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of Life Sciences  
and Technologies

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STUDENTS ON THEIR WAY TO SCIENCE  
(undergraduate, graduate, post-graduate students)  
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## **STUDENTS ON THEIR WAY TO SCIENCE**

(undergraduate, graduate, post-graduate students)

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## **AGRICULTURE**



# **PLANT NUTRIENT BALANCE FOR CIRĪŠI FARM**

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The implementation of a sustainable agriculture approach requires specific indicators to assure that ecologically sensitive inputs and production methods do not cause unacceptable risks for environment and human health. One of the feasible indicators which could show reasonability of fertiliser use, e.g., the amount not exceeding crop requirements, is plant nutrient balance. It shows plant nutrient amount used for a definite area of concern within the reference period (normally one year) and its removal by agricultural products [1–2]. In such a way it is possible to control either plant nutrients are given sufficiently (but not luxury) or scanty and soil resources were depleted [1].

Different methods for plant nutrient balances could be used. The selection depends on information available, how obtained results will be used and other aspects. The prerequisite is that the data comparison is possible only if results are obtained using the same method [2]. For agricultural enterprises (commercial farms), two types of plant nutrient balances are most common. The first one is the so-called soil surface balance, which takes into account cultivated and also fertilized land area. The second one is the farm-gate balance, which takes into account a real or fictional farm.

The study will be carried out in the farm “Cirīši”, where nitrogen, potassium and phosphorus balances will be calculated. The field balance and farm balance will be used. To calculate the balances, the field history will be compiled taking into account all crops to be harvested, fertilizers used and yields obtained. Based on the balance sheets, an appropriate fertilization plan will be developed and its agronomic, economic and ecological justification will be provided.

Nowadays, a great emphasis is put on agriculture practices which are environmentally friendly. Therefore it is necessary to manage the process more rationally, not to use fertilizers so much. Another major problem is that appropriate fertilizer doses are not used, but recommendations that are not agronomically justified are taken into account. Plant nutrient balances are important so that we can understand what is needed for plants and the soil in order to avoid adverse environmental effects.

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# DEVELOPMENT OF CHOCOLATE SPOT DISEASE IN FABA BEAN OVER A FIVE-YEAR PERIOD IN SEMIGALLIA REGION

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Legumes are the second most important crop family in the world, but they are under-represented in the European system of crop production, which is dominated by cereals and oilseed plants. This issue has led to Europe's addiction to genetically modified soybean imports as a protein rich feed for livestock [2]. Taking into account this and the EU regulations on the farmland area greening, the area sown with legumes in Europe and Latvia has increased in the recent years, especially with faba bean. Consequently, the importance of studying faba bean fungal diseases has grown, and one of the most destructive and economically significant diseases is chocolate spot disease in faba beans [1]. The aim of the study was to evaluate factors that can affect the development of chocolate spot disease caused by *Botrytis* spp. in faba beans.

The research was carried out at the Study and Research Farm "Pēterlauki" of the Latvia University of Life Sciences and Technologies from 2015 to 2019. A three-factor field experiment was carried out, where factor A was variety ('Laura', 'Boxer', 'Isabell'), factor B was sowing rate (30, 40 or 50 germinating seeds per 1 m<sup>2</sup>), and factor C was the use or no use of the fungicide Signum (pyraclostrobin, boscalid). The disease was assessed after the first appearance of symptoms and until the end of vegetation season. In each trial plot, 20 plants were randomly selected and the severity was evaluated at a 0–9 points scale, where 0 points mean that there were no visible symptoms of disease and 9 points mean that leaves were completely covered with blotches. The calculation of the area under the disease progress curve (AUDPC) was done to evaluate the impact of disease during all season of vegetation.

Chocolate spot disease was one of the dominant diseases in faba beans in every trial year (values of AUDPC fluctuated from 13 to 120). Sowing rate did not have a significant impact on the spread of chocolate spot disease. Variety, application of fungicide, and year affected the level of disease significantly ( $p < 0.001$ ). The influence of agroecological factors of year was significant – the highest value of AUDPC was in 2016, but the lowest level was in 2015. The highest levels of chocolate spot disease were observed in variety 'Laura', but the lowest levels – in 'Isabell'. Application of fungicides significantly (almost twice) decreased the disease development: values of AUDPC were 74 and 43 respectively. Obtained results show that chocolate spot disease had a higher possibility of developing more severely in variety 'Laura' and the use of fungicide significantly decreased the disease level. Further research should be continued to fully understand the spread of chocolate spot disease in Latvia's agroclimatic conditions.

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# LONG-TERM EFFECTS OF DIFFERENT FERTILIZATION AND LIMING RATES ON PHOSPHORUS ACCUMULATION

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The impact of fertilizer usage on the environment is a very important aspect. Excessive fertilizer use may cause environmental pollution. Not everything of the fertilizer is used by plants, most of it is adsorbed by soil and becomes unavailable. Obtaining more efficient fertilizer usage with optimal rates both for yield and environment is not easy. To achieve this task, it is necessary to make nutrients more available for plants with soil reaction (pH), because pH influences nutrient availability. Phosphorus compounds with aluminum and iron are formed in soils with low < 5.5 pH, becoming unavailable for plants, but phosphorus compounds with calcium are formed in soils with high > 7 pH. The rate pH 6.5 is an optimal reaction for plants to use phosphorus [1]. Having the highest amount of nutrients available, fertilizer rates could be lowered.

The aim of the study is to determine optimal liming rate which provides the highest plant-available phosphorus in soil. The tasks were to analyze factors that influence plant-available phosphorus amounts in soil, find correlation between pH, liming rates and soil organic matter.

The study site was the long-term experimental field "Sidrabiņi" established in 1981, located in Skrīverī parish. Four different fertilizer and liming rates (0, 2.58, 5.70 and 11.40 t ha<sup>-1</sup> CaCO<sub>3</sub>) were used. The experiment was arranged according to a two-factor scheme, where each field was unique. The arrangement was in 16 plots (variants) with different liming and fertilizer rate. The primary soil liming was done in 1981, the maintenance liming was performed in 1994 and in 2014. Four rates of mineral fertilizers: without fertilizer, N<sub>45</sub>P<sub>30</sub>K<sub>45</sub>, N<sub>90</sub>P<sub>60</sub>K<sub>90</sub> and N<sub>135</sub>P<sub>90</sub>K<sub>135</sub> were applied annually. The comparison of data variants with different liming materials was not an objective in this study. The results were sorted in liming stages: the primary liming 1982–1992, the secondary liming 1994–2011, the secondary liming 2014–2019, pH and phosphorus influence were determined within these stages separately.

Preliminary results from the experimental study did not show direct correlation between soil pH and plant available phosphorus. Whereas Anova two factor without replication analysis showed that plant available phosphorus amount in soil was dependent on soil pH.

The soil pH level changes could be a factor for determination of optimal liming rate. The study data showed that liming rates 5.70 and 11.40 t ha<sup>-1</sup> increased pH. Comparing both of those variants, higher pH values were achieved faster with 11.40 t ha<sup>-1</sup> rate, but similar pH values were achieved with 5.70 t ha<sup>-1</sup> rate, but in longer time period. In the first stage, the duration of liming material influence on pH was the same for both liming rates, it was 10 years before pH levels started to decrease. In the second stage the influence duration for 5.70 t ha<sup>-1</sup> was only 2 years, while the influence for 11.40 t ha<sup>-1</sup> was 7 years. It means that more preferable rate could be 11.40 t ha<sup>-1</sup>. The third stage showed gradual pH rise in both rates, with 11.40 t ha<sup>-1</sup> rate higher pH values above 6.0 were reached faster only after 3 years after liming. Compared with 5.70 t ha<sup>-1</sup>, the rate of pH above 6.0 was reached after 5 years. Remembering that there is no direct correlation between P and Ph, the calculation of an optimal threshold, which for P is  $\geq 71 \text{ P}_2\text{O}_5 \text{ mg kg}^{-1}$ , the percentage of P concentrations above the threshold was equal for both rates. Liming rate of 5.70 t ha<sup>-1</sup> can be chosen to keep the optimal P concentration in soil.

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# COMPARISON OF SIRE LINES ACCORDING TO DESCENDANTS' JUMPING TECHNIQUE IN LATVIAN WARMBLOOD HORSE BREED

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Breeding goal for Latvian Warmblood breed sport type is to produce a horse with appropriate performance to show great results in show jumping, dressage or eventing competitions [2]. To reach this goal, we use breeding animals with European sport horse pedigree. In Latvia, the horses are mostly bred for show jumping, so it is important that they have a good jumping technique. The aim for this study was to compare sire lines according to descendants' jumping technique, because it is important to know, which sire lines' breeding stallions give the best jumping technique to their descendants. The linear profiling was used to evaluate the jumping technique. This method is based on deviation from a norm, using scale of 7 points – linear scores ( -3 to 3) [1]. In most of Europe there are 6 dominant sire lines that are used in sport horse breeding, such as Cor de la Bryere, Ibrahim, Ladykiller, Furioso II, Ramzes and Capitol I [2]. In this study we focused on 4 of them – Cor de la Bryere (n= 19), Ibrahim (n= 15), Ladykiller (n= 8) and Furioso II (n= 8), because they are the most common in Latvia. Some of them have formed a related groups in Latvia Warmblood horse breed, such as Aromāts, Gvidons, Levantos, Calliano [2].

In Latvia, the horse's jumping technique is evaluated using 11 traits such as back technique (bascula), forelegs and hind legs, hind leg technique, reflexes, attention, courage, take-off power, flexibility, coordination, overview [1].

In this study Cor de la Bryere sire line had the higher average linear score for the back technique, which was 1, but overall best average linear profile had Ibrahim sire line because the average linear score for the back technique was 0.93, the score for flexibility was 0.20, for forelegs – 0.47, for hind legs – 0.73, for hind leg technique – 0.87, for reflexes – 0.53, for attention – 0.87, for courage – 0.53, for take-off power – 0.80, for coordination – 0.60 and for overview – 0.60.

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# SCREENING OF POTATO BREEDING LINES FOR POTATO VIRUS X AND POTATO VIRUS RESISTANCE BY USING MOLECULAR MARKERS

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The most important viruses in potato seed tuber production are potato virus x (PVY) and potato virus y (PVX) [2]. Therefore the development of virus resistant plants is emphasized in current studies. In order to develop this virus resistant plant varieties, some resistant genes are used. By using molecular markers, these genes can be easily mapped and cloned [3]. These resistance genes can be transferred to sensitive plants, and plants with desired traits can be obtained. Moreover, tolerant and sensitive varieties can be screened with molecular markers and the varieties having these genes can be determined. In this study 46 potato breeding lines were screened by PCR using STM0003, RYSC3, 5Rx1 and 106Rx2 molecular markers, and the PCR products were analyzed by the capillary electrophoresis method. This method is a technique using liquid separation under the electric field, and the separation occurs at different velocities [1]. As a result of the study using PVX resistant and sensitive genotypes, 5Rx1 and 106Rx2 molecular markers accurately defined 56.5% of the resistant genotypes. For PVY resistant and sensitive genotypes, STM0003 and RYSC3 molecular markers accurately defined 65.2% of the resistant genotypes. While 26 genotypes were considered as PVX resistant, 20 were sensitive. The resistance of PVY was considered as 30 genotypes and 16 sensitive genotypes. Consequently, in case of integration of STM0003, RYSC3, 5Rx1 and 106Rx2 markers with potato breeding programs, most of resistant lines would be identified in the early stages of the experiments. According to the conducted investigation, it was concluded that some of potato samples are resistant to the mentioned viruses.

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# COMPARISON OF OAT VARIETIES YIELD AND QUALITY ON A FARM “KALNSPRUKAS”

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Oats (*Avena sativa*) have become more popular in recent years due to the growing demand for oat products, which means that larger areas of oats are needed. The main advantage of oats is their high dietary value in food. Food producers should take into account dietary values as well as the technological characteristics determined by the purchase of grain [1]. Mainly, husked oats are grown, but nude oats (*Avena nuda*) in last years have become more popular. Nude oats generally have better quality characteristics than husked oats, but when husks are mechanically removed, the protein, fatty acids and  $\beta$  – glucan content may be higher in nude oats [2].

The trial was held at “Kalnsprukas” farm in producing field, which is located in Lēdmane parish. Soil – sandy loam, pH KCl 5.6, available for plants, content of  $P_2O_5$  = 19 mg kg<sup>-1</sup> soil and  $K_2O$  46 mg kg<sup>-1</sup> soil. The field was fertilized with NPK 36-36-36, and at GS 32 used NS 63-15. During the trial three oat varieties were sown: ‘Scorpion’, ‘Avanti’ and ‘Galant’. Sowing rate for all varieties was 550 plants per m<sup>2</sup>. Seasonal precipitation was 176.5 mm. The harvest was performed with a combine and bundles. With the combine fixed yield was the following: Avanti 5.88 t ha<sup>-1</sup>, Galant 5.67 t ha<sup>-1</sup>, Scorpion 4.69 t ha<sup>-1</sup>. Oat quality was measured using Infratec 1241 Grain Analyzer. The measured volume weight in these samples was: Avanti 59.23 kg hl<sup>-1</sup>, Scorpion 59.07 kg hl<sup>-1</sup>, Galant 59.72 kg hl<sup>-1</sup>. These results showed almost the highest food quality of oats.

This year was good for oat growing, and presented very good results. More research is needed in this farm to compare also other oat growing factors, such as: different sowing rates, fungicide efficiency, different levels of fertilizers. This knowledge will help to make oat growing in “Kalnsprukas” farm more efficient.

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# THE IMPACT OF SOIL TREATMENT ON SOIL ORGANIC CARBON STORAGE

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Soil is an important element of the climate system and the second largest storage of carbon after the oceans [2]. The soil has a special role in global circulation of carbon, as more than half of the land ecosystem carbon is stored in the organic substance of soil [3].

The carbon stock decreases with intense usage of agricultural lands. Therefore knowledge about renewal of soil carbon resources is needed. The soil structure without organic carbon ( $C_{org}$ ) will not be optimal, which will slow down treatment and decrease the quality of production. It is necessary to use environmentally friendly methods for the treatment of the soil [3].

The amount of organic carbon in soil depends on the management and usage of the land. The policy of planning the land defines the usage and management, the changes in both can cause decreasing of organic carbon in soil [1].

The aim of the research is to analyze the impact of soil tillage and crop rotation on the intensity of soil organic matter (SOM) and soil organic carbon (SOC) accumulation in the soil. The SOC and SOM were determined and conclusions about the accumulation of organic carbon in three year period (2017–2019) in the topsoil and subsoil under minimal and traditional tillage system, including relationship with soil grain size composition and crop rotation were drawn.

The monitoring fields were established in stationary "Poķi" of the training and research farm "Pēterlauki" (Latvia University of Life Sciences and Technologies) in 2009 which is situated in the Zemgale plain. The research fields are drained and cultivated in brown dusty loam soil. The soil acidity is pH KCl 6.6–7. The land is plowed or discarded every year, using traditional and minimal soil tillage as well as plant rotation. The SOM was determined by Walkley and Black method. Higher accumulation of  $C_{org}$  and SOM in the soil was found in the variants where cereals were grown and beans and oilseed rape were used as precursors. Whereas in variants where winter wheat and cereals were used as precursors,  $C_{org}$  and SOM soils declined. The research data showed that  $C_{org}$  and SOM status of the soil decreased in autumn 2019, due to the climatic conditions of the previous years. A significant difference was not found between the types of soil treatment.

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# FUNGICIDE SCHEME'S EFFECTIVENESS ON WHEAT LEAF DISEASE DEVELOPMENT

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Wheat (*Triticum*) is very important resource of food and feed. *Triticum aestivum* is most widely grown [1]. It is very important to maintain the highest possible yield through protecting them against different diseases which can severely reduce the yield [2].

Tan spot of wheat (caused by *Pyrenophora tritici-repentis*) and Septoria leaf blotch (caused by *Zymoseptoria tritici*) are dominant wheat leaf diseases in Latvia, other common diseases in Latvia are powdery mildew (caused by *Blumeria graminis*), yellow rust (caused by *Puccinia striiformis*) and brown rust (caused by *Puccinia recondita*) [3,4]. The aim of this study was to determine how fungicide scheme influences development of wheat leaf diseases.

The field trials were carried out in 2018 and 2019 in "Lazdiņi" farm on two of their fields where wheat has been grown without crop rotation and in no-till technology. The research was conducted in four variants: 1) untreated; 2) treated with fungicide once GS65; 3) treated with fungicide twice GS39 and GS65; 4) treated with fungicide three times GS32, GS39 and GS65. Disease development was assessed every week; its severity and incidence was noted and the value of AUDPC (area under disease progress curve) was calculated.

The weather conditions in both research years were not favorable for wheat leaf disease development and the spread of diseases was low. Tan spot of wheat was the only disease which was observed in trials. First symptoms of tan spot in both years was detected in the beginning of May. The AUDPC values were calculated and it proved that development of tan spot depends on used fungicide application schemes ( $p > 0.001$ ).

The results were controversial: in 2018 the best performance compared to grain yield was gained in the variant where fungicides were used three times: GS32, GS39 and GS65, but in 2019, the variants, where fungicide was used only once, GS65, showed the best effectiveness. To obtain more precise results, the study has to be continued for several years to exclude the effect of variable weather conditions.

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# SUITABILITY OF THE NEW OAT VARIETIES FOR PROCESSING NEEDS IN COOPERATION WITH RIGAS DZIRNAVNIKS

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In recent years, the range of oat (*Avena sativa*) varieties available to farmers has grown in Latvia. Variety comparisons are necessary because of new varieties from different European countries: Germany, Sweden, Poland. In the previous year 12 new oat varieties were submitted for the seed certification in Latvia. That is not too much compared to the range of wheat and barley varieties, but it should be noted that oat selection programmes are relatively small in Europe [2]. The production of quality food requires good quality materials – grain. Not only the biochemical but also the economic parameters of grain are important in the production process: productivity, kernel weight, test weight, amount of hulls and other parameters [1]. There are plenty of oat varieties today, so there is a need for research activities to be able to choose the right oat variety for processing needs, as well as for the optimal quality. The aim of the research was to compare different oat varieties and assess their quality.

