear and rotational generator, Engine lubrication, scavenging process efficiency, piston force, starting process of engine, piston ring, amplitude and stroke, energy storage.

Carbon dioxide emissions of wind machine operating

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Abstract. Global warming is problem of all the countries and required international cooperation to avoid the influences. A new technological application used worldwide has led to the use of fossil fuels and creating more various harms to environment as a result of exhaust emissions from combustion. One of these new applications in the agricultural sector is wind machines usage against to frost protection. This operation performs heat transfer by circulation of the warmer air down to crop level with 360 degrees rotation in horizontal axis. Recently published studies have shown that wind machines caused air temperature increment and prevent temperature falling below 0° C. However, no study has been reported on carbon dioxide emission and environmental effect of wind machines in the literature. To address this question, a power capacity of 172 HP with diesel engine (Orchard Rite, 2600, USA) was used in 150 da lemon orchard. The experiment was conducted in the south of Adana, Turkey (36.83°N; 35.32°W; 50 m a.m.s.l.) on 27 January 2015. In this study, CO₂ gas concentrations of wind machine caused by exhaust were recorded by multi-gas monitor (Rae systems, Multirae lite pgm-6208, USA). The results show that an average CO₂ emission was 10150 ppm in 2270 rpm engine speed. In addition, some studies show that carbon dioxide emission could decrease drastically by using biodiesel mixture with diesel application. Through this work will help to the understanding of wind machines usage with minimal environmental impact.

Key words: Wind Machine, Carbon Dioxide, Emissions, Environmental Effect.

The water content in the engine oil by using E85

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Abstract. The European Union adopted a decision to achieve by 2020 at least 20% reduction in greenhouse gas emissions. To fulfill this task, the EU proposed in 2020 binding targets – further improve energy efficiency by 20%, achieving a 20% share of renewable energy and a 10% share of biofuels in the fuel market. One of the most widely used biofuel in the automotive industry is bioethanol. Bioethanol can be used on low-percentage blending into petrol, which is governed by European Directive 2003/30/EC, and on high-blend bioethanol mixture, particularly E85 consists of 85% bioethanol and 15% petrol BA95. But in recent years, increasingly demonstrating opinions, that biofuels do not produce nearly as much effect as was propagated. This paper deals with the concentration of water in the engine oil with using biofuel E85. The water in the engine oil significantly affects its parameters (especially viscosity). How measurement results demonstrated the use of bioethanol in the fuel increases the concentration of water in the engine oil.

Key words: biofuel, oil, concentration, water.

ACKNOWLEDGEMENTS. The paper was created with the grant support project CIGA CULS Prague 20153001 – Utilization of butanol in internal combustion engines of generators.

Impact of bioethanol fuel blends on exhaust gases in internal combustion engines: a review

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Abstract. The present work reviews the literature related to the use of (bio)ethanol and its mixtures in gasoline and diesel engines. The two main problems of contemporary automobile industry and agriculture are related to the finiteness of oil resources and their negative impact on the environment. Firstly, second generation bioethanol engine fuel is produced from renewable resources and does not compete with food industry. Secondly, the problem of pollution and exhaust gas opacity is not only an acute but also complicated problem in contemporary engine engineering. The present paper reviews the use of different bioethanol fuel mixtures and their proportions (e.g. bioethanol and gasoline mixtures, bioethanol and diesel mixtures) in internal combustion engines. The aim of the paper is on parameters and constituent characteristics of different fuel mixtures and their impact on the exhaust emissions level and content. Also evaluates the efficiency of the application of these fuel blends in internal combustion engines. A particular attention is paid to the analysis of the most toxic parameters of the exhaust gases (i.e. carbon oxide (CO) and carbon dioxide (CO₂), hydrocarbon (CH), nitrogen oxide (NO_x), and smokiness that have a more significant negative effect on both environment and human health. As a result, the authors of the present paper acquired the data on most suitable (bio) ethanol fuel blends to be efficiently used in several types of two- and four-stroke diesel and gasoline engines in order to preserve exhaust gas emissions and their toxicity at a relatively low level. The analysis of the data introduced in the reviewed articles shows that their application in internal combustion engines may lead to decrease in toxic exhaust emissions.

Key words: (bio)ethanol, spark ignition engine, compression ignition engine, two-/ four-stroke engine, exhaust emissions.

X FOOD SCIENCE and TECHNOLOGY

Differences in cadmium accumulation and induced changes in root anatomical structures in plants used for food

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Abstract. A rapid urbanization passes all over the world thus the effect of chemicals, including heavy metals, increases on plants. Heavy metal pollution poses a serious hazard to humans' health, and its uptake into plants is the primary way through which it can enter the food chain. The goal of this study was to investigate the impact of cadmium (Cd) contamination on plant growth responses, Cd uptake, and changes in the root anatomical structures as species-specific reaction to Cd stress. The vegetation experiment was carried out with monocotyledon *Hordeum vulgare* L. and dicotyledonous *Lactuca sativa* L. The plants were grown in quartz sand under controlled optimal growth conditions. Changes in the root structure and Cd accumulation were studied at five levels of Cd added as Cd(NO₃)₂ · 4 H₂O solution in substrate. The level of Cd in the air-dry plant material was estimated by an atomic absorption spectrometer. To identify structural changes in the plant roots which were caused by Cd accumulation cross sections were cut using microtome and stained with Astra Blue/Safranin for observations using a light microscope. Barley and lettuce growth and development were significantly influenced by increasing the amount of Cd in substrate. There were differences in the ability to accumulate Cd in above-ground plant parts depending on a model object. Substrate contamination with Cd caused significant changes in the root anatomical structures. The obtained results confirmed significance of anatomical and physiological studies to reveal species-specific plant response to Cd stress to avoid heavy metal entrance in the food.