There were eight varieties grown in VCU trial: 'Laima', 'WPB 12W460–01', 'STH 6.835', 'ST32553–LELDE', 'Symphony', 'Caddy', 'Delfin', 'Herkules Baltija'. The research was conducted in 2018 and in 2019. The trials were set up at LLU Institute of Agronomy. Growing conditions were the following: sod–podzolic soil and soil with pH<sub>KCl</sub> 5.6. Fertilization was carried out before sowing. The mineral fertilizer NPK 15:15:15+11S was incorporated into the soil. Ammonium nitrate used 200 kg ha<sup>-1</sup> at GS 34–35 in elements N 68 kg ha<sup>-1</sup>. The precipitation in the season from sowing till the grain harvest was 240 mm. The grains of each oat variety were harvested in four replicates. After the harvest oats were tested using inftratec 1241 grain analyser. Oat variety 'Caddy' had the highest average yield 7.68 t ha<sup>-1</sup>, followed by 'Herkules Baltija' with 7.51 t ha<sup>-1</sup>, 'Delfin' and 'WPB 12W460–01' yield was 7.03 t ha<sup>-1</sup>. Other oat varieties had lower yields 'ST32553–LELDE' 6.65 t ha<sup>-1</sup>, 'Symphony', 6.35 t ha<sup>-1</sup>, 'Laima' 6.30 t ha<sup>-1</sup>, 'STH 6.835' 6.13 t ha<sup>-1</sup>. This research was carried out to compare different oat variety yields and their quality for grain processing purposes. The further research is needed to compare grain quality in different regions in Latvia as well as more oat varieties for more extensive research. Every oat variety has their advantages, but processing requires oats that have high beta–glycan, protein and low fat levels as well a high kernel weight and test weight.

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# PLANT NUTRIENT REQUIREMENT FOR JAPANESE QUINCE (*CHAENOMELE JAPONICA*)

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Japanese quinces were introduced in Europe at the end of 18<sup>th</sup> century as ornamental plants, but Latvia was the first country where this plant began to be cultivated for fruit production. Japanese quince fruits are used in the production of bread, cakes and other confectionery, as well as ciders, lemonades and spirit drinks. These fruits are very rich in seeds which can be used for high-value oil production useful in cosmetology, pharmacy, as well as for forage and fuel production [2–3].

As quince fruits are rich in useful substances and have a good taste as well as processing properties, many food companies show increasing interest in them. Therefore cultivation of Japanese quince is growing and production potential is high. Currently, three quince cultivars, 'Darius', 'Rasa' and 'Rondo', are known worldwide and are officially registered.

As industrial cultivation of this plant started recently, therefore no wide information about its fertilisation is available. In general, common practice of fertilisation of orchard crops is used also for Japanese quince, but in details, especially considering cultivars' performance, information is very limited [1]. That is why the aim of the research was to study the plant nutrient requirement of Japanese quince taking into consideration cultivar differences.

The research was carried out at the Institute of Horticulture in Dobeles. Japanese quince plantation was laid out in 2011. The experiment included 3 cultivars of quince with 5 replicates and each plot consists of 5 bushes. Different parameters were examined during the research: the depth and expansion of roots, development of above-ground canopy, plant nutrient (NPK) content in fruits, leaves, roots and stems of quince. Taking into consideration obtained yield and its quality, distribution of plant nutrients through different parts (above-ground, root system) of plants, plant nutrient requirement will be modelled. This will help to work out recommendations for selection of soils suitable for this crop, to calculate plant nutrient need for Japanese quince plants in commercial plantations as well as to work out criteria for plant nutrient diagnosis during vegetation. A special emphasis will be put on cultivars' differences as well as on the integration of fertilisation practice into the overall agrotechnical procedures and methods.

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# ORGANOLEPTIC CHARACTERISTICS OF COLOURED CARROT

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Usually different colour varieties of carrots have similar content of vitamins (except vitamin A), minerals, fiber, carbohydrates, proteins as well as composition of fats, while antioxidant content may vary. Orange carrots are rich in beta carotene, purple carrots are rich in anthocyanins, red ones – in lycopene, yellow carrots are rich in lutein. Yellow, orange and red colours of carrot roots are because of certain carotenoids. These carotenoids can be divided into carotenes and xanthophylls. Xanthophylls give yellow color, they are linked to eye health and reduce the risk of lung cancer. Lycopene is carotene, which is also found in red tomatoes and reduces the risk of heart disease. Anthocyanins and flavonoid pigments are abundant in the purple carrot roots. Anthocyanins act as a powerful antioxidant by immobilizing free radicals. Moreover, anthocyanins can help reduce the risk of heart disease by slowing blood clotting [1]. The genetic background seems to be the most important factor in human control to change the nutritional value and visual appearance of carrots. A large number of qualitative properties, which are determined by various substances, can be changed as a result of selection work. The choice of a genetic factor or variety undoubtedly has the greatest impact on the quality and composition of carrots. Also, it is very important to find the best varieties for the market, so one of the keys for that is determination of organoleptic characteristics [2].

Varieties 'Creampak' F1, 'Deep Purple' F1, 'Gold Nugget' F1, 'Malbec' F1, 'Mello Yello' F1, 'Purple Elite' F1, 'Purple Sun' F1, 'Rainbow' F1, 'Redsun' F1, 'Rubyprince' F1, 'Snow Man' F1, 'Taborska Zluta', 'White Satin' F1, 'Yellowbunch' F1, 'Yellowstone' were analyzed for the organoleptic characteristics test. The test was carried out in December of 2019. The test was set up at the vegetable farm "Bračas". Each participant determined the aroma, taste, look and colour of all 15 varieties. Each test was rated on a 5-point scale, with 1 being the lowest and 5 being the highest score.

The results showed that the highest score for aroma was given to the white rooted 'White Satin' F1 (4.82 points), but the lowest – to 'Purple Sun' F1 (purple root) with 3.44 points. Also, the leader for the taste was 'White Satin' F1 (4.82 points) but the lowest result was given for 'Purple Sun' F1 (3.27 points). However, the highest results for the look and the colour were given to the bright red variety 'Redsun' F1 (4.90 and 4.82 points), but the lowest results were given to 'Deep Purple' F1 (3.50 and 3.70 points, respectively). In addition, the variety 'Gold Nugget' F1 (yellow root) in another experiment by the author received the highest result, where 35% of 418 respondents rated it with the highest score, but the lowest result was given to the red rooted 'Malbec' F1, where only 10% of participants rated it with the highest score.

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# APPLICATION OF MANURE WITH ACTIVATORS – INFLUENCE ON SOIL PHYSICAL PROPERTIES AND CROP GROWTH

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In the Czech Republic, more than 25 % of agricultural land is at risk of wind erosion [3] and 53% of water erosion [1]. Consequently, more than 50 % of the soil in the Czech Republic is potentially threatened by the lack of organic matter [2]. Therefore, it is of utmost importance to consider the addition of the organic matter to the soil profile to provide sufficient fertility and ensure high yields. A field experiment was conducted near the village of Větrkovice in 2018 to verify the potential positive impact of soil improvers Z'fix and NeoSol (Olmix Group) on soil properties and crop status (maize). Plots agricultural management was as follows: manure + Z'fix+NeoSol+NPK for Var.1; manure+NPK for Var.2; manure+NeoSol+NPK for Var.3; NeoSol+NPK for Var.4; and the Control treated only by NPK.

Soil samples were collected using Kopecký's cylinders. Implement draft was measured by a dynamometer with strain gauge S-38/200 kN (LUKAS, Czech Republic) and the spatially related data was recorded by NI CompactRIO (National Instruments Corporation, USA) with sample rate 0.1 s. Remote sensing data was obtained from the Sentinel-2 satellite system (ESA) and processed using software SNAP (ESA) and QGIS (QGIS Development Team). Statistical analysis conducted in R (R Core Team) revealed the decrease of reduced bulk density by all variants (Var.1 was performing the best  $-0.3 \text{ g.cm}^{-3}$ , while Var.2  $-0.22 \text{ g.cm}^{-3}$ , Var.3  $-0.2 \text{ g.cm}^{-3}$ , Var.4  $-0.07 \text{ g.cm}^{-3}$  and Control  $-0.15 \text{ g.cm}^{-3}$ ). Thus, the decrease was more significant for variants enriched by manure. Concurrently, adding only the NeoSol activator led to the lowest decrease. The unit implement draft was evaluated as the comparison to the control variant. Var.1 had a positive value (2.53 %) as the only variant, while the other results were  $-1.07 \%$  by Var.2;  $-1.04 \%$  by Var.3;  $-3.4 \%$  by Var.4. When evaluating the crop status through the NDVI index derived from Sentinel-2 imagery, management had a significant influence excluding Var.4 and Control, where NDVI values were not significantly different.

It is very likely that soil improvement impact on soil and vegetation properties will evolve after some time. Therefore, it would be appropriate to continue the observation over a longer time period and, in addition, various soil types and crops should be investigated.

## Acknowledgments

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# THE EFFICACY OF FUNGICIDE TREATMENT SCHEMES FOR THE CONTROL OF WINTER WHEAT LEAF DISEASES

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Winter wheat leaf diseases are a significant threat to wheat production [1]. To obtain a high grain yield, it is necessary to limit the development of diseases; the application of fungicides is the most common control measure [2]. For disease control, different fungicide schemes are used, and it is necessary to understand the most effective way how to apply fungicides.

The aim of the study was to evaluate the efficacy of different fungicide treatment schemes. The research was being carried out in Bauska region for two years during 2018 and 2019, and winter wheat cultivar 'Skagen' was used. Seven different fungicide treatment schemes and one control variant (without fungicide) were used, and five active ingredients (bixafen, prothioconazole, fluopyram, spiroxamine, metconazole) in different combinations were applied. The development of diseases was evaluated on upper leaves (from 4<sup>th</sup> to flag leaf), depending on the growth stage. To evaluate fungicide efficacy of fungicide treatment schemes, the area under the disease progress stairs (AUDPS) was calculated.

In both trial years, tan spot (*Pyrenophora tritici-repentis*), septoria leaf blotch (*Zymoseptoria tritici*), mildew (*Blumeria graminis*), glume blotch (*Parastagnospora nodorum*), and brown rust (*Puccinia recondita*) were observed. Tan spot was the most widespread disease throughout the trial years – its severity at the time of milk ripening was 2.15% in 2018 and 1.14% in 2019. The severity of Septoria leaf blotch reached 0.08% and 0.27%, respectively. Mildew and brown rust were observed in both years, but their severity was low (did not achieve 5%). Glume blotch was observed only in 2018.

Every treatment scheme significantly ( $p < 0.001$ ) decreased the development of diseases, however, the efficacy of schemes differed. In 2018 and 2019, the best results for tan spot were obtained in two treatment variants: the first treatment, where a fungicide was applied at the stage of flowering (61.GS), and the second treatment with two applications: one was applied at the beginning of flag leaf emergence (37.GS), and the second was applied at the stage of flowering (61.GS). In 2019, best results against tan spot were obtained in two treatment variants: the first treatment was applied at the beginning of heading (51.GS), and the second treatment was applied at the beginning of flag leaf emergence (37.GS) and at the stage of flowering (61.GS). For septoria leaf blotch, the best results were observed in two treatments: the first treatment was applied at the beginning of heading (51.GS) and the second treatment was applied at the beginning of flowering (61.GS).

Further investigations are necessary to understand the best schemes of fungicide application because the severity of diseases and the efficacy of fungicides depend on meteorological conditions and other agroecological factors.

## Acknowledgement

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# TOBACCO EXTRACT AND DISTILLATE EFFECTIVITY ON MANAGING *APHIS FABAE* L. IN FABA BEANS (*VICIA FABAE* L.)

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Organic farming is a trendy industry in the European Union (EU), including Latvia [3]. The total organic area in Latvia has increased more than ten times since 2004, reaching 474 thousand ha in 2018 [2]. It means that new ways to preserve the yield are sought. Meanwhile, because of health concerns, production of tobacco (*Nicotiana tabacum* L.) in the EU has decreased significantly since 2010 [1], although it is used in some remedies against aphids in small scale and potentially could be used in organic farming system for managing pests. Black bean aphid (*Aphis fabae*) can be an important pest in many countries across the world [1]. The aim of the research was to evaluate the effectivity of tobacco distillation products (extract and distillate) against black bean aphid in faba beans.

Tobacco used for distillation was grown in the greenhouse of Latvia University of Life Sciences and Technologies. The whole plant was harvested, afterwards green biomass of tobacco was chopped and distilled. Faba beans were grown in 5 L pots and placed outdoors. All pots were artificially infested with *A. fabae* by placing naturally invaded faba bean stems and leaves among grown plants. After successful infestation, the first experiment was carried out. Effectivity of undiluted tobacco distillate and undiluted tobacco extract was evaluated comparing it to one synthetic insecticide (active substance alpha-cypermethrin) by spraying these products on plants. The extract showed high effectivity against the aphid, so the evaluation continued in the second experiment. Variants of diluted tobacco extract of 50% and 33% were evaluated and showed lower effectivity against *A. fabae* than undiluted extract.

Synthetic insecticide was very effective against *A. fabae*. Undiluted tobacco extract was surprisingly effective, but not as much as synthetic insecticide. Undiluted tobacco distillate was not effective against *A. fabae*. Diluted extract showed mortality of aphids, but not as high mortality as undiluted extract. Lower concentration of the tobacco distillation product caused lower effectivity of the aphid control.

Tobacco potentially could be used as material for insecticide of the natural origin, but further studies are required to make more efficient and effective product, which could be used for pest management.

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# IMPACT OF DIFFERENT NITROGEN FERTILIZER TREATMENTS ON WINTER WHEAT YIELD AND QUALITY

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Common wheat (*Triticum aestivum* L.) is one of the most economically important crops in Latvia. Considering its economic efficiency, the sowing areas have a tendency to increase. Winter wheat is particularly important in Latvia as its sowing areas are larger compared to spring wheat and its yield is usually higher [1]. One of the main goals for a farmer is to obtain as many products of good quality as possible by using as few resources as possible, which will ultimately lead to higher profit [3]. However, doing it without nitrogen fertilizers is almost impossible. Therefore it is important to choose the right fertilizer type, treatment and dosage to get the most economic value out of winter wheat fields [2]. The aim of the research was to determine winter wheat yield, yield components and the quality depending on different nitrogen fertilizer types and treatments.

The field trial was established in the Pēterlauki Training and Research Farm of Latvia University of Life Sciences and Technologies in the growing season of 2018/2019. Ten different nitrogen fertilizer treatments were performed of one, two or three nitrogen applications (N1 = restoration of vegetation; N2 = GS30; N3 = GS51–55 according to the BBCH scale), various nitrogen fertilizer types and different nitrogen dosage proportions. In total 170 kg ha<sup>-1</sup> of pure N was applied in each treatment.

The comparison of the long-term average data showed that an extremely low amount of precipitation and high air temperatures during the vegetation period affected the development of wheat and the performance of nitrogen effectiveness.

The results of this study showed that the use of nitrogen fertilizer had a significant ( $p < 0.001$ ) impact on the grain yield, compared with the control treatment, but no significant difference in grain yield were found between different fertilizer treatments. On average the yield increase of 232 kg ha<sup>-1</sup> was obtained in the treatments, where the biggest part of nitrogen was applied during the N1 and N2 applications. An increase in the grain yield and quality did not occur in the treatments, where some part of nitrogen fertilizer was applied on the N3 application. The nitrogen fertilizer had a significant ( $p < 0.001$ ) effect on all tested yield quality indicators (protein, gluten, Zeleny index, stretch content and volume weight). All nitrogen fertilizer treatments significantly increased all tested wheat grain quality indicators, except stretch content that decreased by the use of nitrogen fertilizer, because it correlates negatively with protein. The yield component results were diverse, because some fertilizer treatments showed significant difference, but some results were very similar.

Considering the relatively dry weather conditions in the growing season of 2018/2019, the lowest economic benefit was found in the treatments, where application N3 was used. Therefore, the third nitrogen application had lower economic effectiveness in dry years compared with treatments, where nitrogen was used in one or two applications.

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# DEVELOPMENT OF *ALTERNARIA/STEMPHYLIUM* SPOT DISEASE IN FABA BEAN

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The grain legume faba bean (*Vicia faba* L.) is grown world-wide as a protein source for food and feed. At the same time, faba bean offers ecosystem services such as renewable inputs of nitrogen (N) into crops and soil via biological N<sub>2</sub> fixation, and the diversification of cropping systems [2]. Production of the crop is, however, constrained by several disease infections including fungal diseases. Correspondingly, the occurrence and importance of faba bean diseases vary temporally and spatially as a result of climate change [1]. Leaf blotch caused by *Alternaria/Stemphylium* complex is one of the most destructive diseases of faba beans [3]. The aim of the research is to clarify factors that influence the development of the disease caused by *Alternaria/Stemphylium* complex.

Field trials were carried out at the Training and Research Farm “Pēterlauki” of the Latvia University of Life Sciences and Technologies in 2015–2019. The two-factor field experiment was carried out, where Factor A was variety (‘Laura’, ‘Boxer’, ‘Isabell’) and Factor B was sowing rate (30, 40 or 50 germinating seeds per 1 m<sup>2</sup>). The disease was assessed during the whole period of vegetation, starting from the first symptoms on the leaves. In each replication, 20 random plants were selected and the disease development stage was determined (0–9 points scale). The total impact of the disease during the vegetation period was estimated by calculating the area under the disease progress curve (AUDPC). The analysis of variance was performed to evaluate the relevance of results.

The development of the disease was significantly influenced by the year ( $p < 0.001$ ). The level of the disease was different each year: the highest development was observed in 2016 (value of AUDPC was 88 units), and the lowest development was in 2017 (one unit). The severity of *Alternaria/Stemphylium* spot slightly varied among varieties, but these differences were not significant. Seed rate did not affect the development of disease.

Further investigations are required to clarify factors that influence the development of *Alternaria/Stemphylium* spot.