Key words: barley, lettuce, cadmium uptake, root anatomy, growth responses.

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The influence of microelements selenium and copper on the rye malt amylase activity and flour technological properties

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Abstract. The positive effect of microelement selenium (Se) on the amylase activity and technological properties of malt is well known. Copper (Cu) is an essential microelement required for the normal functioning of living organisms, plants and most microorganisms. The aim of the current research was to investigate the interaction of two microelements - copper and selenium and its influence on the rye malt and flour properties. Rye grain of 96% viability were soaked and germinated at temperature $+6 \pm 2$ °C for 3 days, using Se (VI) containing solution (Se concentration 8.5 mg L⁻¹) or selenium with copper(II) containing solutions (Se concentration 8.5 mg L⁻¹, Cu concentrations 3 mg L⁻¹, 5 mg L⁻¹, 10 mg L⁻¹). After that sample were dried in the oven for 24 hours at temperature of + 73–108 °C. Control sample-germinating rye grain without microelements additives. Activity of amylase was determined in all experimental samples, because it characterizes the malt quality. Amylases are starch hydrolysing enzymes; more over there are known several amylases: α -amylases, β -amylases, isoamylases, etc. with different mechanisms of reaction. There different analytical methods were used for determination of α -amylase activity. The first was Ceralpha method (Megazyme test kits). The second method use complete reagents for quantitative determination of α -amylases (Phadebas Amylase Test). The third was iodometrical method. Different amounts of malt fortified with Se and Cu were added for investigation of rye flour technological properties. The falling number and the maximum viscosity were determined. The obtained results show that analysed additives of microelement copper decreases the enzyme activity. Analysed rye flour technological properties were better using malt only with selenium supplement.

Key words: selenium, copper, rye malt.

Extraction of biologically active compounds from fruit, berry and grain Grist using ViscoStar 150L enzyme complex

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Abstract. This work aimed to evaluate the efficiency of treating plant tissue with enzymatic agent ViscoStar 150L for the extraction of biologically active compounds. In the current study the screening of extraction methods from citrus fruit peels (grapefruit, lemon, orange) was performed. The samples treated with enzymatic agent ViscoStar 150L showed better extraction results than the traditional ethanol/water extraction method. Citrus peels' extracts assayed for antioxidant activity (determined as ferric reducing antioxidant power – FRAP) decreased in the following order: grapefruit > orange > lemon. The enzymatic agent ViscoStar 150L proved to have a positive synergic effect on juice yield from cowberry previously treated with a complex pectolytic enzymatic agent. The enzymatic agent ViscoStar 150L proved to have a synergic effect on grain grist mashes previously treated with an amyolytic enzymatic agent, the inhibitor activity of the compounds produced by actinomycetic microorganisms grown on substrates based on these mashes being higher than that of previously known inhibitors.

Key words: ViscoStar 150L, cowberry, citrus peel, grain grist, antioxidants.

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The application of green tea Extract as a source of antioxidants in the processing of dairy products

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Abstract. Regular consumption of foods containing antioxidants reduces the bodily content of free oxygen radicals, which can cause pathological changes and premature organism aging. The aim of this work was the development of the formulations and determination of the parameters for the production of cottage cheese products with polyphenol fraction of green tea extract as a source of plant antioxidants. Parameters to obtain extracts with the high content of extracted substances and high antioxidant activity were determined. Optimal performance was achieved by brewing dry green tea leaves with (70 ± 2) °C water, followed by steeping at the same temperature for 10 minutes with continuous mechanical stirring. Optimal dry tea leaves to water ratio used for tea extracts' preparation was identified. The level of tea extract in cottage cheese products' recipes was determined. The flavour fillers which combine the best with green tea extract and taste were identified. The positive effect of tea extract component on shelf life of cottage cheese product was shown.

Key words: Antioxidant activity, polyphenols, the parameters to obtain extracts, cottage cheese products.

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Image analysis of the shapes and dimensions of Teff seeds (*Eragrostis tef*)

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Abstract. With aid of the image analysis using trio ocular microscope the dimensions, circumferences and areas in two perpendicular planes of Teff seeds were measured and based on this information the new ellipsoid model of the seed's shape was derived and compared with measured values. From statistical analysis implies that this model on probability 0.95 is significantly identical with measured values of the Teff seeds. Determined model can help more accurately set up and developed accurate mathematical model for describing mechanical behaviour of individual seeds as well as bulk seeds.

Key words: model, ellipsoid, ball, cereals, grain, dimension.

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Development of new pig carcasses classification formulas and changes in the lean meat content in Latvian pig population

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Abstract. Pig classification is based on objective estimation of the lean meat content of the carcasses. The European Union established a common framework for the classification of pig carcasses. Carcass classification serves as a quality development tool to encourage the breeding of animals, from which it is possible to get high quality carcasses for processors and consumers. It is a common practice to recalculate pig carcasses classification formulas and update existing classification methods (or develop new methods) after every five years.