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# EFFECT OF ALPHA S1 CASEIN POLYMORPHISM ON THE PRODUCTION OF GOAT MILK CHEESE

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It is crucial to perform genetic evaluation of the animals in the selection of goats to find the best genetic traits. During high quality goat milk processing, especially, in cheese production, the most important milk protein is Alpha S1 Casein ( $\alpha_{s1}$ -CN), and it is important to research how to increase the quantity of this casein in goat milk. Results of scientific research suggest that milk that is best for cheese making has high concentrations of  $\alpha_{s1}$ -,  $\beta$ - and  $\kappa$ -casein, it has high  $\kappa$ -casein in relation to the total casein and contains Beta-lactoglobulin. A high concentration of casein in the total protein showed a significant impact on the protein transfer from milk to cheese [4]. It is important to mention that cheese yield is directly related to the amount of casein in the goat milk. With a larger fraction of the casein protein, that is, higher casein content, it is possible to produce more cheese from the same amount of protein [2], therefore there is a bigger cheese outcome. It also means higher economic income for cheese producers. The comparison of two groups of goats showed that one has high and second has low  $\alpha_{s1}$ -CN synthesis, therefore significant differences were observed. Milk from animals having high rate of  $\alpha_{s1}$ -CN synthesis was richer in dry matter, fat and casein and had a smaller average micelle size [3]. All results showed that milk from goats that had high  $\alpha_{s1}$ -CN synthesis also had better rennet coagulation property. In addition, total solids in the cheese, fat recovery and gross yield were significantly higher. Textural differences were also observed, especially in curd hardness and plasticity [3]. The milk from high  $\alpha_{s1}$ -CN variant goats lead to a better and more stable cheese quality. The cheese from the low  $\alpha_{s1}$ -CN variant milk has a frequent rancid flavour and a lower percentage of dry matter content. It is important to use milk for cheese production from goats that have BB genotype, because this genotype provides milk that will have higher cheese outcome. Studies show that  $\alpha_{s1}$ -CN B allele is associated with higher milk yield, and the C allele of  $\alpha_{s1}$ -CN is associated with higher fat and protein content in the milk [2]. To be more specific, it is possible to achieve higher yields of cheese (Edam, Gouda, Cheddar, Mozzarella) from milk with BB genotype of casein. For example, when cheese is manufactured from milk with AA genotype, it has weaker “goat flavour” compared to the one produced from milk with FF genotype [1]. The research of the genotypes of goats can increase accuracy of breeding values for milk yield, dry matter, fat and proteins and cheese yield.

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# PLANT NUTRIENT BALANCE FOR THE FARM “ZEMGAĻI”

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The importance of a plant nutrient balance is versatile. It helps to ensure the creation of a balanced fertilizing system, which increases the plant nutrient utilization and ensures the plant nutrient use is efficient. Effective use of plant nutrients allows fertilizers to be applied in optimum quantities and proportions that contribute to maintaining soil fertility. The calculation of plant nutrients enables farms to make financial savings by using what plants really need at a given time [1]. Equally sufficient to the importance and interest of the plant nutrient balance worksheet is the growing use of the balance as a decision support tool to gain insight into the environmental impact of agriculture and the environmental performance indicators used by policy makers for policy making [3–4]. On 16<sup>th</sup> November, 2017, an agreement was reached between organizations and authorities of Switzerland, Norway and the Member States of the European Union for a uniform calculation of the gross balance for the calculation of phosphorus and nitrogen. The resulting calculations have to be done annually for each country with which the agreement was reached [2]. The way in which the necessary calculations are made and the methods used are standardized. The calculation methodology manual has been developed to allow Member States to calculate using a single, well-defined methodology [5].

The study will be carried out to calculate nitrogen, phosphorus and potassium balance for the farm “Zemgaļi”. The NPK balance will be calculated using two internationally recommended methods – Field balance and Farm Gate balance. The history of the field will be summarized focusing on the crops to be grown, the fertilizer used and the size of the harvest, as well as the quality indicators of the crop. On the basis of these data, the NPK balance will be calculated, and a farm fertilization plan will be developed providing its agronomic, economic and environmental justification.

Plant nutrient balances are widely used and included in national action programmes to limit the environmental impact of agriculture. This is done on the basis of data obtained and reflected from the field and farm balance worksheets. The resulting data are collected and disseminated to inform the concerned authorities as well as the farmers themselves about the nutrient cycle.

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## **INFORMATION TECHNOLOGIES**

# **SUSTAINABLE DEVELOPMENT OF BAUSKA MUNICIPALITY COMPUTER NETWORK USING OPEN SOURCE MANAGEMENT SOLUTIONS**

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Nowadays, IT and business processes in companies are mostly automatized and standardized because of the need to develop a sustainable and competitive environment for growth. These processes are implemented not only in the private sector, but also in the public — or in this case government — sector. To implement these processes, either a qualified workforce or outsourcing with costly software is needed to implement these processes. Very often, outsource hiring is costly and may take up a huge part of a company's budget. The aforementioned arguments are the main reasons why many new ideas and products are not implemented and deployed in the government sector. They are not forgotten, but the realization sometime takes a few years, and ideas that were relevant at that moment are no longer relevant today.

At the very moment, many expensive software solutions have open source alternatives which can replace enterprise solutions. Of course, open source alternatives cannot fully compete with enterprise solutions, but they can handle a lot of tasks. These open source solutions are implemented more and more in the private sector, and only recently in the public sector because of budget shortages. When it comes to computer network management and deployment, there are many open source solutions like Zentyal, Spiceworks, etc. They are a good competitive for Microsoft Windows server, and in some aspects, such as e-mail servers, they are even ahead of Microsoft software.

Zentyal Server is an open source unified network solution that offers advanced and efficient computer network administration for small and medium-size companies. It can be used as a gateway, an infrastructure manager, a unified threat manager, an office server, a unified communication server or a combination of them. These functionalities are highly integrated; they help to schedule tasks, avoid mistakes and save time for system administrators.

In Bauska municipality's schools, there is no unified remote management and deployment system that could manage end user workstations, multimedia devices etc., but it would save local municipalities' IT department staff time, fuel and other resources. A standardized and unified framework for management is needed as a long-term solution for device and end user management. With Covid-19, pandemic remote infrastructure management would be an essential asset, because there would be no personal contact and it would lower the risk of getting this harmful disease.

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# **POSSIBILITIES FOR APPLYING OPEN DATA IN LATVIA**

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Data sets are currently being published in the Latvian Open Data Portal, which aims to give the public access to information held by the State or local governments. Furthermore, there are specific criteria that this information must meet, and data publishers must provide data descriptions (metadata) and regular updates, so that the published information is always up to date. Additionally, priorities and surveys on what information is essential for the public to be able to access in an open format.

However, the open data portal is focused on professional data users, not on ordinary citizens. It is specified that the data must be in a machine-readable form. This means that such data is difficult to read, such as in xml or json format, and is intended only for professional data analysts. In addition problems with the quality of the data have been encountered. In some cases, the data structure and missing metadata leads to problems when using data published in the open data portal. This shows that data publishers are not paying enough attention to the data quality that they publish.

Solutions were sought to demonstrate to the public the importance of data opened to data publishers, and how they can be used. One of the options for using open data is developed on the base of the RStudio software using Shiny addon, which allows data visualizations to be created, including interactive analytic solutions [1]. Rstudio provides the ability to process information in different ways, such as copying from an open data portal in the form of a file, accessing the information by using a hyperlink from the open data portal, or using an API key, gaining access to all the portal data and getting the ability to search for the needed data sets already using the local capabilities of RStudio (CkanR)) [2].

The created solution allows for the publication of information online and offers opportunities to create interactive data visualizations. Depending on how the data is published (if the published files are supplemented without changing the name and structure), it also ensures that the published information can always be up to date.

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# DETECTION OF USER'S PROFESSION OR HOBBIES CONTEXT BY USING CORRELATED TOPIC MODEL ON FACEBOOK POSTS TITLE TEXTUAL DATA

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Topical models have become a useful tool for “topic” discovery in a collection of documents. Models, such as *Latent Dirichlet Allocation* (LDA), allow for the detection of a small number of topics in a large text documents where each word belongs to one of those document's topics. Topic probabilities can then be used to understand what these documents are about and classify them [2].

The LDA itself is unable to model topic correlation; for example, sports will more likely be about health than finances. To overcome these limitations, a Correlated Topic Model with logistic normal distribution is used instead of the Dirichlet distribution [1].

The main goal of this research was to find out if visited places shared in the Facebook posts can tell something about the profession or hobbies users are involved in, and later be useful for personalized content recommendations. The researched user group is students under the age 30 living in the city of Daugavpils. Facebook posts have been scrapped using automated software *Ultimate-Facebook-Scraper* and stored into .csv files [3]. 10 random people with different background were selected. Text have been translated to English for better Topic model performance. Initially, 2 topics per document were set. English stop-words, punctuation and whitespaces were removed from the Facebook posts title text.

For example: A girl, 18 years old, studies at Daugavpils University, dancer. She has traveled across Latvia and several countries abroad such as Austria, the Canary Islands, Estonia, Lithuania and Ukraine.

Fig. 1. shows that for topic No 1 (first column) and No 2 (second column), the highest word-topic probability was for the word *Daugavpils*, because it is mentioned several times in the text; but if it is eliminated, there remain words like *center*, *hall*, *art*, *latvia*, *culture*, *university* that can be associated with young student - dancer.

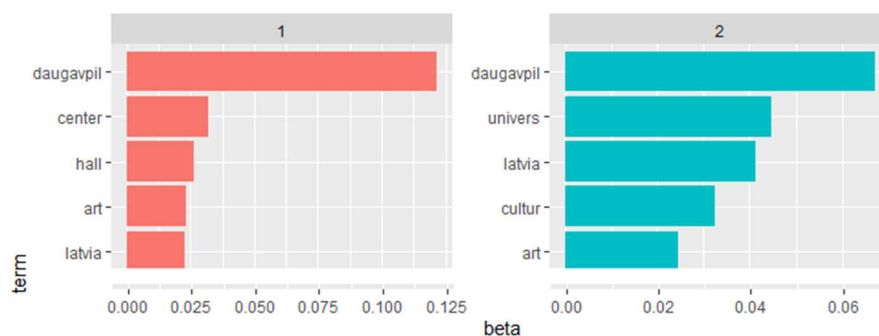


Fig. 1. Word – Topic probabilities

The research proved that the Correlated Topical model can be used for Facebook post title text, specifically for check-in data and analysis, and can give an overview of the professional or hobby context in which people live. Analysis shows that 2 or 3 topics per text was the optimal choice. The Topical model performed better on people with longer check-in history.

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# REMOTE PRESENCE TECHNOLOGIES AT HOME – HOLOGRAPHIC COMMUNICATION

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Nowadays, holograms are commonly used in many spheres of human life; in medicine, they are used to improve diagnostics [1], and in marketing – to reach better results in sales by showing products in a magnificent light [3]. Holograms can save not only lives, but also history – some artefacts in museums are shown in a 3D view by using hologram technologies [2]. But what about communication? There are 3D-technologies for “real-time” conferences, but they are expensive and require a lot of space [4].

The goal of the present research is to identify the advantages and disadvantages of using a hologram as a communication tool. During the research, the following aspects have been studied: the possibilities of creating remoteness; the possibilities of obtaining a holographic image; the possibilities of holographic communication as a way of remoteness; and the effect of the self-made peripheral device on the quality of the holographic type of communication.

For the practical part, a prism was created to display a hologram along with a web-page containing a streamed video. As a result, a hologram was made.

The students' view of the use of holograms and their relevance was analysed in the empirical part of the research. In addition, the opinions of information technology experts for the possibility of the use of holograms as a means of communication were determined.

The research began in 2017 in Jelgava Secondary School No 5 and continued in 2019 at Latvia University of Life Sciences and Technologies. The main findings were: 1) Holograms have a lot of uses. In a spatial manner, holograms can contain both graphic and audio information. Expansion of the hologram with virtual reality makes the objects livelier and more interesting. 2) Spatial holograms are an excellent demonstration of an object that can be used in a learning process. With 3D holograms, students can not only get acquainted with the subject, but also experience the presence, which makes the learning process more enjoyable and interesting. 3) The holographic way of communication makes life more intimate and creates a sense of presence. This will be a new product in the communications market.

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# **APPLYING THE DATA FUSION APPROACH IN THE FRAMEWORK OF PRECISION BEEKEEPING**

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Precision beekeeping is an apiary management strategy with a focus on monitoring individual bee colonies aimed to minimize resource consumption and maximize the productivity of bees. To achieve this objective, beehive states are detected and predicted [5] by monitoring apiary and beehive related parameters such as temperature, weight, humidity, noise, vibrations, air pollution, wind, precipitation, etc. These parameters are collected as a raw input data by use of multiple different sensory devices, and are often imperfect and require creation of correlation between time data series.

Currently, most research [1] focuses on monitoring and processing each parameter separately, whereas a combination of multiple parameters produces information that is more sophisticated. Raw input data sets from multiple sensors that complement one another could be pre-processed to achieve an understanding of the global research subject [3]. In order to process such data sets, a data fusion approach can be applied. There are numerous studies [2] regarding data fusion methodology, classification and application. These studies focus on providing new applications of data fusion methods in the form of machine learning algorithms [4], however there is a very limited amount of data fusion applications for precision beekeeping. The requirement of data fusion appliance for precision beekeeping is determined by global objective, i.e. bee health, foraging prediction. The data fusion approach requires processing raw data into information to develop an understanding about processes that affect the global research objective. Accumulation of understanding leads to knowledge that is later used for development of decision support systems. The quality of information and thereafter knowledge is proportional to the quality and sophistication of raw data.

This study analyses the existing data fusion methods and process in order to identify data fusion challenge and correlate them with precision beekeeping objectives, thus introducing raw data requirements and precision beekeeping data sets required to achieve global research objectives.

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# **DEVELOPMENT OF INTERACTIVE POSTER EVALUATION ELEMENT**

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Feedback is a vital part of effective communication and the improvement process. Summary of the given feedback allows one to evaluate, for example, how well a certain presentation (talk or poster) was given. Most scientific conferences also include poster sessions. Therefore, it is important for the authors to know if their poster informed the public and if there was enough emphasis put on their research. Nowadays, there are three types of poster evaluation – form type, online or e-voting. Each type of evaluation has its advantages and disadvantages.

Obtaining evaluations and data visualization of poster presentation sessions is most often done manually [1] [2]. In order to simplify and digitalize the poster evaluation process, a prototype of an interactive poster evaluation element was developed which includes an electronical physical platform, database and data visualization in real-time.

Although there are different electronical platforms available, the interactive element is based on the Adafruit HUZZAH ESP8266 Wi-Fi module due its cost, power consumption and performance [3]. Additionally, there are used other components such as buttons, piezo buzzer and radio-frequency identification (RFID) reader to detect RFID tags. RFID technology is used to detect only unique evaluation, so one person can vote only one time. To store feedback data such as RFID tag identification number, date and time, voting value, a MySQL database is used on external server. To ensure data upload from ESP8266 module, a Wi-Fi connection is used to connect to the WEB server. Also, on the same WEB server, a webpage is hosted to ensure real-time data visualisation. On the webpage, it is possible to view statistics and graphs for current and previously attended poster sessions.

Poster presentation feedback influences the future performance of a poster presentation, both in terms of content and visual appearance. The developed prototype significantly eases the process of obtaining feedback and data visualization, which allows the poster presenter to estimate whether the poster has successfully informed the public about the research.

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# EVALUATION OF ALTERNATIVE ENERGY USAGE IN PRECISION BEEKEEPING

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Precision beekeeping is an agricultural sector where information technology methods are used to solve problems related to bee colony behavior monitoring and detection of the development state. Typical research problems include data management, monitoring system installation, configuration and continuous system availability. Thereby, there is potential for alternative power supply methods to ensure environmentally friendly system development and uninterrupted operation. The aim of the study is to analyze system development efficiency as well as the power supply performance with the help of ThingSpeak, Raspberry PI, DHT22, Solar power bank, USB voltage meter tester.

One of the traditional agricultural sectors in Latvia is beekeeping, where manual operations are performed to care for the bee colony and monitor the condition of the apiary [2]. Precision apiculture is defined as a management strategy for an apiary based on monitoring individual bee colonies to reduce resource consumption and increase bee productivity [3]. Application of environmentally friendly solutions in the development of bee monitoring systems is essential. The production of electricity from renewable energy sources is important in the context of economic growth, as it brings significant benefits at regional and national levels [1].

The use of renewable energy resources is essential in establishing the technological process for the observation of the bee colony. According to the scientific literature, monitoring can be done remotely using IT methods (ThingSpeak, Raspberry PI, DHT22 sensor, solar panel), where the remote system receives information from sensors. The prototype defined the problems such as continuous data availability, power consumption monitoring, secure internet connection management to prevent data loss.

A prototype system for remote evaluation of bee colonies has been developed. The system provides continuous data acquisition using the following components: ThingSpeak, Raspberry PI, DHT22 sensor, solar panel. A USB Voltage Meter Tester analyzes the amount of power received and consumed to ensure the efficiency of the selected power source. The software is designed, implemented and tested on the basis of research-based information.

The use of environmentally friendly energy sources (solar panel) can ensure the functioning of a bee monitoring system prototype. Research-based data is the basis for the interaction of the necessary components of the prototype (circuitry, software, code). The resulting data can be processed online or downloaded in CSV format remotely. Future research could include the development of recommendations for beekeeping based on non-standard data acquisition (rapid changes in temperature, humidity, etc.)

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# INFORMATION TECHNOLOGY INNOVATIONS FOR MEDICINE IN LATVIA

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The topic of the present research is innovative news in Latvia. Despite the fact that Latvia is a relatively small country, it is competitive in the global economy. Numerous Latvian start-up companies win various competitions and promote the popularity of Latvia, and entrepreneurs choose them.

Originally called Anatomy Next, the Latvian startup Exonicus has not only perfected and developed its name and product, but has also concluded its first successful deals. In the United States, there was demand for another product that Anatomy Next decided to launch as Exonicus (Anatomy Next remains a subsidiary that still works in creating anatomical materials for artists and students). However, Exonicus is developing a trauma simulator for the US Army – a virtual reality simulator where it is possible to train and replicate skills to save seriously injured people [1].

Another Latvian startup develops a prescription rehabilitation guide that uses artificial intelligence to help people recover faster and more efficiently from a stroke by providing therapeutic guidance, practical assistance, and tools based on cognitive behavioral therapy, in a smartphone interface [2]. It was clear to both companies that the capacity of human resources and rehabilitation facilities would never be sufficient to ensure full rehabilitation for each patient. Vigo arose when the two decided to combine efforts to make stroke rehabilitation radically accessible through digital technologies [3].

The first autism simulator has been created in Latvia, which is currently the best way for healthy people to understand and feel its effects. This virtual reality video is currently available for everyone. The small three-minute video is designed to be watched with virtual reality glasses [4].

The medical industry is developing every year thanks to IT companies. In Latvia, 3D printers are used to make devices that replace gypsum. This year, the first heart with all the internal tissues and blood vessels was made in Israel with a 3D printer, which means that something similar will happen in Latvia soon. To sum up, the innovations in Latvia in the field of medicine are numerous. In order to create something new, it is necessary to explore the facts and information of previous achievements.

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## **FORESTRY AND WOOD PROCESSING**

# TREE DISEASES CAUSING DAMAGE OF NORWAY SPRUCE (PICEA ABIES (L.) H.KARST.)

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Norway spruce is one of the most common tree species in Europe, used in construction, paper and wood industry, tonewood and medicine. It is native to Europe but due to its good properties it has also been planted in North America. However, its cultivation can be disturbed by damages caused by the weather, other plants, animals or diseases, particularly in non-native areas.

The topic of this research is diseases. Norway spruce is not affected by many diseases in Europe but they are responsible for causing economic losses. According to the European Forest Genetic Resources Programme, the most important pathogen is the fungus *Heterobasidion annosum* (Fr.) Bref., it causes root and butt rot that decreases the quality of the wood's final cutting, and it impacts the growth of trees [2]. An article from the Latvian University of Agriculture and the Latvian State Forest Research Institute "Silava" shows that *Heterobasidion spp.* does not have an impact on radial growth of Norway spruce [1].

Another important root rot disease is caused by the fungi of the genus *Armillaria*. There are a lot of different *Armillaria* species. Several species are important components of a forest ecosystem to decompose dead wood in organic matter, however *Armillaria spp.* can also attack healthy roots and the butts of trees [4]. Both *Armillaria spp.* and *Heterobasidion annosum* weaken trees and can cause the die off of young trees. In North America, a non-native area for Norway spruce, other diseases occur like Cytospora canker and Rhizosphaera needle cast [3]. These diseases seem not to be a problem in Europe because European studies on Norway spruce diseases do not discuss them. Armillaria root rot is a problem in North America like it is in Europe, but Heterobasidion rot has not been spotlighted.

To conclude, Norway spruce in Europe can be attacked by root and butt rot caused mainly by the fungi *Heterobasidion annosum* and *Armillaria spp.* In North America, some other diseases can attack Norway spruce like Cytospora canker or Rhizosphaera needle cast.

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# PESTS OF NORWAY SPRUCE (*PICEA ABIES* (L.) H.KARST.) – THE RESULT OF CLIMATE CHANGE

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One of the main tree species grown in Latvia is *Picea abies* L. (H.) also known as Norway spruce. As other species, spruce can be found in monocultures in Latvia, however, monocultures tend to make trees weaker in the presence of pests.

For example, *Picea abies* monocultures are the prey of *Lymantria monacha* L. The caterpillar of this insect is foliophage. First, these larvae climb to the crown of trees and eat the young, soft needles. Then, when there are no young needles left, they start to feed on buds and male cones until the needle buds grow again. This pest may completely defoliate their hosts and make them unable to complete the process of photosynthesis leading to the trees' death [5].

Other pests like *Ips typographus* L., called spruce bark beetle, colonize the weakened trees by digging galleries in the bark, which makes the trees unable to defend themselves from other invasions (fungi and other pests) [2]. This beetle is one of the most serious pests in Europe. Thus, a lot of research has been done in order to reduce their impact on forests [1].

*Hylobius abietis* L. also cause damages to spruce by eating the bark and young roots. Originally, the larvae of this beetle develop themselves in the ground by feeding on the roots of freshly cut trees or dead wood. When they become adults, they leave the ground and start spreading around to attack living trees. Old trees usually survive but young plantings (1-2 years old) of spruce may be completely destroyed.

Some pest species, such as *Adelges piceae* Ratz. slowly weaken spruces by feeding on their exuding sap, thus leading to the death of the infected trees. This insect has a huge propagation capacity as it is able to go through parthenogenesis and can be a serious issue [4].

Even if some pests are able to attack a healthy spruce, most of the time they need the tree to be already weakened to colonize it. Due to climate change, dry periods seem to increase. Dryness makes the trees weaker by decreasing their resistance capacity (exudation of oleoresin is less efficient) and promoting the range of pest expansion [3].

Therefore, the problems in Latvia's spruce forests may be caused mainly by the climate change.

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# VITALITY OF THE SCOTS PINE (*PINUS SYLVESTRIS* L.) STANDS AFTER A FOREST FIRE

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Forest fires are one of the main factors affecting forests in Latvia. According to the area of the dominant tree species, Scots pine (*Pinus sylvestris* L.) was the most common species in Latvia, especially in Ziemeļkurzeme in 2018 [3]. The wildfire in the nature reserve “Stiklu Purvi” was the largest fire in Latvia in 2018 [3]. The impact of the forest fire on the natural forest stands was therefore analysed. According to the research, the stand can die just in the first 2 years after the fire. The trees have been weakened by fire and have been quickly surrounded by a variety of pest species [1].

Research plots were selected in the area where the forest fire occurred in 2018. In total 9 research and 3 control plots were established in the stands. The edaphic and ecological prospects — forest site type and dominant species were taken into consideration as the basis for plot installation. Each plot assessed the impact of the fire on the stands' development as well as the effects of biotic and abiotic conditions. The identification of the number of trees, a survey of the height of the burn, an assessment of the impact of fire on the vegetation and trees were carried out. The plots were examined by the recovery of the plant condition with the Braun-Blanke method.

After the fire in the dry site types the amount of viable trees represented 42.5% of the total number of trees, while in the wet peaty soil forest types the amount was 49.1%.

Studies in Latvia have shown that *Acanthocinus aedilis* L., *Monochamus galloprovincialis* and *Tomicus piniperda* are the most commonly identified forest pests in the research site types [1]. By counting the damaged shoots of the *Tomicus piniperda*, the average number of damaged shoots in the plots in the following spring after the fire was 10, but at the end of autumn of the following year, the average number of damaged shoots was 24.

In the naturally recovery pine stands (without management of young stands) 23 years after the fire, pine was found to be the dominant tree species (in 51% of cases) in the forest site types *Cladinoso Callunosa*, *Vacciniosa*, *Vaccinoso-sphagnosa*, *Sphagnosa* [2].

In the research plots the most common forest recovery herbaceous vegetation species are *Populus tremula*, *Vaccinium myrtillus*, *Betula pubescens*, *Vaccinium vitis-idaea*, *Calluna vulgaris*, *Senecio sylvaticus*, but the most common moss floor species are *Marchantia polymorphine*, *Polytrichum commune*, *Funaria hygrometrica*.

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# **EVALUATION OF FOREST NATURAL REGENERATION IN BURNED AREA OF MYRTILLOSA TURF. MEL. FOREST SITE TYPE IN AKMENSRAGS FOREST DISTRICT (JSC “LATVIAN STATE FORESTS”)**

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The reaction between forest and fire is an interesting and complex process which results in a complete land transformation. The aim of the research was to analyse forest natural regeneration results after a forest fire. To achieve this goal, research fields were made in 3 forest subquarters: 6.84 ha of forest land. The total number of sample plots were 17. In the control stand there were 5 sample plots made. Research objects were located in the area of Dienvidkurzeme region of the joint stock company “Latvian state forests”. The research fields were created in the 138th quarter, subquarters 10, 13 and 21. Data were also collected in a similar age non-burnt stand where natural regeneration had taken place. In Pavilosta County’s Akmenrags forest region there was a forest fire which broke out in Akmenrags forest district in 2008. The fire damaged about 10 ha of forest land.

In these research fields information was collected about the tree species, tree height and tree diameter. The burnt forest stands had naturally regenerated with pubescent birch and Scots pine. Pine is able to grow both in poor sandy soils and in moist peat soils, in pure stands, as well as in mixed stands - together with spruce and other deciduous trees [1, 2]. In areas where there has been a fire and no economic activity has taken place, natural regeneration is becoming more intense and biodiversity is higher [3].

In burnt forest stands the number of naturally regenerated trees varies from 2860 to 5350 trees/ ha<sup>-1</sup>. The number of naturally regenerated tree species: Scots pine varies from 933 to 1000 trees/ ha<sup>-1</sup>, pubescent birch from 1860 to 4267 trees/ha<sup>-1</sup>. In the control stand the total number of naturally regenerated trees is 2240 trees/ha<sup>-1</sup>. The number of naturally regenerated tree species is the following: Scots pine - 480 trees/ha<sup>-1</sup>, pubescent birch - 1860 trees/ ha<sup>-1</sup>.

In the burnt area the dominant tree species is pubescent birch, which lowers Scots pine’s natural regeneration rate. According to the Regulations of the Cabinet of Ministers of Latvia natural regeneration in *Myrtillosa turf. mel.* has successfully proceeded with permissible species, but Scots pine’s natural regeneration has not occurred successfully. In burnt areas the dominant tree species is *Betula pubescens* Ehrh.

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# WIDE USE OF WOOD AND NON-WOOD PRODUCTS OF NORWAY SPRUCE (*PICEA ABIES* (L.) H. KARST)

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The use of Norway spruce is important because of the fast growth of this species in Europe. What can we make from wood and non-wood parts of Norway spruce?

Wood is used for the manufacture of containers, telegraph and telephone poles, railway sleepers, furniture and musical instruments. Wood is used as lumber in construction [2].

Light-weight and soft wood Norway spruce contains a lot of cellulose and certain amount of resin, so spruce is the main material for the pulp and paper production. Turpentine, and wood vinegar are made from resin [3].

Spruce cones contain essential oils, resin and tannins. They are collected in the summer before seed ripening and then they are dried. A decoction and infusion of cones are used to treat respiratory diseases and bronchial asthma [1]. Spruce bark contains tannins, and because of that bark is used in the leather industry to create tannic extracts [3].

Needles contain vitamin C, so vitamin concentrates and anti-scurvy infusions are made from it. Needle baths also help to cure rheumatism [3].

Norway spruce shoot tips have been used in traditional Austrian medicine internally as syrup or tea and externally as baths, for inhalation, as ointments, resin application or as tea. It helps to treat disorders of the respiratory tract, skin, locomotor system, gastrointestinal tract and viral infections [4].

Norway spruce is used in many aspects of our life, especially for home and for health.

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# POSSIBILITY OF USING EXCAVATOR WITH HEAD RISUTEC TK-120 FOR MECHANICAL REGENERATION OF CONIFERS

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In Latvia, various machined forest regeneration productivity studies have been carried out so far for different planting machines, but mainly as research attempts. No research on Risutec TK-120 under Latvia's conditions has been conducted so far. Machining is a solution to regeneration in overlapping, fertile forests if the most appropriate soil treatment is mound preparation. The aim of the study is to investigate the possibilities of using an excavator equipped with the Risutec TK-120 planting head for mechanized planting of containerised seedlings of Scots pine and Norway spruce during the summer and autumn periods in *Hylocomniosa*, *Myrtilloso-sphagnosa*, *Myrtillosa mel.*, *Mytillosa turf. mel.* and *Oxalidos turf. mel.* forest types.

In Latvia, a trial planting with the planting machine Bracke P11a was carried out in 2007. The results of the trials showed that the productivity of this machine was slightly higher than in the trials carried out in Finland, but it was not sufficient, because the costs of establishing plantations with Bracke's P11a under Latvian conditions also significantly exceeded the costs regarding manual planting tools. For the study comparing Bracke's P11a and M-planter, total estimates indicate the fact that the costs of mechanized forest planting mostly depend on the number of seedlings per site [1]. Despite the studies conducted in the last 50 years, mechanized tree planting has also not been successfully promoted on a large scale in the Scandinavian countries. In Sweden mechanized planting proportion of planted plantations historically reached a maximum in the 90s of the 20th century with Silva Nova techniques, but in the mid-2000s again dropped and has not notably increased [2].

The study sets out the work tasks of assessing the size and quality of sites prepared and calculation of the productivity of planting mechanized with Risutec TK-120 head during summer and autumn periods. Comparing mechanized work operations in different forest types, it has been ascertained that the most of working time is spent on the directly manipulative movements of the boom and establishment of the mound (~ 60-70%). Meanwhile, the planting work in all forest types and seasons is fairly constant. The displacement process took between 8% and 10% of the total working time (the shortest displacement time was spent in wet *Myrtilloso-sphagnosa* 8%, but the highest displacement time in *Mytillosa turf. mel.* - 10%). Nearly all of the planting process operations took more time in the summer season. Considering all 20 experimental areas, the average planting time including the whole operation of one plant (without considering pauses) is about 14.85 seconds.

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## **FOOD SCIENCE**

# EFFECT OF GERMINATION AND ILLUMINATION ON BIOACTIVE COMPOUNDS OF HEMP AND BROCCOLI SEEDS

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Different seeds (hemp, broccoli etc.) play an important role in human diet, which can provide the organism with nutritional components (macros and microelements) as well as bioactive compounds (vitamin C, dietary fibre, phenolic compounds etc.) [1]. To increase the amount of these compounds, germination process can be used. Germination is one of the most common and effective processes for physiological, biochemical and morphological changes and also for improving the quality [2]. Due to the nutritional value, low calorie and beneficial effects on human health of germinated seeds and sprouts, people around the world consume more and more sprouted seeds - sprouts. The aim of this research was to study the effects of light, darkness and the germination time on phenol content and antioxidant properties in hemp (*Cannabis sativa*) and broccoli (*Brassica oleracea*) seeds.

Seeds were germinated in dark and light conditions at the temperature of  $22\pm 2$  °C and the relative humidity of  $85\pm 2\%$  for 12, 24, 36 and 48 hours. TPC was determined using Folin-Ciocalteu reagent and measured by a colorimetric method [4, 3], but antioxidant activity was measured using the method described by Yu L. [5]. Ungerminated seeds were used as the control.

The total phenol content in ungerminated broccoli seed was 208 mg GAE g<sup>-1</sup>, but in ungerminated hemp seed it was 46.71 mg GAE g<sup>-1</sup>. Comparing the germination process in the dark and in the light of ungerminated to germinated hemp and broccoli seeds, it was observed that the amount of TPC increases both in dark and light conditions till 36 h of germination process, while at 36 h the TPC decreased for hemp and broccoli seeds in both germination conditions. Germinated seeds showed higher TPC in the dark than in the light for hemp and broccoli seeds. The data of this study also showed that the germination time and illumination affected the DPPH of hemp and broccoli seeds. In germination process of hemp seeds DPPH decreased in both illumination conditions, while broccoli seeds showed a completely opposite result, DPPH increased both in the dark and the light at all germination times. Overall, broccoli seeds showed higher amount of TPC in the dark and higher amount of DPPH in the light, compared to the control and hemp seeds. Therefore, the TPC and DPPH amount changes depend on the germination time, illumination and the type of seeds.

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# RHEOLOGICAL PROPERTIES OF LACTOSE-FREE YOGHURT IN RELATION TO ENZYME CONCENTRATIONS

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Lactose-free yoghurt is one of the main sources of useful nutrients (protein, calcium) for people who have lactose intolerance (Souza et al., 2018). Therefore, production of lactose-free yoghurt is considered to be a significant issue (Kasimov et al. 2015). Many factors can affect the rheological and textural parameters of lactose-free yoghurt, including enzyme concentration. The aim of the study was to evaluate enzyme concentration impact on the rheological properties of lactose-free yoghurt. Four combinations were made from two different cultures and enzymes. The combinations were FD-DVS YC-X11 + Nola Fit 500, FD-DVS YC-X11 + Ha-Lactase 5200, YoFlex Acidifix 1.0 + Nola Fit 5500, YoFlex Acidifix 1.0 + Ha-Lactase 5200. The control sample and sample with 500 BLU L<sup>-1</sup> enzyme were made from pasteurized milk (fat content 2.5%, Tukuma piens Ltd., Latvia) for each combination. The cultures and enzymes used during the experiments were produced by Chr Hansen JSC., Denmark. Milk was pasteurized (95±1 °C, 5 min), cooled down (40±1 °C), inoculated with starter and enzyme, mixed and fermented up to pH 4.8±0.1, then the samples were mixed and cooled down to 5±1 °C. The textural properties and viscosity of yoghurt samples were measured using the texture analyser TA.HD Plus and DV-III Ultra Programmable Rheometer. The sugar content was measured by HPLC (SHIMADZU, Prominence, USA). The FD-DVS YC-X11 culture with both enzymes had a lower viscosity compared to the control samples, while YoFlex Acidifix 1.0 showed opposite results. According to Mende (2012) and Folkenberg (2005), EPS impact the water binding capacity, thus increasing the viscosity of yogurt. FD-DVS YC-X11 + Nola Fit 500 reflexed in a higher firmness, consistency and cohesiveness in comparison to the control sample, whereas the same starter with Ha-Lactase 5200 provided lower textural properties, compared to the control. The results from chromatography did not show lactose presence in any experimental sample with enzyme. Due to the increased sweetness of lactose-free yogurts, the amount of sugar, added to make commercial flavoured yogurts, may be reduced resulting in the production of even healthier products. That is why for obtaining lactose free yoghurt with acceptable rheological properties, the lowest concentration of β-galactosidase (500 BLU L<sup>-1</sup>) is recommended.

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# **WINE BUYING HABITS OF LATVIAN CONSUMERS**

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Wine is an alcoholic beverage obtained from grape juice fermented under anaerobic conditions [1]. It is widely produced and consumed all over the world. As an example, in 2018 a total of at least 246 million hectolitres of wine were consumed worldwide. Most of the wine was produced in France, Spain and Italy (up to 54 million hectolitres of wine per year) [2]. In addition, it should be emphasised that the preference for a particular alcoholic beverage and consumption habits highly differ depending on the geographical region. Wine is more popular in Europe and America [3]. In Latvia most wines are produced from different berries and fruit. Although wine drinking has been very widespread in the Western Europe for over 2000 years, only in the recent years the grape-based alcoholic beverage has caused a bigger interest in the Baltic States and as well in Latvia. For that reason the aim of this research was to analyse wine buying habits of Latvian consumers.