The representative samples of 145 pig carcasses from all regions of Latvia were used for the dissection trial. The precisely dissected carcasses with the warm carcass weight 60–110 kg were selected according to fat thickness and gender of pigs (the sex ratio were 50% females and 50% castrated males). From the experimental data were developed new formulas for the four methods Intrascoper (Optical Probe); Manual method (ZP); Pork Grader (PG200); Optigrade MCP. During sampling the average warm carcass weight was 89.31 kg. New coefficient was detected and formula was developed for calculation of carcass standard presentation in all cases if some of the carcass parts are missing; for the missing head 8.345, for the missing tail 0.072, for the missing forefeet 0.764, for the missing hind feet 1.558. The comparison between the currently used and new experimentally obtained formulas showed difference up to 1.86% in lean meat content. The results suggest high accuracy of new regression formulas, which fully meets requirements of EU legislation.

Key words: pigs, carcass classification, lean meat content, meat quality.

Effect of lovage phenolics to formation of acrylamide in French fries

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Abstract. One of the novel methods for reduction of acrylamide in food is application of plant phenolics in technological process of Latvian plants as lovage contain significant amounts of plant phenolics and other natural antioxidants. The aim of current research was to determine the effect of lovage extracts to the formation of acrylamide in French fries. Variety 'Lenora' potatoes were used. Potatoes were sliced and blanched in hot water (85 ± 2 °C 8 min). After blanching samples were treated with lovage water and ethanol extracts and four samples were obtained: control (without additional treatment); SW – sprayed with water extract, IMW – immersed in water extract, SE sprayed with ethanol extract. After treatment all samples were fried in oil (180 ± 2 °C) for 7 minutes. Total phenolic (TPC), vitamin C content and antioxidant activity (DPPH and ABTS) were determined for all samples before and after frying. For fried potatoes acrylamide and breaking force with texture analyser were determined. TPC of samples during frying decreased significantly but comparing fried samples the highest TPC in SE sample was determined. The highest DPPH radical scavenging activity was observed in samples treated with water extract but during frying the DPPH activity for all treated samples was lower than to control sample. The most significant changes in ABTS radical scavenging activity were observed and also the highest activity of sample SE was observed. Vitamin C content decreased significantly during frying, the highest vitamin C content in SE sample was determined. The highest maximal breaking force of fried potatoes was detected for sample IMW, but the lowest for sample SE. The lowest acrylamide content was found in sample, which was sprayed with lovage-water extract.

Key words: French fries, lovage, treatment, ABTS, ascorbic acid, breaking force.

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Gas chromatography–mass spectrometry study of lipids in northern berries

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Abstract. Wild berries from forests and bogs of Northern Europe are an excellent source of natural antioxidants, vitamins and fatty acids, all of which are substances with high biological activity. This study investigates lipids extracted from fresh and powdered berries, using low-polarity solvents (chloroform, diethyl ether and others) and a mixture of chloroform and methanol. Berry lipids were analysed by gas chromatography–mass spectrometry. The following berries were analysed: blueberry (*Vaccinium myrtillus* L.), bilberry (*Vaccinium uliginosum* L.), two cultivars of highbush blueberry (*Vaccinium corymbosum* L.), lingonberry (*Vaccinium vitis-idaea* L.), cloudberry (*Rubus chamaemorus* L.), black crowberry (*Empetrum nigrum* L.), cranberry (*Vaccinium oxycoccos* L.) and rowanberry (*Sorbus aucuparia* L.). One hundred and eleven compounds were identified and quantified in the 9 species of analysed berries. The lipid fraction contained compound classes like fatty acids, sterols, triterpenoids, alkanes, phenolic and carboxylic acids and carotenoids. All fresh berries contained high amounts of C18 unsaturated fatty acids (for example, up to 102 $\mu\text{g g}^{-1}$ of blueberries) and phytosterols (86 μg of β -sitosterol g^{-1} of blueberries), and high amounts of benzoic acid were found in lingonberries (164 $\mu\text{g g}^{-1}$). The analysed berry lipid profiles were compared using the principal component analysis and hierarchical cluster analysis. The two analyses showed that the lipid profiles of the studied berries reflect their taxonomy.

Key words: Northern berries, lipids, extraction, GC/MS, chemotaxonomy.

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Egg yolk oil as a source of bioactive compounds for infant nutrition

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Abstract. Egg yolk oil is a natural source of bioactive compounds such as DHA, fat-soluble vitamins, lutein, phospholipids and cholesterol. These important compounds are also found in breast milk: DHA for infant brain development, lutein for eye health, vitamins A and E to support developing cells. Egg yolk oil naturally contains vitamin D which is required for a normal bone development. Fatty acid profile of egg lipids is also close to human milk. The aim of this study was to evaluate the conformity of egg yolk oil for infant nutrition. In this study egg yolk oil extracted from liquid egg yolk using two-stage solvent extraction with polar and non-polar solvents was used. Extracted egg yolk oil was analyzed for fatty acids, fat-soluble vitamins, lutein, phospholipids and cholesterol using GC and HPLC methods. Results were compared with the chemical composition of human breast milk and nutritional recommendations for infant feeding. Fatty acid profile of egg yolk oil was similar to breast milk in terms of palmitic, stearic, linoleic and α -inolenic acids. Egg yolk oil used in this study was high in DHA, but low in ARA. Vitamin A, D and E content was sufficient for infant biological needs. Lutein and phospholipid content in egg yolk oil was lower than their content in breast milk fats, but cholesterol in opposite was in much higher concentration than available in breast milk. Chemical composition of egg yolk oil still makes it an excellent source of bioactive compounds for infant nutrition.