A survey consisting of 20 questions was developed. The survey was conducted online using [visidati.lv](http://visidati.lv) platform. Only persons who had reached the age of 18 could participate in the survey. Respondents were able to answer the questions only once. Participation in the survey was voluntary. Both sexes had an equal opportunity to take part in the survey and be represented. The questionnaire consisted of two parts: the first part consisted of demographic questions (gender, age, place of current residence, education level, current job status, monthly income), the second part focused on wine buying personal habits. The questionnaire consisted of several single and multiple-choice questions. The obtained results were processed using Microsoft Excel 2010. The survey was conducted in March 2020 within the framework of the master thesis. A total of 300 respondents participated in the questionnaire, 214 of them were women and 86 were men. The distribution of respondents by age showed that the largest cluster belonged to the age between 18 to 24 years and 25 to 34 years. Most of the respondents (61%) lived in Riga. 250 of the respondents (83%) were employed and 203 (68%) had higher education. Most of the respondents (40%) had a monthly income of more than 1000 euros after taxes. 269 out of all respondents admitted that they did buy wine. Wine type, price and taste were the determining factors when buying it. Most of the respondents (37%) admitted that they bought wine once a month or on special occasions. The survey showed that the main purchasing channel for buying wine was the supermarket (68%). As for the price, the consumers mostly chose wine in the price ranging from 5 to 10 euros per bottle. Moreover, the survey also showed that the consumers chose sales ( $p < 0.05$ ) or special offers when choosing the right bottle of wine. Consumers most often chose 1 to 5 year old wines in glass bottles of 0.75 litres. Italian, French and Spanish wines were the most popular among respondents. 53% of respondents chose red wines, while 34% of respondents admitted that they did not pay attention to grape varieties of red wines. Most of the respondents preferred dry wine. Respondents acknowledged that a high quality red wine would most likely have a fruity taste, ruby red colour and a spicy aftertaste.

Results of the survey indicate that wine consumers in Latvia buy wine relatively rarely, mostly choosing wines from well-known wine producing countries. Furthermore, their choice is mostly influenced by wine type (colour) and the price rather than grape varieties.

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# SUPPLY OF VEGAN PRODUCTS IN LATVIA MARKET

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Abandonment of animal products is nothing new, yet thanks to the research activities about health and mortality rates among vegans, there is a growing interest in veganism [1]. A vegan diet is characterized by a lower BMI and lower risk of obesity, which is one of the most serious problems in the world [2]. This in turn has created a growing interest and demand for vegan products, forcing scientists and manufacturers to develop new vegan products that can meet the nutritional needs of this consumer group. That includes alternatives to meat and dairy products such as vegan sausage, vegan ice cream, vegan burgers, etc. which have entered the food market.

The aim of the study was to identify and analyse the supply of vegan products and beverages, and their diversity in the Latvian market. The study was conducted in the Latvian supermarkets like “Rimi” and “Maxima” along with the online stores from November 2019 to February 2020, gathering the information from the labels of vegan products and beverages. The information included the country of production, ingredients, nutritional value and energy value. A database of vegan products and beverages was created for the purpose of the study. Data processing was done with *Microsoft Office Excel*.

A total of 197 vegan products and beverages made in different countries were analysed. The largest supplier of vegan products and beverages in Latvia was Germany with 32.5%, followed by Italy with 11.7%, the Czech Republic with 10.2%, Latvia, Lithuania and the United Kingdom with 5%. The substantial supply of vegan products and beverages from Germany could be explained by a large number of vegetarians and vegans in Germany, which in 2018 accounted for 7.8 and 1.6 million, respectively [3]. The most widely used ingredients for the production of vegan products and beverages (81.2%) were soybeans or their raw materials like soy protein. The energetic value of vegan products and beverages ranged from 13 kcal (sugar-free almond milk drink) to 451 kcal per 100 g (soy flakes). The vegan diet is characterized by low levels of saturated fatty acids, which are associated with health benefits [1, 4]. Analysing the content of saturated fatty acids in vegan products and beverages offered in Latvia, their content was comparatively low, except for certain product groups such as vegan cheese, desserts, butter, pates, and ready meals. The supply of vegan products tends to grow, increasing the choice not only for vegans, but also for omnivores.

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# MICROBIOLOGICAL ANALYSIS OF THE ENERGY BAR MADE WITH CAFFEINE, L-THEANINE AND GINKGO BILOBA EXTRACT

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The microbiological parameters of a food product are important indicators of its quality. Heat treatment reduces the water content of the product, thereby prolonging storage time and increasing microbiological stability [1]. The main goal of thermal processing is to inactivate the spoilage and pathogenic microorganisms by denaturation of membranes, ribosomes, and nucleic acids and produce a safe product with enhanced shelf life [2]. The baking time and temperature differ according to the specific characteristics of the finished product [3].

The aim of this study was to evaluate microbiological quality of raw and heat-treated energy bar made with caffeine, L-theanine and Ginkgo Biloba extract. Twelve samples of bars were made with the following raw material ratio: caffeine powder (0.27 %), L-theanine powder (0.67 %), Ginkgo Biloba leaf extract (0.05 %), cocoa powder (15 %), flaxseeds (5 %), shelled hemp seeds (5 %), almonds (10 %), dried dates (47 %) and raisins (17%). The raw materials were mixed and the mixture was formed to a standard weight bars (30 g). Three samples were not heat-treated. The other nine study samples were baked in an electric oven in convection mode at three different temperatures and time modes: 100 °C for 15 min, 120 °C for 30 min and 130 °C for 15 min. The bars were cooled down after baking. The microbiological analysis was made on the same day. The total plate count was determined by plating tenfold saline dilutions in triplicate on Plate count agar with incubation for 48 h at 30 °C. The presence of *E. coli* and coliform bacteria was tested on ENDO agar with incubation for 24 h at 37 °C, yeasts and moulds – on malt extract agar with incubation for 72 h at 25 °C.

Table 1. Microbiological quality of energy bars

Method label	Heat treatment method	Total plate count, CFU g <sup>-1</sup>	Number of yeasts and moulds, CFU g <sup>-1</sup>	<i>E. Coli</i> and coliform bacteria, CFU g <sup>-1</sup>
T-0	0 °C 0 min	$1.1 \times 10^2$	$2.6 \times 10^2$	$7 \times 10^1$
T-1	100 °C 15 min	$6.7 \times 10^1$	$4.2 \times 10^1$	$4 \times 10^1$
T-2	120 °C 30 min	$< 4 \times 10^1$	$5.5 \times 10^1$	$< 10$
T-3	130 °C 15 min	$< 4 \times 10^1$	$< 4 \times 10^1$	$< 10$

The obtained data (presented in the table above) show that the total plate count in samples did not exceed the maximum allowable limit of  $5 \times 10^3$  CFU g<sup>-1</sup>. The maximum permissible limit for the number of yeasts and moulds (100 CFU g<sup>-1</sup>) exceeded in samples treated with method T-0. *E. coli* and coliform bacteria was found in samples T-0 ( $7 \times 10^1$  CFU g<sup>-1</sup>) and T-1 ( $4 \times 10^1$  CFU g<sup>-1</sup>). Using the methods T-2 and T-3 enable to reduce the presence of *E. coli* and coliform bacteria below the detection limit. As a consequence, the microbiological parameters show that heat treatment 130 °C for 15 min is the optimal treatment mode.

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# PUMPKIN SEED BY-PRODUCTS USAGE IN NEW ALLERGEN FREE PRODUCTS DEVELOPMENT

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Food losses cost over US \$ 990 billion a year for the global economy, causing environmental damage and malnutrition in the parts of the world [3]. Nowadays, great interest is paid to the food processing of by-products as a source of valuable biological compounds. By-products combined with technological capabilities can bring to society not only the recovery of residues, but also the recycling of valuable ingredients and the provision of a sustainable food chain. At the same time, the number of different food allergies is rapidly increasing all over the world [1]. One of the most common food allergies is gluten intolerance. Replacing gluten in food is becoming a modern necessity for creating innovative gluten-free products. Adherence to the gluten-free diet in daily diets is becoming a market trend among consumers who do not suffer from food allergies at all [2], raising concerns about the nutrients in gluten-free foods, in most cases nutrient deficiencies. Nutrient-rich and biologically active compounds such as pumpkin seed by-products can be very successful in creating new gluten-free products. Pumpkin seed by-products are a protein source (66.12 g per 100 g of dry matter), high in fibre (15.4 g per 100 g of product). The total fat content is about 8%. Pumpkin seed by-products are rich in such minerals like P, Mg, Fe and Zn. The most important vitamins found are niacin, thiamine and vitamin E, as well as essential amino acids such as lysine and leucine. The aim of this research was to evaluate the suitability of pumpkin seed by-products for the production of gluten-free bread. The technological process for pumpkin seed flour acquisition was developed, creating a new recipe for gluten free bread. Dehulled pumpkin seeds were used, heated at  $100\pm 2$  °C, 10 min, pressed in a mechanical oil press, separating the oil part. The pumpkin seed by-products were grounded in a flour mill. The recipe included milled pumpkin seed by-products (17.8%), corn starch (10.5%), rice flour (7.3%), potato starch (5.2%), sugar (4.2%), gluten-free backing powder (2.1%), psyllium powder (1.0%), dry yeast (1.5%), salt (0.4%), and xanthan gum (0.2%). The plant oil (2.6%) and water (47%) in  $23\pm 2$  °C temperature were added. The dough was fermented in  $35\pm 2$  °C, 40 min, moulded and baked at  $220\pm 2$  °C, for 40 min. The moisture (AACC Method 44-15A standard method), textural properties (hardness) and colour ( $L^*a^*b^*$  system) for the ready-made bread were analysed. Sensory evaluation was carried out by trained tasters. As a control sample gluten-free rice flour bread (Schar Mix B Bread-Mix, IT) was used. The pumpkin seed flour (PSF) bread sample was appreciated higher for its colour, aroma and taste. Texture of rice flour (RF) bread sample was valued low. The moisture of PSF bread was  $7.99\pm 0.92\%$ , compared to RF bread –  $14\pm 2\%$ , The hardness of PSF bread was  $5.95\pm 2.7$  N, but RF bread –  $3.2\pm 0.13$  N. The colour of PSF bread was from light brown to light green. The results of the research proved that pumpkin seed by-products are possible to use for the production of gluten-free bread.

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## **VETERINARY MEDICINE**

# GIRAFFES HEAD SOFT TISSUE IN COMPARISON WITH BOVINE AND EQUINE

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It is well known that giraffes are the tallest living terrestrial animals and the largest ruminants. They are quite strange animals because of their body and the way they move. For veterinarians it is an obligation to know everything about different species of animals. Giraffes are animals that peak our interest as they are not known very extensively and deeply. The purpose of this study is to understand better the soft tissue composition of giraffe's head and to compare its head muscles to bovine and equine muscles.

At the beginning of March 2020, in Riga National Zoological garden a 14 years old giraffe male died. It was transported to Latvia University of Life Sciences and Technologies, faculty of Veterinary Medicine where necropsy was performed. After the necropsy, the body of the giraffe was donated to science. For this study, the head of giraffe was used. The skin was carefully removed and then the muscles were dissected and compared to bovine and equine head muscles based on literature. Some anatomical features were measured using a ruler. The whole process was documented using the photography method.

The inside of bovine cheeks is covered with *bucall papillae*. They serve to retain the cud during lateral jaw movement [1].

The bovine cheek is similar to the giraffe's cheek. Bucall papillae of giraffe's cheek was measured using a ruler. The biggest measurement was 24 mm closer to premolars.

The giraffe's lips are highly muscular and very mobile [2].

According to our observation, it is true. Giraffe's lips consist of *m.orbilcularis oris*. At the corners of the mouth *m. zygomaticus* is connected to provide some movement of lips. Some movement of muzzles sides is provided by *m. depressor labii maxillaris*. Frontal portion of muzzle is moved with the help of *m. levator labii maxillaris*.

Hard palette that forms the roof of the mouth has approximately 18 transverse folds which turn the free edge backwards [3]. These transverse folds have papilla that are like bovine transverse folds, but are more exaggerated.

Having compared giraffe head's soft tissue to equine and bovine tissues, the authors of this paper concluded that giraffes are more similar to bovine. Muscles that are involved in facial expressions are thin, but upper lip muscles are well developed. Also, more studies are necessary to understand better precise movements of muzzle as it plays an important role in feeding.

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# ANTIMICROBIAL SUSCEPTIBILITY OF *PSEUDOMONAS AERUGINOSA* ISOLATED FROM DAIRY CATTLE FARM'S ENVIRONMENT

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*Pseudomonas aeruginosa* has been identified as an animal pathogen responsible for various infections. It is common in the farm environment and has often been cited as a source of pseudomonas mastitis in cows. In this way, *P. aeruginosa* may contaminate milk or dairy products and can even be transmitted to humans. Eradication of bacteria has become increasingly difficult due to its remarkable capacity to resist antibiotics. The main reason of resistance pattern is a common and improper use of drugs in most of the livestock production systems. *P. aeruginosa* expresses a multi-resistance to antibiotics, which is now recognized as a major threat worldwide (1).

The aim of this study was to determine the antimicrobial susceptibility of *P. aeruginosa* isolated from dairy cattle farm environment.

The study was carried out in 2019 between March and May in three Lithuanian dairy cattle farms. In total, 60 swab samples were taken from four different sources (calves' and cattle's bedding, feeding area and milking equipment). For *Pseudomonas* spp. isolation Cetrimide Agar (Liofilchem, Italy) and Tryptic Soy Agar (Biolife, Italy) were used. To identify the isolates of *P. aeruginosa* PCR assay was performed (2). Ten *P. aeruginosa* strains resistance to 6 antimicrobial agents (tetracycline, ciprofloxacin, streptomycin, ceftriaxone, imipenem and colistin) were determined using E-test (Epsilon meter test). The results were evaluated according to EUCAST 2019 and CLSI 2017 antimicrobial susceptibility breakpoint guidelines. A total of 21 *Pseudomonas* spp. strains from 20% of environmental swab samples were isolated in this study. Thirteen bacteria were confirmed as *P. aeruginosa* by testing with PCR method. Most common *P. aeruginosa* were isolated from the samples of milking equipments (37.5%) and calves' bedding area (50%). The antimicrobial susceptibility investigation test was performed on ten strains of *P. aeruginosa*. The results have shown that all strains (n=10) were susceptible to imipenem and colistin, while some of them demonstrated intermediate susceptibility to tetracycline (60%) and ceftriaxone (30%). A high frequency of resistance among *P. aeruginosa* was found for streptomycin (100%), followed by ciprofloxacin (40%). Multidrug resistance was present in 6 (60%) out of 10 tested isolates and the resistance to streptomycin, ciprofloxacin and tetracycline was the most predominant.

The study indicated the high prevalence of multidrug-resistant strains of *P. aeruginosa* in calves' bedding and milking equipment's. This type of organism, found in the environment of dairy cattle farm and even food products, may depend on inadequate extent of cleaning and the sanitizing of milking equipment and utensils or use of contaminated water as a potential transmitter of *P. aeruginosa* to livestock and further to humans.

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# ANTIMICROBIAL RESISTANCE OF *ESCHERICHIA COLI* BACTERIA ISOLATED FROM RAW COW'S MILK AND MILK PRODUCTS

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A variety of foods and environmental sources harbour bacteria that are resistant to one or more antimicrobial drugs used in medicine and agriculture. Antibiotic resistance in *Escherichia coli* is of particular concern because it is one of the most common Gram-negative pathogen in humans [1.]. Raw milk can be contaminated with *E. coli* during clinical mastitis and either directly through animal faeces or indirectly during milk collection through farm employees or the milking equipment [2.]. The aim of this study was to determine the antimicrobial resistance of *E. coli* bacteria isolated from raw milk of cows and milk products (curd). In total, 21 samples from seven different dairy cattle farms located in Lithuania were tested for *E. coli* during the period of September and December, in 2019. Additionally, 3 curd samples collected from different local farmers were tested. *E. coli* bacteria were isolated using Chromogenic coliform agar (Biolife, Italy) and Tryptic soy agar (Biolife, Italy). The morphology of the bacteria was checked by performing Gram staining. All typical *E. coli* strains were additionally identified with multiplex PCR by the detection of *upsA* and *uidA* genes as described by Godambe et al. 2017. Antimicrobial susceptibility for amoxicillin (AML), gentamicin (CN), kanamycin (K), tetracycline (TET) and chloramphenicol (C) was tested on 13 *E. coli* strains isolated from raw milk of cows and curd using MIC strip tests (Liofilchem, Italy). The results were interpreted according to CLSI 2019 and NARMS 2019 antimicrobial susceptibility breakpoint guidelines.

*E. coli* was found in 47.2 % of the tested raw cow milk and 100% curd samples. The antimicrobial resistant testing revealed that all (13) tested *E. coli* strains were susceptible to all tested antibiotics. The detected minimum inhibitory concentration (MIC) varied from 1 µg/mL to 32 µg/mL for AML, from 0.25 µg/mL to 16 µg/mL for CN, , from 8 µg/mL to 64 µg/mL for K, from 4 µg/mL to 32 µg/mL for TET, and from 2 µg/mL to 32 µg/mL for C. Raw milk from dairy cattle farms and also milk products (curd) from local farmers in Lithuania are frequently contaminated with *E. coli* bacteria. However, antimicrobial susceptibility testing revealed that all isolated *E. coli* strains were sensitive to the tested antibiotics.

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# **OPHTHALMOLOGICAL PRE-BREEDING SCREENING TEST RESULTS IN LATVIAN HUNTING DOGS**

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Inherited ocular disorders comprise a large number of ocular pathologies and represent a growing problem in many dog breeds all over the world. Hereditary eye disease scheme is a standardized clinical eye examination used to eliminate or reduce the incidence of ocular disorders, proven or presumed to be inherited. Many of these conditions are either disabling, painful, have serious effects on animal welfare and health, or require life-long therapy or surgical treatment. The main purpose of the eye screening is to identify signs of ocular disorders proven or suspected to be hereditary in breeding dogs to avoid passing these diseases on to their offspring. The scheme includes identification of inherited eye disease, as well as general assessment of the entire eye and its adnexa. A routine ophthalmic screening includes the assessment of visual processes and examination of the ophthalmic reflexes. Ophthalmic screening examination includes slit lamp biomicroscopy (at least 10x magnification), then the use of a mydriatic, followed by indirect ophthalmoscopy. Further testing might include tonometry, Shirmer tear test, ultrasonography, gonioscopy, and electroretinography [1, 2, 3]. The aim of this research is to screen for inherited eye disease in Latvian hunting dogs.

18 Latvian hunting dogs (36 eyes) of varying age and sex were included in this study. Eye screening was done during the period of 2018-2020. It took place in veterinary clinics (Grobina, Ergli, LLU Veterinary hospital) and in the 2nd National hunting breeds specialty dog show. All dogs underwent complete ophthalmic examination, followed by measurement of tear production (STT-1), and intraocular pressure (TonoVet®).

No ocular disorders presumed to be inherited were found. However, we detected bilateral nuclear sclerosis (age-related change) in 10 y.o. dog and post-inflammatory retinal dystrophy in 13 y.o. dog (left eye). In the present study, the mean  $\pm$  SD STT-1 and IOP values were in normal range for dogs:  $21.4 \pm 3.2$  mm and  $17.6 \pm 3.2$  mmHg, respectively.