Key words: egg yolk oil, infant nutrition.

Total phenols and antioxidant capacity of hull-less barley and hull-less oats

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Abstract. Grain products are the main source of carbohydrates but they also contain other bioactive substances such as phenolic compounds. Content of phenolic compounds differ among cereal types, varieties, and farming methods. The aim of the current study was to assess total phenolic content and radical scavenging activity in different oats and barley varieties compared to hulled ones. In the experiment hull-less varieties / lines were analysed: three barley (line 'GN 03386', from Norway and 'Kornelija', 'Irbe' from Latvia) and three oats varieties ('Bikini', 'Nudist', from Norway and 'Stendes Emilija,' from Latvia). One hulled variety of barley and oats from each country was included in the experiment for comparison. For the isolation of phenolic compounds ultrasound assisted extraction was used. For all extracts the total phenol content and DPPH, ABTS⁺ radical scavenging activity were determined spectrophotometrically. Overall, the highest content of total phenols was detected in hull-less barley samples. The barley variety with the highest content was line 'GN 03386,' followed by varieties 'Kornelija', 'Irbe,' and hulled Norwegian barley variety 'Tyra'. High DPPH and ABTS⁺ radical scavenging activity was recorded in barley line 'GN 03386'. Generally, there was strong correlation between total phenol content and ABTS⁺ radical scavenging activity and moderate correlation between total phenol content and DPPH radical scavenging activity. In conclusion, the barley varieties had generally higher content of bioactive substances than oats and the barley line 'GN 03386' seems to be one of the best.

Key words: hull-less oats, hull-less barley, total phenols, antioxidant.

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Effects of germination on total phenolic compounds and radical scavenging activity in hull-less spring cereals and triticale

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Abstract. The aim of the current research was to evaluate changes in the content of total phenolic compounds and radical scavenging activity at different germination stages of triticale, hull-less barley, hull-less oats, wheat, and rye. Grain germination was performed for 12, 24, 36 and 48 h at controlled conditions. Ultrasound assisted extraction was used for isolation of total phenolic compounds. For all extracts the total phenolic compounds content, DPPH radical and ABTS⁺ radical scavenging activity were determined spectrophotometrically. The results of the experiments demonstrated that the highest content of total phenolic compounds and the highest antiradical activity was determined in hull-less barley samples. In all studied grains the content of phenolic compounds increased significantly during soaking and germination process. DPPH radical scavenging activity during germination increased. ABTS⁺ radical scavenging activity also increased after soaking process and dynamics were cereal type dependent. Pearson's coefficients between the phenolic compound levels and antioxidant activity taking into account all obtained results were high. Very strong positive correlations between the content of phenolic compounds and antioxidant activity were determined for triticale during germination. Also antioxidant activity determined by both tests correlated with the highest results for barley and oats. The highest content of total phenolic compounds determines the optimum duration of germination to be 24 hours, except rye samples where the highest value was reached only after 48 hours of germination. Shorter time was required to reach the highest values of DPPH radical activity – for wheat rye, and triticale, namely 12 hours.

Key words: cereals, germination, total phenolic compounds, radical scavenging activity.

ACKNOWLEDGEMENTS. The research leading to these results has received funding from the Norwegian Financial Mechanism 2009–2014 under Project Innovative approach to hull-less spring cereals and triticale use from human health perspective (NFI/R/2014/011).

Grain processing by enzymes to increase bioavailability of minerals in cereals

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Abstract. Nutritionists recommend cereal products to provide food allowance with dietary fiber, protein, vitamins and minerals, located mainly in shells of grain. However, cereal products include minerals not only in available form. Many of them have bonds with phytin in insoluble complex forms or with polysaccharides of cell wall. Purpose of the study was to increase the availability of mineral elements in grain products. To achieve this a complex enzyme preparation (producer *Penicillium canescens*), containing cellobiohydrolase, xylanase, β -glucanase and phytase was used.

Using X-ray EMF detector miniCupin scanning electron microscope the contents of minerals in grain were determined and their distribution within the grains were mapping. It was found that the relative amount of biogenic elements that are part of metalloenzymes and biologically active compounds, has increased in endosperm, where in process of grain swelling oxidative decomposition processes of high-replacement compounds intensified.

Chemical elements, characterized by high mobility, moved from central position to peripheral part of caryopsis. Since dietary fiber and phytates are found together in fiber enriched peripheral layers of grain, it is difficult to separate effects of non-starch polysaccharides fibers degradation processes and phytate on the redistribution of polyvalent metal ions.

Thus, study have shown that phytase combined with xylanases - effective mechanism of regulation of mineral dietary value of food allowance.

Key words: enzymes, phytase, grain, mineral elements, bioavailability.

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Water and water clusters in biological systems

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Abstract. Water is inherently a simple substance, but from Aristotle's time until today it raises a lot of questions. Living cells are about eighty per cent water. Organisms consist essentially of liquid water, which fulfils a lot of functions and should never be considered just an inert diluent. The unique properties of water are of fundamental relevance for human life and play a substantial role in many biochemical and biological systems. In the second half of the previous century, researchers came to an understanding about the differences between biological water and ordinary water. This article reviews previous studies on water function and its significance in biological systems. Present knowledge about water clusters, the understanding of water cluster role in biological systems and common methods used in the analysis of determining water clusters are examined in this paper.

Key words: biological water; water structure; water biology; clustered water; cell water; hydrogen bonding.

Nitrogen fertilizer effect on winter wheat wholemeal protein content and rheological properties

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Abstract. Winter wheat (*Triticum aestivum* L.) is one of the most productive and significant cereal species in Latvia used for food grain production. The aim of this investigation was to clarify variation of protein content on winter wheat grain, water absorption and mixing properties of wholemeal dough, depending on nitrogen fertilizer. Field experiments with winter wheat cultivars 'Bussard' and 'Zentos' were conducted at the Latvia University of Agriculture, Study and Research farm 'Peterlauki' during a three year period (from 2009/2010 to 2011/2012). Nitrogen (N), was applied (N60, N90, N120, N150 kg ha⁻¹) in spring after resumption of vegetative growth. Grain was harvested at full ripeness. Grain protein content was calculated multiplying total nitrogen content by factor 5.7 determined by Kjeldahl method (ICC 105/2). The farinograph water absorption and dough mixing characteristics—dough development time, dough stability time and degree of softening were tested by Brabender Farinograph (ICC 115/1). Average data in our investigation (three years) show that nitrogen fertilizer significantly ($P < 0.05$) affected protein content, farinograph water absorption and mixing properties of winter wheat wholemeal dough. Cultivar 'Bussard' wholemeal had significant ($P < 0.05$) higher protein content, water absorption, longer stability time and shorter degree of softening compared with 'Zentos'. With increase of the dose of nitrogen fertilizer (N120, N150), protein content was higher, water absorption increases; prolonged the dough development and stability time. Degree of softening was higher when wheat was fertilized with lower nitrogen doze (N60 and N90). Additional nitrogen fertilizer reduced degree of softening, which had a positive effect on bread-making quality of wheat.

Key words: farinograph, cultivars, water absorption, dough development time, dough stability time degree of softening.

Effect of sowing date on oil, protein and glucosinolate concentration of winter oilseed rape (*Brassica napus* L.)

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Abstract. The effect of time of sowing on oil and meal quality of winter oilseed rape (*Brassica napus* L. cv. Express) was investigated at the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences in the period of 2001–2005. The rape seeds were sown at weekly intervals on four different dates: 8th, 15th, 22nd and 29th of August. The study shows that sowing date and environmental conditions affect the seed quality of winter oilseed rape. Early sown oilseed rape plants were more adapted to stressful conditions associated with high or low temperatures. The seeds of such plants had higher oil concentration (up to 50.2%) and a lower protein concentration (approximately 19%). Plants sown in late August were less tolerant to stressful conditions and their seed oil concentration was lower (47–48% DM). Oil and protein yield were higher in the early sown crops because the seed yield was higher. Also the glucosinolate (GSL) concentration of the seeds was affected by the time of sowing and weather conditions. Shortage of rainfall before harvest increased the GSL concentration in the seeds. Plants sown in late August did not tolerate the extreme environmental conditions and their seed glucosinolate concentration appeared to increase.

Key words: cv. Express; glucosinolate concentration; oil concentration; oil yield; protein concentration; protein yield.

The hygienic and nutritional quality of milk from Saanen goats bred in the Moravian-Silesian region

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Abstract. The aim of the study was to monitor milk yield and the hygienic and nutritional quality of milk of Saanen goats in the Moravian-Silesian region in Czech Republic. Milk samples were collected once a month during the lactation period. The average milk yield in the standardized lactation was 1,100 liters. The somatic cell count in pool samples ranged from 470×10^3 to 696×10^3 . The total microorganism count ranged from 3.6×10^3 to 1.4×10^5 . The pathogen *Staphylococcus aureus* was proven no more than in 6.3%. The highest values of all main components of milk were achieved within a relatively short time after kidding (April 2015). The average content of fat was 3.64 ± 0.52 g 100 ml^{-1} , 3.17 ± 0.16 g 100 ml^{-1} of protein, 2.60 ± 0.06 g 100 ml^{-1} of casein, 4.56 ± 0.24 g 100 ml^{-1} of lactose, and 12.02 ± 0.80 g 100 ml^{-1} of solids. Average content of vitamin A was 0.27 ± 0.14 mg kg^{-1} and average content of vitamin E was 0.60 ± 0.34 mg kg^{-1} . Content of vitamin E increased almost continuously during the lactation, and the content of vitamin A was significantly higher at the end of lactation. In lyophilized milk powder the average trace metal contents were 7.76 ± 0.92 g kg^{-1} Ca, 1.62 ± 0.26 g kg^{-1} Mg, 15.3 ± 1.43 g kg^{-1} K, 789 ± 111 mg kg^{-1} Na, 23.2 ± 2.73 mg kg^{-1} Zn, and 0.85 ± 0.55 mg kg^{-1} Cu. Contents of minerals varied during the lactation period, but no significant trends were observed.