Eye screening enables to make informed breeding decisions, adapt breeding programmes and reduce the risk of inherited and potentially inherited conditions to appear in future generations. Our study showed no ocular disorders, proven or presumed to be inherited in examined group of dogs. The study should be continued to increase the amount of dogs examined and to improve the quality of Latvian Hunting dog breeding programme.

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# THE EFFECT OF THE MULTIPLE OVULATION AND EMBRYO FLUSHING PROCEDURE ON COWS' PRODUCTIVITY AND REPRODUCTIVE PERFORMANCE

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Multiple Ovulation and Embryo Transfer (MOET) is a method to reproduce genetically valuable animals effectively (Mikkola, 2017). Multiple ovulation (MO) in a cow is reachable using hormone treatment protocols. Embryo flushing (EF) is a process to obtain multiple produced embryos in a non-invasive manner.

The aim of this study was to examine the effect of MO and EF procedure on productivity and reproduction performance of cows, if the present lactation continues. The data for this study is from the ERDF project No.1.1.1.1/16/A/025 "Latvian Brown and Latvian Blue cow gene pool conservation using embryo transfer and related biotechnologies".

The multiple ovulation method was induced in 39 donor-cows ( $6.2 \pm 3.18$  years old; 1.5-15.7 years,  $3.7 \pm 2.25$  lactations; 1-10 lactations) of which three of them were heifers. The cows were  $252.6 \pm 221.33$  (70-1064 days) days post parturition. Before MO and EF, 14 cows were planned for slaughter due to different reasons – age, hoof health, SCC in milk, however 25 cows were expected to be kept.

There were  $5.1 \pm 6.31$  embryos obtained from discarded cows, of which  $3.0 \pm 4.1$  were transferable, and  $3.0 \pm 4.1$  embryos obtained from un-discarded cow group, of which  $3.0 \pm 4.40$  were transferable. According to the information of the Agricultural Data Centre, milk production dropped through lactation. It was  $19.4 \pm 7.40$  kg before MO and EF, but during the next month it was  $17.3 \pm 7.16$  kg, and after another month it was  $16.4 \pm 7.00$  kg per day ( $P < 0.05$ ). SCC in milk changes were not statistically significant ( $543.8 \pm 1094.90$ ,  $690.5 \pm 1076.34$  and  $562.0 \pm 1100.35$  thousand/mL respectively;  $P > 0.05$ ). Nine discarded cows (23.1%) and 19 healthy donors (48.7%) did not receive AI before MO and EF. Six cows (15.4%) received AI once, but five cows (12.8%) were inseminated unsuccessfully 2 up to 8 times. After MO and EF 14 cows (35.9%) were not inseminated because of discarding MO and EF previously, but 25 cows (64.1%) received AI and 18 of them (72%) became pregnant after first AI; two or more AI were needed in 6 cows (24%). Cow productivity correlated with the age of cows ( $r = 0.58$ ,  $P < 0.001$ ) and days after parturition ( $r = -0.44$ ;  $P < 0.05$ ). Small changes in SCC were observed, which became stable within a few days and a drop in milk yield could be observed as the cow is under stress due to the hormonal therapy (Callesen et al., 1996).

In our study, milk dropping could be explained by physiological diminishing through lactation. Just 15 cows had milk SCC below 200 thousand/mL. In 19 cows we observed SCC increasing in the next milk recording after MO and EF and in the same number of cow SCC it was decreased.

In conclusion, no harmful effects were observed in cows related to MO and EF. In the future, it could be of interest to understand which obstacles are important for SCC elevating after MO or EF.

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# PREVALANCE AND ANTIMICROBIAL RESISTANCE OF *STAPHYLOCOCCUS SPP.* ISOLATED FROM CATTLE FARM'S ENVIRONMENT

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Antibiotics are widely administered to farm animals to treat and prevent infectious diseases, or as food supplements. This use of antibiotics is recognized as a major cause of antibiotic resistance in bacteria's (like, *Staphylococcus* spp. and others) colonizing the digestive tract of domestic animals (1). Most of the resistant bacteria found in these animals can be transmitted to humans through contact with them or through contaminated food products (such as milk or other dairy products) and environment (untreated water or contaminated objects).

The aim of this study was to establish the prevalence and antimicrobial resistance of *Staphylococcus* spp. bacteria isolated from cattle farm environment.

The study was carried out in 2019, in three Lithuanian dairy cattle farms. In total, 60 swab samples were taken from four different sources (calf and cattle bedding, feeding area and milking equipment). For *Staphylococcus* spp. isolation and identification Manitol salt agar (Biolife, Italy), Baird-Parker agar (Biolife, Italy) and Microgen Staph ID test (Microgen Bioproducts, England) were used. Additional confirmation of *Staphylococcus aureus* (*S. aureus*) was done by PCR during *nucA* gene identification (2). Eighteen *Staphylococcus* spp. strains resistance to 5 antimicrobial agents (amoxicillin, tetracycline, ciprofloxacin, streptomycin and ceftriaxone) were determined using E-test (Epsilometer test). The results were evaluated according EUCAST 2019 antimicrobial susceptibility breakpoint guidelines.

In total, 48 staphylococcus strains were isolated from 80% of the environmental swab samples. *S. aureus* (14.3%), *Staphylococcus haemolyticus* (11.4%) and *Staphylococcus schleiferi* (5.7%) were the most prevalent species among the isolated staphylococci. Seven bacterias were confirmed as *S. aureus* by PCR. In this study, most common *Staphylococcus* spp. were isolated from the samples of calves bedding (39.5%) and feeding areas (22.9%).

The 18 *Staphylococcus* spp. strains antimicrobial susceptibility investigation has shown that 16.6% of staphylococcus were resistant to tetracycline, 16.6% to streptomycin and 5.5% to ciprofloxacin. All strains (100%) were susceptible to amoxicillin and ceftriaxone. Multidrug resistance was present in 2 (11%) out of 18 tested isolates, and the resistance to streptomycin, tetracycline and ciprofloxacin was most predominant.

Our studies have shown that the highest prevalence of antimicrobial resistant *Staphylococcus* spp. was found in the calf bedding and cattle feeding areas. The contamination of the environment with antimicrobial resistant staphylococci can increase the spread of bacteria in the food chain, which can lead to the outbreaks of difficult to treat-staphylococcus infections.

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# ANTIMICROBIAL RESISTANCE OF *ESCHERICHIA COLI* BACTERIA ISOLATED FROM DAIRY CATTLE FARM'S ENVIRONMENT

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Antimicrobial resistance of different bacteria has become a major issue in public health worldwide. *Escherichia coli* is one of many bacteria that can develop resistance. Most strains of *E. coli* are non-pathogenic commensals that form a part of natural microflora in the digestive tract of dairy cattle, but pathogenic strains also occur [1]. Consumption of unpasteurised milk and milk products, contaminated with such pathogenic *E. coli*, can lead to various health problems in humans. Moreover, if bacteria causing the infection is resistant to antibiotics, treatment can be even more complex [2].

The aim of this study was to evaluate antimicrobial resistance of *E. coli* bacteria isolated from dairy cattle farm environment.

Altogether three dairy cattle farms located in Lithuania were tested during the period of April and May, in 2019. In total, 60 swab samples from four different surfaces (cows beddings, calves beddings, feeding area and milking parlours) on each farm were collected. *E. coli* bacteria were isolated using Chromogenic coliform agar (Biolife, Italy) and Tryptic soy agar (Biolife, Italy). The morphology of the bacteria was checked by performing Gram staining. All typical *E. coli* strains were additionally identified with multiplex PCR by the detection of *upsA* and *uidA* genes as described by Godambe et al. 2017 [3]. Altogether 18 *E. coli* strains (six isolates from each farm) were tested to antimicrobial susceptibility for amoxicillin (AML), ceftriaxone (CRO), tetracycline (TET), ciprofloxacin (CIP) and streptomycin (STR) using MIC strip tests (Liofilchem, Italy). The results were interpreted according to CLSI 2019 and NARMS 2019 antimicrobial susceptibility breakpoint guidelines.

In total, 38.3% of the environmental surface samples were *E. coli* positive. Most often bacteria were found in swab samples of cows and calves' beddings (73.3% and 66.7%, respectively). In total, 44 *E. coli* strains were isolated and confirmed with PCR in this study, and 18 *E. coli* strains were further tested for antimicrobial susceptibility. The same percentage of resistant *E. coli* strains (38.9%) was observed for AML, TET and STR, respectively. In total, 27.8% of *E. coli* strains were resistant to CIP. No resistant strains to CRO were found. Altogether 7 out of 18 (38.9%) tested *E. coli* strains were confirmed as multidrug resistant with a dominant profile AML-TET-CIP-STR.

The results of this study revealed that a high percentage of *E. coli* strains, isolated from dairy cattle farm environment, were multidrug resistant. Such bacteria, possibly accessing the human body through contaminated dairy products (such as milk and milk products), pose a risk to consumers' health.

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# OCCURRENCE OF COXIELLA BURNETII DNA IN DAIRY PRODUCTS IN RETAIL IN LATVIA

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*Coxiella burnetii* is gram-negative intracellular bacteria which cause Q fever in both, animals and humans. Infected animals shed bacteria into the environment through milk, products of abortion, faeces and urine. Q fever is a significant public health concern with a potential for outbreaks to occur [1, 2].

Since 2012, there is a surveillance programme to detect *C.burnetii* occurrence in Latvia. From 2012 to 2015, in total 2088 cow blood samples were tested which represent 1010 dairy cattle sheds in Latvia, 13.2% of the tested sheds were positive [3].

Consumption of contaminated dairy products has been suggested as a potential route for transmission. Findings with ingestion in mice show that only a portion of *C.burnetii* are able to perform transition from the gastrointestinal tract and disseminate [4].

The present study was focused on dairy products in the retailing in Latvia. The presence of *C. burnetii* DNA was detected using a commercial real-time PCR kit, targeting the IS1111 element. 112 of cow and goat milk product samples were tested, 99 from Latvian milk processing companies and 13 from other countries. 19 yogurt samples, 16 pasteurized milk samples, 13 cheese samples, 12 unpasteurized milk samples, 9 cottage cheese samples, 7 kefir samples, 29 other dairy products and 4 goat milk products were examined. 71 (63.4%) samples of 112 product samples were positive. 81.3% of pasteurized milk samples were positive, 63.2% yogurts, 84.6% cheese, 25% unpasteurized milk, 66.7% cottage cheese, 42.9 kefir contained DNA of *C. burnetii*, but none of goat product samples were positive. For conclusion, milk processing companies should be aware of the importance of pasteurisation process. Processing companies, farmers, veterinarians and consumers should be informed about *C.burnetii* zoonotic aspects and the One Health approach.

## Acknowledgements

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## **ENGINEERING**

# **DEVELOPMENT OF COMMON STANDARD FOR DIGITAL RELAY CONFIGURATION IN THE POWER COMPANY**

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None of nowadays existing power supply systems are fully fault tolerant. It means that consumers may be affected by various electrical fault types varying from simple blackouts to serious power surges that can cause permanent damage to equipment. It is true for all kind of power systems in household, industry, farming, automotive industry, etc.

Protection relay is a special device, following any deviations in the energy system and preventing further damage development (disconnecting the damaged phase, equipment, etc.) in the energy system. The essential task of protection relay (hereinafter referred to as relay(s) or relay protection) is to immediately disconnect its energy system element from the rest of the system where the damage has occurred (most often short-circuited) or disconnect the energy system element if it operates in any other unforeseeable and unacceptable mode for that element, which may cause damage to the system or interfere with the efficient operation of the electrical system [1].

The system engineer must have a thorough knowledge of protection systems, protection equipment, protection functions and the configured functional logic in the protection relays. The installation and commissioning personnel must have a basic knowledge in handling electronic equipment [2].

In the past, the relays that were used to detect and clear a fault depended only on the fault current value. However, today, non-standard characteristics the voltage value can also be used to diagnose the faulty part of the power system due to the fact that directional overcurrent relays (DOCRs) have generally become more accessible and are able to measure both current and voltage values on the line which they are connected to via current and voltage transformers [3].

In this research, it is intended to develop a methodology for configuring protection relays in a company, as this is important because of the above mentioned. Conclusions can be drawn that there are many factors which affect developing digital relay configuration, and they are as follows: power grid, digital relay manufacturers, consumers and others. There are several possibilities how to create digital relay configuration with graphical interface, non-graphical interface, with dipswitches. Also there are several options how to build configuration with various curves of voltage, current, and frequency.

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# TRIBOLOGICAL PROPERTIES OF FEEDING UNIT FOR PACKING MACHINE CLINIPACK

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During the process of the development of the dosage unit for the tablet packaging machine, the author of the research realized that there is necessity for further investigation of the tribological properties of product and dosage unit, because the quality of the packaging process of product depends on it. The theoretical part of the research describes the relationship between the tribological theory and the experiment. Currently, no slip friction study has been carried out to test production and machines at JSC Olainfarm.

During the manufacture and packaging of pharmaceutical products, the machine working surfaces and their assemblies interact with the open product and various types of forces are formed between them: friction, normal reaction, and Van der Waals forces. Research has proven that vibrations also affect the friction force [3]. Tablets, capsules and metered powders, their geometric shape characteristics, surface roughness and mass are the most important factors influencing the movement of the product, the dispersion rate in the packaging area of the dosage unit during packing of the finished dosage forms.

There are three main theories in tribology scientific literature: the frictional force is proportional to the normal load, the frictional force is independent of the visible contact area, and the kinetic friction is independent of the slip rate [2].

Slip friction studies for various materials are the integral part of machine design as they can effectively solve problems connected with choosing the right materials and surface roughness treatment. Slip friction coefficients also determine the minimum slope angle to overcome static friction forces. In practice, slip friction calculations are used to determine the tilt angle of powder loading containers, tablet press tablet tray, and coating pan surfaces to ensure optimal product handling. Slip friction coefficients for capsules and tablets are important tribological factors that influence the frictional forces between machine surfaces and output.

Studies were carried out to determine the sliding friction coefficients for the production of various tablets and capsules by a simple method, by a manual experiment and the coefficient was calculated using the formula  $\mu = tg\alpha = \frac{h}{l}$ . The sliding friction coefficient ranged from 0.17 to 0.29. The weight of tablets and capsules is between 240 and 650 mg. Tablets are compacted powder solid forms with and without coatings. The capsules are covered in a gelatin shell [1]. Based on the results of the theoretical research, a measuring device for in-depth study of the tribological process will be developed.

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# **ALTERNATIVE ENERGY SOURCES FOR LIGHTING**

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Alternative energy is energy that does not harm the environment or pollutes it to a small extent compared to other types of energy. In the modern world alternative energy resources play a major role in ecology. Energy obtained from oil and oil derived products produces a lot of harmful emissions while being burned, whereas the use of energy from the sun or wind does not adversely affect our planet, except by producing equipment that collects that energy [1].

The aim of the research is to investigate the possibilities of providing lighting by using different alternative energy sources. The following hypothesis has been formulated: by using wind energy from ventilation and solar energy flowing through the windows it is possible to provide at least 20% of the energy required for LED luminaires. The research methods include the experiments, observations and data analysis.

Many cities are densely built with high-rise buildings that create significant shading, therefore solar panel installation becomes a problem. When solar panels are mounted on the walls, they interfere with the architecture of the building. There is a similar problem with wind turbine installation.

Solar windows take up as much space as regular windows. This technology can be implemented by installing new windows or applying a thin transparent film to the existing ones with an organic photovoltaic array or upgrade them with solar batteries. Many buildings still use natural ventilation. Masses of air flow back and forth through the ventilation shafts. Placing wind turbines in ventilation shafts could make good use of this energy. By using these alternative sources of energy, it would be possible partially or completely provide a building or room with LED (light emitting diode) lights [2; 3].

The use of alternative energy is an important factor in the fight against climate change. The alternative energy production process does not emit greenhouse gases, which makes it one of the most sustainable solutions to prevent environmental degradation.

By creating a solar window prototype where solar panels are attached to the window frame, it would be possible for a standart window with 12 volt voltage system to have power around 4 watts. The generated energy would not be enough to operate permanent lighting but it would have a great potential for places with motion sensors such as staircase areas. Currently the efficiency of solar cells and solarium glass is below 10 percent but it will probably rise with the development of these systems.

By using these solar windows, it would be possible to obtain cleaner energy and further use it to operate various lights. The only emissions would come from the production of needed materials and the devillery process.

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## **FIRE RESISTANT MATERIALS**

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There are many fire-resistant materials, which could be classified based on chemical composition, manufacturing process, material shapes and other methods. Fire resistant materials may include such materials as Chromite, Zircon, Graphite, Molybdenum, Silica, Tungsten [1]. Refractory materials of different uses are essential for the scientific classification of refractory materials to facilitate research, rational selection and management. Based on the high and low degree of fire resistance, the materials are divided into general refractories: 1580 °C ~ 1770 °C; advanced fire resistance: 1770 °C ~ 2000 °C, special fire resistance: > 2000 °C. If a production method is taken into account, the refractories can be divided into fired products and amorphous refractory products. If classification is done according to chemical properties of the substance, the materials can be divided as acid resistant, neutral refractory, alkaline refractory [1]. Generally, refractory materials are used for structures exposed to high temperatures, ranging from simple to complex, for example, fireplace brick linings to the space shields. In industry, they are used for all types of boilers and furnaces - reactors, ladders, distillates, furnaces. Depending on the application, refractory materials must withstand chemical attack, molten metal and slag erosion, thermal shock, physical effects, catalytic heat and similar adverse conditions [2]. Refractory materials are exposed to frequent changes in ambient temperature. For example, in steel casting, the charging, venting, and changes in the furnace temperature of a metallurgical furnace cause product cracking, scaling, or even collapse, which not only limits the heating and cooling rate of furnace products and furnace, but also limits furnace operation. They are one of the main reasons for faster destruction of refractory brick and furnace [2]. World scientists research experimental results revealed that the nanoclay modified cement mortar exhibits higher compressive, tensile, and flexural strengths than control specimens, especially at higher temperatures [3]. In conclusion, the description of different characteristics of fire resistant materials is necessary for better understanding of the metallurgical processes.