Key words: total microorganism count, somatic cell count, pathogens, fat, protein, casein, lactose, vitamin A, vitamin E, Ca, Cu, K, Mg, Na, Zn.

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The content of minerals in milk of small ruminants

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Abstract. The aim of this study was to determine and compare the content of sodium, potassium, calcium, magnesium, zinc, copper, lead, and cadmium in sheep and goat milk of different breeds from 9 farms in the Czech Republic (herds of 18–330 goat's heads and 30–380 sheep heads). Pool samples of milk were collected once a month (April - September) during lactation in the years 2011–2013. The content of minerals was determined using atomic absorption spectroscopy. Most of the analyses of the contents of Cd and Pb were below the limit of detection. Other determined values of these two contaminants were lower than maximal tolerable amount according to previously valid regulation No. 298/1997 Sb of the Ministry of Health of the Czech Republic given for cow's milk. The contents of each element in the whole of the reference period were in a relatively wide range. Determined levels of Ca, Mg, K, Na, Zn and Cu in goat milk related to the weight of lyophilized milk powder varied from 1.40–8.08 g kg⁻¹, 0.16–1.42 g kg⁻¹, 8.16–31.10 g kg⁻¹, 0.72–5.43 g kg⁻¹, 7.59–44.10 mg kg⁻¹, and 0.21–1.46 mg kg⁻¹ respectively. Determined levels of Ca, Mg, K, Na, Zn and Cu in sheep milk varied from 1.69–9.13 g kg⁻¹, 0.21–1.36 g kg⁻¹, 3.53–11.90 g kg⁻¹, 0.65–5.05 g kg⁻¹, 13.70–34.30 mg kg⁻¹, and 0.15–2.10 mg kg⁻¹ respectively. Statistically higher ($P < 0.05$) content of potassium was determined in goat milk in comparison with sheep milk. The contents of all followed minerals in milk samples from each farm collected during the lactation period were very variable, but it is not possible to find any direct relationship between the content of studied elements and the date of sampling. It was found that the year has statistically significant influence especially on the content of Ca and Mg in milk of small ruminants.

Key words: goat milk, sheep milk, Ca, Cd, Cu, K, Mg, Na, Pb, Zn.

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Partial Purification of β -glucosidase enzyme from soybean (*Glycine max*) and determination of inhibitory effects two quercetin derivatives on enzyme activity

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Abstract. Glucosidases are enzymes that catalyze the hydrolysis of the glycosidic linkage of glycosides, leading to the formation of a sugar hemiacetal or hemiketal and the corresponding free aglycon. Activity of glucosidases is crucial for several biochemical processes. Thus, discovery of new glucosidase inhibitors is crucially important owing to potential therapeutic applications of this enzyme in the treatment of diabetes, human immunodeficiency virus infection, metastatic cancer, lysosomal storage disease etc. In the current study, inhibitory potential of 'quercetin' and its isomeric form 'morin hydrate' on the activity of β -glucosidase enzyme, present in the extract of soybean (*Glycine max* L.) seeds, were investigated. The compounds exhibited moderate inhibitory action in low millimolar concentrations. I_{50} values were calculated as 0.188 and 0.138 mM for quercetin and morin hydrate, respectively. The results have confirmed that these compounds can be used as leads for designations of novel glucosidase inhibitors which would be used in medicinal biotechnology and food science and technology.

Key words: beta-glucosidase, inhibition, quercetin, morin hydrate, soybean.

The influence of heat transfer coefficient on moisture evaporation rate during the cooling of fresh baked white pan bread

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Abstract. Cooling rate is a very critical parameter. Low cooling rates can limit production capacity in a bakery, while higher cooling rates can lead to a higher moisture evaporation rate and result in the greater weight loss of the product. The principal objective of this work is to study the effect of heat transfer coefficients on heat and mass transfer processes, which take place in freshly baked white pan bread during its cooling.

The model of bread cooling process is built based on experimental results, Fourier's second law for heat transfer and Fick's second law for mass transfer. The new model allows studying what influence the heat transfer coefficient has on the cooling rate. Several dependencies are revealed and discussed in this article. Several pieces of advice for developing an air distribution system are also provided.

Key words: Bread cooling, heat transfer coefficient.

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Effect of heat treatment at constant 120 °C temperature on the rheological and technological properties of pork

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Abstract. The aim of the study was to evaluate the influence of low-temperature heat treatment on the physical and technological properties of pork. The *Longissimus thoracis* muscles from four pigs were used to determine the quality indicators of pork at 24 hours after slaughtering. Meat samples were cooked at constant 120 °C in a cooking bag until the internal temperatures of 62, 67, 72, 77 and 82 °C. Raw meat was the darkest and differed considerably ($P < 0.05$) from the heat-treated meat. The colour values of the heat-treated meat differed slightly among internal temperature phases. The ultimate pH value of raw meat also differed significantly ($P < 0.05$) from that of cooked meat. The pH value of cooked meat varied only within the range of 0.05 units. The electrical conductivity of muscle decreased gradually as the temperature increased. In case of heat-treated meat, the cooking loss increased considerably (from 18.88% to 31.73%) along with the increase in the internal temperature. The Warner-Bratzler shear force value was the highest (38.50 N) in the meat cooked until 77 °C, and the lowest (28.51 N) in that cooked until 67 °C. Strong negative correlation ($P < 0.001$) between electrical conductivity and cooking loss was observed during the heating procedure. Heat treatment can significantly decrease the electrical conductivity and increase the cooking loss of meat. Meat was the toughest when the internal temperature was 77 °C. However, the best rheological properties were observed in the meat cooked until the internal temperature of 72 °C.

Key words: pork, *Longissimus thoracis*, temperature, heat treatment, technological properties, rheological parameters.

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Changes in the total phenol content in the industrial potato peel wastes during the storage

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Abstract. As a zero value by-product from the economic point of view, potato (*Solanum tuberosum* L.) peel is a good source of phenols. As a manufacturing waste, potato peels are stored at the uncontrolled conditions and are exposed to the fermentative, oxidative, and microbial degradation. The aim of the present study was to determine the phenol degradation dynamics in the stored peels so the maximum storage time could be defined to achieve the efficient phenol extraction. Three different types of samples were prepared by abrasion peeling method and stored at room temperature, in open air, up to six days. Phenol extracts were obtained using ethanol-based solvent. Total phenol content was expressed as a gallic acid equivalent; antiradical activity was measured using the 2,2-diphenyl-1-picrylhydrazyl radical. Results revealed that total phenols during the storage are more stable in the larger peel samples that can be stored up to two days without significant changes in the total polyphenol content and antiradical activity. Finely shredded peel demonstrated significant decrease in the total phenol amount and in the antiradical activity already on the second day of the storage. This fact indicated that in the finely shredded peel samples phenols are easily accessible to the oxidative and fermentative processes. It is possible, that after peeling there were big amounts of chlorogenic acid in the samples. When total amount of polyphenols decreased, chlorogenic acid degraded and caffeic acid was released in sufficient amount to hold antiradical activity of the extract on the high level.

Key words: antiradical activity, potato peel utilization, phenols.

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Influence of the packaging material on the quality parameters of tobacco during ageing

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Abstract. Tobacco is one of the most extensively studied plant materials in the history. During its production tobacco leaf goes through many different operations from curing (drying) to ageing. Among all of them storage and ageing are very important operations. Properly stored tobacco develops its full flavour, becomes more aromatic and is ready to be sent to a customer for cigarette production. In this work changes in the quality of dried tobacco leaves during ageing (12 and 24 months) in different packaging materials are evaluated. Four samples of the FCV tobacco (Flue-Cured Virginia) grown in Northern Light Soils (NLS) region (India) were analysed. Two different liners inside of C-48 cartons – polyliner and kraft paper – were used for tobacco packaging. Quality evaluation of tobacco samples was done on the basis of analysis of chemical components (total alkaloids, reducing sugars, volatiles) and colour changing during the ageing process. Organoleptic analyses were performed as a final assessment of tobacco flavour and quality.

Key words: tobacco, total alkaloids, reducing sugars, volatiles, kraft paper, polyliner.

Winter wheat grain baking quality depending on environmental conditions and fertilizer

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Abstract. Yield and quality of wheat grain depends on many factors such as environmental conditions, soil quality, genetic parameters and fertilization, especially nitrogen fertilizer which is one of the most important factor influencing quality parameters of winter wheat. Field experiments were done at the Research and Training Farm Vecauce of the Latvia University of Agriculture during 2013 till 2015. The aim of our study was to determine effect of nitrogen fertilization and environmental conditions on winter wheat (*Triticum aestivum* L.) variety 'Kranich' grain quality parameters. The investigated factors were six different nitrogen application norms (0 – control, 85, 153, 175+S21, 187 N kg ha⁻¹) and differential nitrogen norm according to chlorophyllmeter (Konica Minolta Ltd.) data 180 N kg ha⁻¹ in 2013, 150 N kg ha⁻¹ in 2014 and 205 N kg ha⁻¹ in 2015. One more variant was added – 175 N kg ha⁻¹ in 2015. During the study years the meteorological conditions were significantly different. Our trials results showed that protein content suitable for bread making was obtained in variants N175+S21, 180 and 187 in year 2013, in all N application forms in 2014, but in 2015 – in all applications except N0, N175+S21, N85. The meteorological conditions had factor influence (η^2) 46% on protein content, but fertilizer application – 35%. Strong significant relationship at the 0.01 probability level between protein content and gluten content ($r = 0.99$), sedimentation value ($r = 0.97$) and falling number ($r = 0.74$) was found.

Key words: winter wheat, protein content, gluten content, fertilizers.

Physical and Chemical Properties of Extruded Pea Product

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Abstract. Peas (*Pisum sativum* L.) are a good source of protein, dietary fibre, and certain minerals, thus making them valuable nutrients in human diet. Unfortunately, peas are not commonly used in human diet due to their long cooking time. New products should be manufactured to increase the presence of peas in human diet. In order to make the grey peas easier for people to consume, extrusion cooking was used. Due to varying recipes, different products were obtained. Peas of the variety 'Bruno' with and without the addition of wheat and oat flour and egg powder were used in the experiments. Protein, fat and starch content of these products was analysed chemically but their pH, size, hardness, and volume mass was measured using physical methods. The average pH for all the samples was 7.3 ± 0.5 , size differences ranged from 5.4 ± 0.4 mm to 10.3 ± 0.5 mm in length and 6.4 ± 0.2 to 11.7 ± 0.8 mm in width. More fat was found in the sample with onion flavour – up to 9.5 ± 0.5 g 100 g⁻¹ – but the least amount of fat was found in the sample without any seasoning – 0.6 ± 0.05 g 100 g⁻¹ on average. The average starch content was 23 ± 2 g 100 g⁻¹, while the highest protein content was discovered in the sample where grains and egg powder had not been added – 26.9 ± 0.2 g 100 g⁻¹, and the lowest – 18.6 ± 0.5 g 100 g⁻¹ – in the sample with the largest grain proportion. The samples with the highest volume mass were the ones with added egg powder – 43 ± 2 N and 387 ± 2 g L⁻¹. The obtained results show that the largest and crispiest sample was acquired using only pea flour, and pea and wheat flour mixed in the proportion 1:1.