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# HEATING SYSTEM SOLUTIONS FOR THE ELECTRIC BUS COMPARTMENT USING HEAT ACCUMULATION

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Electric vehicles have evolved in recent years. There are more charging stations available than ever before, so it is clear that the world needs to use more electric vehicles. Electricity has been used for a long time as a power source, metro stations and subways still use it today. However, it has only recently become feasible to implement this technology across wider range of public transport. Transportation contributes over 27% of Europe's greenhouse emissions and transition to electric public transport results in less harmful pollution [1].

The aim of the research is to investigate possible materials which can be used in the heat accumulation device, and to build a prototype heat accumulator for an electric bus. The hypothesis of the research is the following: using an independent heat accumulation device, warmth will be provided to the interior of the bus, without draining the electric battery which provides energy for bus propulsion. Research methods include heat distribution and loss measurements in the bus interior, and calculations to find out the necessary power output of the heat accumulator.

The weather can get cold in Eastern Europe in winter, and it is necessary to heat the compartment of a vehicle. But the main issue with electric vehicles is that while heating the compartment with an electric heater, it drains the battery and severely affects the mileage. A possible solution to this problem is usage of heat accumulation in a special battery which would only be used to heat the compartment. If this technology gets implemented in public transport, it would make the lifetime of the main electric battery much longer because it would go through much less charging and discharging cycles [2]. That means batteries must be changed less often, so less batteries must be built, which means less harmful emissions. The idea is to use a specific substance which in normal state is crystallic, but when heated it becomes liquid and preserves the heat energy very well. Once it has been put in a vehicle the heat can be returned to heat the compartment. The main goal is to heat the compartment of an electric bus, which is used as a public transportation vehicle [3], [4].

It is necessary to build a prototype of a heat accumulation device and make a usable charging system to make it function. If this technology gets implemented in next generation electric vehicles, it would help to make the air much cleaner in the big city centres and, most importantly, slow down the pace of climate change.

From the results of this research it would be possible to conclude whether it is possible to use this kind of system in electric vehicles, how efficient it would be and how difficult it would be to integrate this system in vehicles.

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# POTENTIAL OF ENERGY MANAGEMENT SYSTEM IMPLEMENTATION IN APARTMENT BUILDINGS

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Energy consumption is the amount of heat and electricity that is consumed to ensure that all the processes necessary for living (heating, ventilation, lighting, hot water supply, etc.) take place in the building. Accordingly, promoting the energy efficiency of a building means a set of measures that significantly reduces the heat and electricity consumption of the building.

Renovation measures in multi-apartment buildings would save money spent on utility bills, which would allow the savings to be used to further improve energy efficiency, share lighting, improve building infrastructure and environmental management.

The aim of the study is to substantiate the potential of implementing energy management in apartment building. The research methods include inspecting and comparing apartment buildings, performing heat loss calculations, the average cost of maintaining a house before and after reconstruction.

Many buildings today use energy-efficient light bulbs to illuminate common areas and entrances, therefore by installing LED solutions and combining them with motion and time relays, it is possible to significantly reduce electricity consumption while maintaining or even improving lighting quality [1].

Another thing that could reduce costs is the change a heating station of each building and install a new one, as most building heating stations have served for a long time and are no longer energy efficient. Residents would be able to choose the appropriate air temperature in their home, the continuous circulation of hot water at any time of the day, regardless of the time of year.

Most of the buildings have single-pipe systems, which are no longer as efficient as they were at the time of construction. Therefore, in order to save energy, each radiator is equipped with a thermostatic valve, the radiator connection unit is rebuilt during the renovation of the building-apartments thus lower costs can be achieved [2].

One of the things that residents of non-renovated buildings face is that the thermal insulation of a building is no longer effective and results in large energy losses, therefore buildings are insulated, roofing is changed, windows and exterior doors are replaced, heating system is modernized to reduce energy loss. As a result, people do not have to pay for unused energy. One example of such a building is the 464 series of the new Lithuanian project, where the energy consumption before the renovation was 139.64 kWh / m<sup>2</sup> where every month after the renovation about 45% of energy consumption from the total energy consumption was saved, which is significantly higher compared to the previous data [3].

Energy efficiency measures in apartment buildings will save energy, save money, increase the level of comfort for the building's occupants, improve the economic environment, improve the condition of the building, as well as reduce energy imports, which allows to save money and divert it to other needs.

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# HEATING SOLUTION FOR THE TRUCK CABIN USING THERMAL BATTERY

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Taking into account the rise in fuel prices and the fact that fuel makes up to 50 percent of total operating costs, transport companies explore different solutions to reduce the costs [1]. The aim of the study is to research possibility to accumulate the heat energy from internal combustion process and heat cabin of a truck when it is parked, thus reducing fuel consumption and operating costs. The hypothesis of the research is the following: by using thermal battery device, heat will be provided to the truck cabin without burning fossil fuel. The available information in different sources offers solutions for heating of truck cabins. One such solution is to absorb the heat of the internal combustion engine into the heat thermal battery device and use their heat to heat the truck cabin to provide a driver with heat during the specified rest period. This reduces the amount of fuel needed to heat the cabin. Reducing the consumption of fuel also means reducing CO<sub>2</sub> emissions. If this technology gets implemented in trucks, it would help to transport companies reduce running costs.

Another variant for heating solutions focus on the thermochemical energy storage which is a new technology offering the advantage of high heat densities and small thermal losses. This makes the technology advantageous for high temperature and low temperature storage, as well as for long term storage options. Thermochemical energy storage mechanisms varies from reversible chemical reactions to physical adsorption and, there are available a lot of storage materials. Implementation of this technology in thermal battery will ensure that this battery is relatively small due to the high energy capacity [2].

It is possible also to keep warmth by covering the windows with curtains thus reducing the heat load on the truck's sleeper cabin. Using standard curtains reduces the heating load of the berth by 21%, while the arctic curtain reduces it by 26%. Reducing the heating load in the cabin can reduce the size and capacity of the thermal battery [3].

The research will include heat loss measurements in a truck cabin, calculations of the required heat capacity of a thermal battery and fuel consumption measurements.

It is possible to reduce fuel consumption by heating the truck cabin with thermal batteries. Thermochemical energy storage should be used as it has a high energy capacity. Covering windows with curtains reduces cabin heat consumption.

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# **POSSIBILITIES OF PROVIDING ENERGY EFFICIENCY AND MICROCLIMATE OF THE 20 KV INDOOR SWITCHING CENTER BUILDING**

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Nowadays efficiency and cost-effectiveness are a very topical issue and could be said to be a problem. The technical regulations determine the temperature range and humidity to be provided at existing distribution points [3]. Unfortunately, in most cases, existing heating systems fail to do so. Temperatures during the cold winter months fall below the minimum allowable. Energy resources are also wasted, including electricity, because these heating systems are, as a rule, made up of electric radiators without a control system. The theme chosen is relevant not only to substations but also to all buildings used in the economy, as the cost of energy consumed increases every year, both for electricity and for wood, gas and other energy sources used to heat buildings. Similarly, the efficient use of energy resources and maximum preservation of the ecology of the environment must be taken into account when insulating and choosing the type of heating [2].

The aim of the research is to investigate and justify the most appropriate way of 110 / 6-20 kV switchgear insulation and microclimate provision, taking into account technical and economic criteria.

The following hypothesis has been formulated: an energy-efficient solution to provide the necessary microclimate parameters of distribution points by insulating the enclosing structures.

A thermal insulation material is a building material that is used to protect a building or an individual room from heat loss. In construction, by using thermal insulation materials, it is possible to reduce the thickness of building structures, their weight, the amount of materials and costs. In order for switchgear to be able to operate for a long time and without accidents, it is necessary to observe the appropriate operation, as well as the microclimate and temperature in the building. Indoor switchgear contains switchgear with circuit breakers, relay equipment, various meters, and telecontrol systems. They all need an appropriate temperature, as well as the condition that the relative humidity of the air does not exceed the norms specified in regulatory documents [1].

The use of heat-insulating materials in construction makes it possible to reduce the thickness, weight, quantity and cost of building structures. The purpose of thermal insulation is to protect the room from cold in winter and overheating in summer.

Insulating a building will result in significantly lower losses through enclosing structures, thus significantly reducing the bills of energy used to heat the building. By using stone wool 150 mm, the average gain is 50% when insulating a building.

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# ANALYSIS OF OPERATING PARAMETERS FOR ELECTRIC SCOOTERS

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The use of electric scooters in recent years has become very popular. They are used as both personal and rental vehicles. An electric scooter is a simple and easy, single person, two-wheeled vehicle that works well on the road. The general electric scooter has no seat and the driver is standing still. But there are manufacturers who make scooters where it is possible to sit. The aim of this study is to analyze technical parameters of electric scooters and to make a comparative analysis [1].

The electric scooter must be sufficiently durable, light and easy to use. In the framework of this research many scooters were analysed and one with the best performance and another one with the lowest price were chosen. The study showed that out of the electric scooters analyzed, the *Kaabo Wolf Warrior Scooter* has the best performance with a top speed of  $80 \text{ km h}^{-1}$ , a maximum load of 150 kg and with a single full charge capable of 112 km driving distance. The average price of a scooter is 2.900 EUR. A user can also go for the cheaper *GOTRAX GXL V2 Commuter Scooter* with a top speed of  $25 \text{ km h}^{-1}$ , a maximum load of 100 kg and a mileage of 19 km with one full charge [3]. Every scooter has a different design, weight, dimensions as tire size, handle size and the main frame, as it will require a different method to drive with each manufactured scooter. Most of the scooters have soft handles to make driving comfortable. An electric scooter may be dangerous because of their small tires, because they can be stuck between potholes. Standard scooters have very bad suspension design that is why it is not soft to drive. Manufacturers produce different designs of suspension and try to make them more comfortable.

Nowadays it is very popular to drive with rentable scooters and it is a fun to drive them with friends and what is most important it is not expensive. Also rentable scooters may have issues with people who do not take care of rented scooters so it is very important to choose one that is fixed or not damaged.

Which scooter to buy and use is a huge question because some of people want a fast and other ones want it to be durable and with a high range. The analysis of the selected scooters shows that the *Kaabo Wolf Warrior Scooter* has the best dynamics parameters, but it also has the highest price. Users of scooters are often schoolchildren and young people, so scooters with lower prices and worse technical parameters are purchased.

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**RURAL ENGINEERING AND ENVIRONMENT**  
**LAND MANAGEMENT AND GEODESY**

# CREATING 3D MODEL OF KVĖDARNA - PADIEVAITIS MOUND USING UAV-PHOTOGRAMMETRY TECHNOLOGY

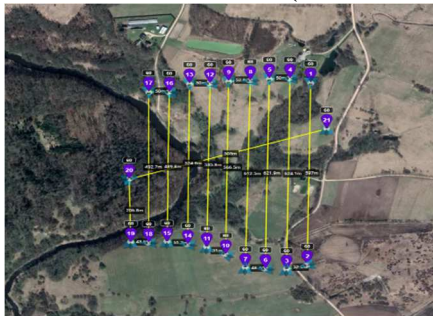
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In the wake of the evolution of smart technologies, measurement science and technologies are rapidly improving due to the increase in differing data collection methods. One of the newest methods is called remote sensing. It is the acquisition of information about the physical, biological, and chemical properties of objects without having any physical contact with objects-in-analysis. When applying the remote sensing method, data is gathered using various sensors operating in spectral zones ranging from visible to microwave radiation, that collect electromagnetic radiation that is reflected, emitted or scattered by the objects. Such measurement data can be obtained using airplanes, helicopters, unmanned aerial vehicles (known as drones), submarines, etc. [1]. Remote sensing systems are split into several approaches: using “passive” sensors, which detect reflected or emitted electromagnetic radiation (traditional and digital aerial photography, main space-based remote sensing systems - Spot, Landsat, Ikonos, etc.); using “active” sensors that themselves generate electromagnetic waves and send them to the Earth’s surface and capture the different reflection characteristics (RaDAR – Radio Detection And Ranging, LiDAR – Light Detection And Ranging); lastly, using infrared sensors – thermal photos. One of the remote sensing methods using “passive” sensors is aerial photography. Aerial Photography is Earth’s surface photography done using an aircraft in order to construct a dedicated terrain plan of a select area. Aerial mapping is one of the most advanced ways of obtaining information about the Earth's surface and other objects using photographic imagery [2]. High-precision (quality) orthophoto maps and three-dimensional (3D) surface models are the main products created by using the aerial photography technology. For these reasons, remote sensing was chosen as the primary method in order to achieve the aim: to make the necessary measurements and create a 3D model of Padievaitis hillfort (of Kvėdarna).



To achieve the aim of the study, “Litchi” software was used. It is the professional software for waypoint area mapping that is available on all platforms, including personal computers, with seamless mission synchronization across multiple devices. Depending on the terrain of the area, the flight height was set at 60 meters, the flight distance was 6.2 km, the drone's flight time was 18 minutes, and the film strips were parallel every 51 meters. In addition, the data was processed using “TerraScan” software, a major program in the “Terrasolid” software family for managing and processing LiDAR point clouds. It is also capable of automatically finding thousands of common points between images. That is the most important condition in order to get a high level of image similarity. The measurements resulted in the 3D model of Padievaitis hillfort (of Kvėdarna).

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# **COMPARISON OF MEASUREMENT ACCURACY IN CABLE LINE SURVEY AT OPEN AND CLOSED TRENCH**

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The regulations of the Cabinet of Ministers in Latvia require that engineering communications must be surveyed at open trenches. Although the goal of these requirements is to ensure the surveying quality, in practice building companies face several difficulties in meeting them. The major difficulty with surveying at open trenches is that, due to objective circumstances, it is not always possible to ensure the permanent presence of a surveyor on the site. Also, occasionally, the construction is influenced by seasonal characteristics and the composition of the soil [1].

Taking into account these factors, it would be necessary to explore alternatives to the open trench method. One solution could be the use of cable locators and signal transmitters in cases when surveying is not possible at an open trench. Therefore, the aim of the research is to find out what accuracy this method provides in determining the depth and horizontal location of a cable.

To do this, the survey of the cable line was carried out at both open and closed trenches. In both cases, the measurements were performed using a Sokkia GCX3 GNSS receiver with three measurements in RTK mode on each survey point. Surveying at the closed trench was performed using a Leica Digicat 550i cable locator and Digitex 100t signal transmitter. In straight sections of the line, the cable was located with the help of a locator, while at the pivot points, plastic pipes were placed to increase the accuracy [2;3].

The measurements started at the first object using the closed trench method in 66% cases, it was possible to determine the depth of 850m long cable line within 10cm precision. As for horizontal deviations, only 22% of the measurements were within 10cm. However, in 57% of the cases at the second object it was possible to determine the depth of 200m long cable line within 10cm using the cable locator. As for the horizontal deviations, 72% of the measurements were within 10cm. It should be noted that as regards the first object, it was possible to connect the signal transmitter only at both ends of the line, so the signal in the middle of the line deteriorated where the errors had the highest value. As regards the second object, the horizontal deviations were significantly lower due to the transmitter being significantly closer to the target line and receiving a better signal. However, the proximity of the transmitter also has drawbacks, as signal distortions were observed 30m from the transmitter, which significantly reduced the accuracy of the depth detection at this section of the line. It has also been mentioned in various application sources that signal distortions can be observed within a 25-30m radius around the transmitter [4].

Therefore, it can be concluded that this survey method is applicable in places where the transmitter can be connected in several line sections to provide a good enough signal, but the transmitter is not within the 30m range. Although this method shows relatively stable results in both depth and horizontal deviations, it is not suitable for areas with high communication densities, as some measurements with errors above 20cm can be observed.

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# DEFORMATION DETECTION METHODS DURING AND AFTER CONSTRUCTION PROCESS

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Monitoring of the technical condition of structures and their deformations is an observation and control system, which is performed according to the specified programme for tracking the degree and speed of changes in the technical condition of the object. It is carried out to assess the impact of construction work on or near buildings, and, if necessary, the adoption of urgent measures and the prevention of adverse factors [1].

The construction standard “Technical inspection of buildings” determines that the purpose of the technical inspection of structures is to determine the conformity of the structure with the essential requirements specified for the structure, including the determination of the exact extent of existing damage, its cause as well as the measures to be taken to prevent damage [3]. The construction standard “Geotechnical design” provides that both new buildings located away from other buildings and new buildings adjacent next to existing structures must form a foundation and the foundation project. The projects shall include measures which ensure normal operating conditions of structures during the construction and operation of the projected structure. When designing new buildings which are next to existing buildings, the foundation of the existing buildings must be determined – parameters of foundations and possible additional deformations of the substrate caused by loads and other effects of the designed structures. The effect of foundations and loads on the substrate is determined by considering the interaction between the foundation and the substrate. For the “building – foundation” or “basics – foundation” system, a calculation scheme shall be selected for determining the stress state and deformations of the foundation and the structural elements of the structure, which takes into account all relevant factors, including static schemes, peculiarities of construction works, the impact of the foundation soil structure and physical and mechanical properties and their possible changes during construction and operation of the structure [2].

In practice, structural deformation measurements are mostly organized already at the beginning of the construction process. After the commissioning of the structures, depending on the complexity of the structure, deformation measurements are also organized during the operation of the structure. Various types of deformation measurements are organized, such as surveying and researching the heights of objects, as well as surveying concrete elements. Deformation monitoring can be performed using several geodetic surveying methods, such as tachimetry, geometric levelling, hydrostatic levelling, trigonometric levelling, micron levelling, global positioning, as well as photogrammetry and laser scanning. The combined methods are often used to measure deformations.

Deformations and their timely fixation during the construction and operation of buildings is one of the most important engineering geodetic works. Deformation fixation must be performed with the highest possible accuracy in order to stop and prevent possible deformations of structures as early as possible.

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# APPLICATION OF REMOTE SURVEY METHODS TO OVERHEAD POWER LINE MONITORING

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Today infrastructure monitoring, which is a system for monitoring, controlling, analyzing and forecasting the situation, is important in many sectors of the economy. It also plays an important role in electricity, especially in the maintenance of power transmission lines. It helps to detect unwanted changes in the power line and to timely eliminate the causes of damage that could lead to accidents on it in the future [1]. Monitoring facilitates safe transmission of electricity and helps to reduce maintenance costs.

Today the monitoring of power transmission lines has been increasingly performed using remote survey methods. Remote survey is a branch of science and industry engaged in the acquisition, measurement, analysis and visualization of objective information through the acquisition of data using non-contact imaging systems [2]. Such methods offer preservative data collection using space satellites, unmanned aerial vehicles and manned aircraft equipped with sensors [1]. The most common sensors are optical or digital cameras, laser transceivers (Light Detection and Ranging LiDARs) and multispectral cameras that photograph in the range of the spectrum invisible to the human eye [3].