Key words: Peas, extrusion-cooking, characteristics.

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Developing a household vacuum cooking equipment, testing its performance on strawberry jam production and its comparison with atmospheric cooking

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Abstract. In this research, the performance of a kitchen appliance cooking equipment prototype, which can operate either under vacuum or at atmospheric pressure, is aimed to be developed and tested on strawberry jam production. Vacuum cooking applications were carried out at two different conditions as 17.5 and 25 minutes at 75 °C. Strawberry jam was also cooked at atmospheric pressure for 5, 10, 15 and 20 min. The effect of cooking conditions under vacuum and atmospheric pressure was determined by the following analysis; brix, color (L*, a*, b*) values, chroma (C*), hue (h°), pH value, titratable acidity, reducing and total sugar content (%), hydroxymethylfurfural content (HMF) and sensorial analysis. When the strawberry jam that is produced at atmospheric pressure is compared to the ones that are produced under vacuum, atmospheric cooked jam got higher Brix and was more viscous depending on the applied elevated temperature. HMF content of jam produced at atmospheric pressure was also found to be excessively high compared to the jam produced under vacuum. As it has been foreseen in the beginning of the study, vacuum cooking has been effective in reducing the HMF content of the strawberry jam due to the low temperature application. Sensorial quality of the vacuum-processed strawberry jam was superior in terms of color, appearance, consistency, taste and overall acceptance comparing to the atmosphere processed jams. This data could be utilized to contribute to the development of a household vacuum cooking equipment and the opportunity to produce with less harmful ingredients in home environment.

Key words: Jam, Strawberry jam, Vacuum Cooking, Evaporation, HMF.

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The temperature changes of barley malt during its disintegration on a two roller mill

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Abstract. This article discusses the change of temperature during disintegration on two roller mill. The production of barley and its treatment to malt is first step of beer brewing. The malt is the produced in malt plants. Crushing the malt is realized in only the brewery and is a core activity of brewing technology. This operation is performed both in craft breweries and in industrial brewery. This article therefore is focused on the theory of crashing solid phase with a respect of development of heat. Grinding barley malt is realised using mills of various designs or disintegrators. They are widely used mills with 2, 4, 5, 6 grinding cylinders. These roller mills are used in many other applications, not only in industrial food or drink production. For next treatment solid phase should be broken into smaller pieces (comminuted). The greater the extent of comminution, the large the surface area for impact on next treatment. The amount of mechanical energy converted to heat energy depends on the principle of the process disintegration and other parameters, i.e. distance of grinding gap, capacity, mechanical properties of crashing material etc. For these reasons, it is important to pay attention to the temperature change of barley malt during its disintegration on a mill.

Key words: temperature, barley malt, two roller mill, grinding cylinders, disintegration.

Modeling of impact parameters for nondestructive evaluation of firmness of greenhouse tomatoes

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Abstract. In this research, the potential of a nondestructive method for predicting firmness using impact parameters taken by a low-mass lateral impact device was explored. The tests were carried out on *Bandita F1* greenhouse tomato variety at different maturity stages. In the nondestructive impact measurements, impact acceleration and contact time were sensed by an accelerometer attached on impact head, and main impact parameters such as maximum impact acceleration (A), time required to reach maximum acceleration (t) and contact time (t_c) were extracted from the impact acceleration-contact time curves. Other impact parameters were derived through the theory of elasticity. These nondestructive impact parameters were compared with destructive reference parameters for predicting firmness of tomatoes. Force-deformation ratio at rupture point was used in the measurements of destructive reference parameter and this was expressed to be tomato firmness. A total of 10 (A , t , t_c , A/t , A/t_c , A/t^2 , A/t_c^2 , $(1/t)^{2.5}$, $(A/t)^{1.25}$, $A^{2.5}$) measured and derived impact parameters were analyzed with the destructive reference test. A correlation matrix, stepwise regression and multiple linear regression were used for statistically evaluation. The effect of maturity stages on firmness and impact parameters was investigated by ANOVA test. Statistical analysis showed that the correlations between destructive reference and nondestructive impact parameter test results were significant at 1% level except t and $(1/t)^{2.5}$. The number of parameters being processed was reduced with stepwise regression analysis. The best model using MLR on variables t , A/t_c^2 , and $A^{2.5}$ was selected for predicting tomato firmness. As a result, low-mass impact device tested in the laboratory conditions gave high prediction of firmness for greenhouse tomato.

Key words: greenhouse tomato, nondestructive low-mass impact device, tomato firmness, impact parameters, multiple linear regression.

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