In March of this year the power transmission line monitoring was performed using two most popular remote surveying methods, i.e., orthophotography and laser scanning from the air with an unmanned aerial vehicle. The power transmission line was located in Jelgava and Jelgava county. It is of a local importance, bare-wire, medium voltage, AC overhead power transmission line, with the total length of 4,671 m.

Orthophotography was performed with a DJI Phantom 4 RTK UAV and laser scanning with a YellowScan Surveyor laser scanner. As a result, visual data on the locations of the power line supports and wires were obtained from orthophotos, distances to the tree tops, to the adjacent high-voltage power line and to other obstacles near the power line were determined. The laser scanning results allowed to create a 3D model of the power transmission line, which showed the changes in the perpendicularity of the supports, the level of sag of the wires, the location of the branches of the specific trees to be cut and their size.

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# APPLICATION OF DIFFERENT GEODETIC METHODS FOR GEOSPATIAL JUSTIFICATION OF RECLAMATION SYSTEMS

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The forest reclamation system is a hydrological and hydraulically-linked linear bottom-structure network for regulating groundwater treatment. A large part of the forest drainage system under the management of JSC "Latvian State Forests" has already worn out and needs to be restored. Renovations are currently required for 13 037 km of trenches (30% of the total length). The maintenance and restoration of forest drainage systems have to be carried out by cleaning the existing ditches to improve the water treatment of the drained land and the surrounding area and to ensure their functioning [1].

To design drainage system reconstruction, it is necessary to measure the existing structure according to the requirements of the legislation of the Republic of Latvia and "Technical regulations for forest infrastructure design" [2] issued by JSC "Latvian State Forests".

In the framework of the master's thesis, measurement data were obtained and compared with different geodetic methods. The following geodetic methods were used:

- Geometric levelling with the leveller and levelling rods;
- Tachymetry with a total station and a reflector prism;
- GNSS measurement method [4].

Measurements were carried out in the JSC "Latvian State Forests" forest drainage system of the southern Kurzeme region, "Lanciņi" in Kuldīga Municipality, Kabile and Renda Municipality rural territory. Trenches with different density of the forest were selected for measurements: no trees – bare-cut; rare tree density – new generations, shrubs; thick forest – large trees, bushes.

The comparison of the obtained results and the geodetic methods used led to the conclusion that the most accurate height value data can be obtained using geometric levelling, but this method is the most time-consuming, thus economically unsuitable. Measurements with the total station were a little bit less accurate as they were based on trigonometric functions. The most inaccurate method was measuring with the GNSS method as it was significantly influenced by the forest density.

Before measuring the forest drainage system, it is necessary to track networks of existing ditches and to consider a geodetic method to be used to ensure maximum possible measurement accuracy and economic efficiency.

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# REMOTE SENSING IN PROTECTED ENVIRONMENT OF SMILTYNĖ RECREATIONAL TERRITORY

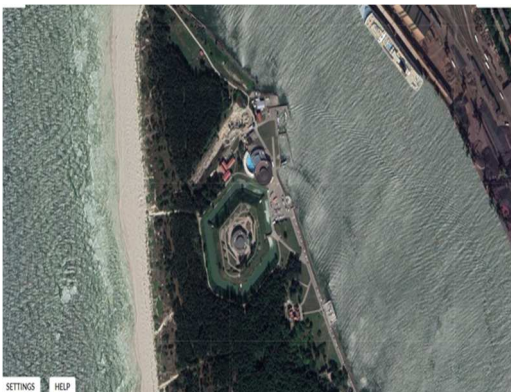
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With the fast advances in surveying technology there is an increased variety of data gathering methods. One of the latest and most innovative methods is remote surveying. By using various technologies this kind of surveying allows remote gathering of spatial data about physical, chemical and biological object characteristics without a physical contact. Remote surveyal data can be gathered using unmanned aerial vehicles, space apparatus and satellites, submarines, land stations etc. [1]. When using remote surveying, data is being collected by measuring reflected, radiated or dispersed electromagnetic radiation. That is done by using various sensors that operate in spectrum from ultraviolet rays to microwaves [2]. The basis of remote researching systems are: passive sensors that gather reflected or radiated electromagnetic radiation (traditional and digital aerophotographs, main distant probing robotic spacecraft systems - Landsat, Spot, Ikonos ect.); active sensors that generate and send electromagnetic waves to the surface of the Earth and collect the data of the reflections (RaDAR - Radio Detection And Ranging, LiDAR - Light Detection And Ranging); sensors of radiated energy – a thermal image. One of the remote research methods that use passive sensors is aerial photography. Aerial photography is taking photographs of the Earth's surface from a plane so they can later be used to construct a special plan of the area. This is why our main aim is to make required measurements and create Smiltynė recreational area 3D model. To achieve the aim, we used “Litchi hub” software.



“Litchi hub” software allows you to create, edit and share flight missions online. Taking into account the terrain of the photographed area and the current situation, the height of Smiltynė forest area was set at 65 meters. Flight trajectories are parallel, every 60 meters. 70-80% overlap of aerial photography is recommended. Speed should fluctuate between 2 and 8 m/s for copters and is not contacting during the flight since the drone slows down to trigger pictures. Moreover, “Pix4D mapper” software was used to process the data. “Pix4D mapper” is an image processing software that is based on automatically finding thousands of common points between images. As we said before, the main rule is to maintain high overlap between the images. As a result, Smiltynė recreational area 3D model was created.

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# FOREST LAND AND ITS USE IN LATVIA

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Forests are the national wealth of each country. They play an important role in the economy of the country, in meeting the needs of the economy, in ensuring the well-being of society and in the life of the people. Agriculture and forestry are the main sectors of the national economy in Latvia, and the area of forest and agricultural land changes every year. The aim of the study is to find out the situation of forest lands and forest resources in Latvia, to evaluate the dynamics of the of forest land area.

Land classification in land use patterns has developed and evolved along with land use development. The term *land use* means to describe the area of land according to its natural characteristics and the current economic use of the land, which corresponds to the classification of land use (The Land Use Planning Law). The Republic of Latvia has a unified the classification of land use. The procedure for classification of land use types and the criteria for their determination on the basis of the Land Use Planning Law were determined by Regulation No. 562 “Regulations on the Procedure for Classification of Land Use Types and Criteria for their Determination” as of 21 August 2007 of the Cabinet of Ministers. The largest areas in Latvia account for forests and agricultural land out of eight types of land [1].

According to the Forest Resources Monitoring Data, as of January 1, 2019, forests in Latvia occupy 3,285 thsd. hectares, of which the state administers and manages 1,519 thsd. hectares, which is 46.2% of the total forest area, while the forest area of other owners was 1,766 thsd. hectares, which is 53.8% of the total forest area [3]. Compared to other European countries, Latvia can be considered a forest-rich country, as forest land covers more than half of Latvia's total land area, which is about 52%, while forest land occupies an average of 33% of land area in Europe. Latvia ranks fourth in terms of forest area, ahead of Finland (77%), Sweden (76%) and Slovenia (63%) [2]. However, nowadays, many people think that deforestation occurs on a very large scale or it is careless. The forest ecosystem provides the wealth of resources at all stages of forest development and regardless of ownership. Forest ecosystems can provide a wide range of services to humans. For example, trees produce oxygen, attract carbon, which results in a reduction in the concentration of greenhouse gases in the atmosphere. The forest is able to protect the soil from erosion and the waters from pollution. It plays a very important role in preserving biodiversity. Forests with wide range of species are also diverse forests, and therefore they are an important recreational area for the population [3].

To conclude, forests are one of the key resources in the national economy and, if they are sustainably and properly managed, they provide very important resources. This is evidenced by the fact that forests cover about half of Latvia's total area.

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## **CIVIL ENGINEERING**

# **STEEL WELDING APPLICATION ADVANTAGES AND DISADVANTAGES OF USING FLUX CORE AND GAS METAL FILLINGS**

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Steel industry relies on different processes to create and produce constructions. One of the main processes to make production of steel constructions more efficient and less complex is welding. The process of welding has been constantly advancing from joining metals by forge welding in the Middle Ages to laser welding for thin metals, and researchers continuously work on developing new welding methods. Thus gas metal arc welding and flux core arc welding emerged as the main processes for welding steel due to their universality, easier application, and speed [1]. Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW) are defined as arc welding processes which produce the coalescence of metals by heating them with an arc between a continuously fed filler metal electrode and the surface metal. The process uses shielding from an externally supplied gas to protect the molten weld pool. The application generally requires DC+ (reverse) polarity to the electrode [2,3]. GMAW and FCAW processes are commonly used for small or big scale construction, ship, bridge and pipe welding. Although the principle of the processes is the same, the analysis of the sources show that these welding processes have their own advantages and disadvantages: 1. High deposit rate - with the FCAW method, you can deposit up to 25 pounds of wire per hour. With the GMAW method, you can deposit a maximum of about 8 pounds of wire within an hour; 2. FCAW method is suitable for welding of rusted and dirty metals [4]; 3. the ability to join a wide range of thicknesses with the FCAW process due to high current and voltage output [2]; 4. flexibility permits all-position welding capability; 5. the ability to join a wide range of material types [4]; 6. GMAW method has a reduced fume generation rate; 7. the lower heat input characteristics of the short-circuiting mode of metal transfer restricts GMAW to thinner materials; 8. The higher heat input axial spray transfer generally restricts GMAW use to thicker base materials [3].

To summarize the information from the sources, the conclusion can be made that FCAW is a better process for outdoor, thick steel material. Higher outputs of current and voltage ensure penetration, and good shielding ensures resilience against windy conditions. As for the cost efficient GMAW, this process should be used indoors for medium thickness material.

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# THE NEED FOR ANTI-TREMOR SYSTEMS FOR BUILDINGS AND THE WAY THEY WORK

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The Earth is an active place and earthquakes often happen somewhere. In fact, the Iris (Incorporated Research Institutions for Seismology) locates about 12,000-14,000 earthquakes each year [1]. So the need of dampers in buildings will never cease to exist. The number of population has been growing and buildings become higher and higher. So the problem of natural seismic activities is one of the most problematic, and engineers are working with seismologists and geologists to find ways to understand and solve this problem. Professor Ian Stewart from Plymouth University states, "it's not earthquakes that kill people - it's buildings." and he is right. The building structures that are old or does not meet the seismic building codes are the cause for deaths. They crumble and lives are lost. So what is done to deal with this natural disaster that takes thousands of lives away?

L.Di Sarno in his paper explains the process of the earthquakes and the way buildings collapse [2]. There is also explained how dampening works and that there are 2 ways to increase stability in buildings. They are: base isolation and tuned mass dampers. Base isolation is used to isolate the foundation's displacement from the rest of the building while tuned mass damper systems cancel resonance. While these are two ways, engineers are figuring out other ways to improve these systems to build taller and taller buildings. For example, the well-known Burj Khalifa is one of the most iconic supertall structures in the world. The structure is composed of mechanical floors where outrigger walls connect the perimeter columns to the interior walling. The system of base and foundation was designed by conducting extensive seismic and geotechnical studies [3]. Another good example of today's engineering in this field is the Taipei 101 tower. The tower has one of the biggest tuned mass dampers in the world and it is constructed between 87<sup>th</sup> and 92<sup>nd</sup> levels [4]. It counteracts transient loadings like the wind and earthquakes. And there are more amazing engineering solutions that is preventing building collapses and loss of lives.

To conclude, hopefully, in the future buildings will be built with systems that are appropriate to withstand natural disasters and to prevent the loss of lives and still have a wonderful view to see from above the top of scrapers.

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# **FLAT ROOF INSTALLATION METHOD USING BITUMEN AND PVC COATINGS**

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Flat roof is a type of roof with an angle of inclination ranging from 0.7 to 7 degrees, which is most often coated with PVC or bitumen materials. These types of roofs are commonly used in both commercial and residential buildings. At this moment, there is a huge variety of waterproof coatings [2,3]. The most traditional type of coating is bitumen, modified with polymers, which has been used from the end of the 19<sup>th</sup> century. Bitumen coating is comprised of several main layers: reinforcement layer polyester or a fiber glass layer; bitumen layers which are modified with polymers; and rubbles, comprising slate, basalt or granules. In 1996 “Tracol”, a German company, presented a formula for PVC (polyvinyl chloride) roof membrane [4]. Although both of these roof coatings are reliable, both of them present some advantages and disadvantages.

PVC coatings are coated in a single layer. It can stay flexible in low temperatures, although the lowest recommended installation temperature ranges from -5°C to -10°C. Synthetic PVC coatings are resistant to roots of vegetation. Also, its service period is several times longer than bitumen coatings'. However, PVC coatings can be relatively easily damaged by mechanical impacts, thus it is recommended to install paths for walking around the coated region of the roof. Another disadvantage of this coating is that, compared to the bitumen installation, PVC coating installation requires higher skilled labour [1].

Roof coating from rolled modified bitumen materials is installed with several layers. The resulting coating has high resistance to water, heat or cold and is more ecological than PVC coating. Layer coating employs gas burners, but the coating cannot be overheated. Service time of such coatings can range from ten and more years [1].

To conclude, PVC coatings can be superior over the bitumen coatings regarding its service time, but traditional modified bitumen coatings is a more ecological solution for a flat roof insulation.

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# **BUILDING COMMISSIONING PROBLEMS AND SOLUTIONS IN OZOLNIEKI DISTRICT**

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On October 1, 2014, the new Construction Law came into force [1]. The Construction Law stipulates the maximum term of 8 years for construction work and 5 years for structures subject to an environmental impact assessment of the intended activity [2]. For all constructions commenced before this date, the deadline for completion of construction works shall be counted from October 1, 2014, until September 30, 2022. If the structure is not put into operation by the indicated time, new buildings with the prolonged term will be subject to increased real estate tax rate of 3% of the highest value - the cadastral value of the structure or its land and administrative liability for the use of the structure. Such a large amount of the tax means that some people will have to pay more than their monthly salary or pension if this tax will be imposed on them. The aim of the research was to find out the effectiveness of construction laws and regulations for the general construction tendency in Ozolnieki district, to analyze the technical condition of buildings and to perform statistical data analysis, offering guidelines – recommendations for construction and commissioning of buildings. The hypothesis of the research was the following: rapid developments in construction technology and innovations during legislative changes affect the construction process creating additional costs and facilitating control of the construction process before and after commissioning.

The tasks of the research were to get acquainted with the data of Ozolnieki district Construction Board, objects and normative acts in the field of construction, to identify and assess problems of unfinished buildings, to provide constructive solutions during construction surveys, including: deviations from the construction design, arbitrary construction and depreciation of building structures for buildings constructed during the Soviet era, the role of the Construction Information System in the identification of unfinished building objects, its advantages and disadvantages.

The research in Ozolnieki district was carried out in accordance with the method of practical research, observations, statistical data processing and comparative analysis with the data of the Republic of Latvia. According to the data of Ozolnieki district Construction Board, as of February 1, 2020, there were 716 objects with the building permit in Ozolnieki district, but they had not been put into operation. The identified problems in the Ozolnieki district showed similarity with other regions of the Republic of Latvia, as well as highlighted the characteristic ones. The problems of commissioning of structures in Ozolnieki district are topical in the construction industry throughout the Republic of Latvia and they are affected by changes in the Construction Law. Overall, the construction industry is booming: both regarding construction technology and the administrative process of construction, which add costs to all players of construction industry.

The obtained research results proves the hypothesis and provides an opportunity to assess the situation in the construction sector in Ozolnieki district and to promote the cooperation of construction participants by offering guidelines - recommendations for construction participants to complete the construction process during changes. Proposals have been made to improve Latvian legislation, including the facilitation of the handover process for the first and second group buildings in rural areas; mandatory use of BIM (Building Information Model) for the third group buildings.

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# **SOLAR ENERGY APPLICATIONS FOR INDIVIDUAL HOME**

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Solar energy is the radiant energy emitted by the sun. Solar energy can be used to produce heat and electricity. Solar radiation energy is converted into heat energy in solar panels and electricity is obtained directly from sunlight [1,2]. The purpose of the work is to analyze what are the opportunities for using solar energy for an individual home. What is the advantage of solar energy over other alternative heating systems?

Solar energy is the only external source of energy from which the Earth receives energy [1]. Although only a very small fraction of the sun's power reaches the Earth and 1/3 reflects from our planet and returns to space, the remainder is tens of thousands of times beyond the current energy needs of humanity.

Advantages of solar energy: no fuel is needed, no solar power is provided, solar power plants are not affected by rising fossil fuel prices, and they do not release any environmentally harmful substances [1,2]. As a result, people are now more likely to opt for a greener and cheaper way of using solar energy. Solar collectors in individual houses, whether on the roof of the house or in the yard on the ground, have become very popular. Their installation is supported by the European Union. According to scientists, solar power plants pay off in 7-10 years [3,4]. People get cheap electricity and reduces CO<sub>2</sub> emissions that contribute to global warming.

Another use of solar energy is for heating and hot water production. Two types of solar panels are used: flat and tubular vacuum. The latter is to be considered more effective [2]. Solar panels can be efficient at 80- to 90% or more. The following factors are key to the energy performance of the daily cycle: cloudiness, date and time of day.

It is cheap and environmentally friendly energy that we can use to create human well-being. Solar energy is inexhaustible energy with limitless possibilities. It is a guarantee of the future.

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# **ADVANTAGES, DISADVANTAGES AND INSTALLING ERRORS OF USING METAL CONSTRUCTIONS FOR GYPSUM WALLBOARDS MOUNTING**

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Nowadays gypsum wallboards are being used every single day in the construction industry. As soon as it was introduced, a revolution happened in the industry. Why? Because gypsum wallboards enable many works to be done simpler faster and sturdier. Earlier these works had to be performed using a lot of more complex methods and materials. This article reviews the advantages, disadvantages and installing errors of gypsum wallboards using these mounting techniques: metal profiles, profiled wood and glueing.

Metal constructions are resistant to fire so, if used correctly, they contribute to fire proofing and safety significantly. Labour costs of installing metal constructions are lower compared to other methods, but the materials cost more. If appropriately mounted, metal constructions do not deform and are perfect for fulfilling bent constructions indoors [1]. Also, CW metal profiles with adapted holes are used to install wiring and communication networks [4].

If wooden constructions are used, then labour costs are approximately twice as expensive compared to using metal constructions, but the materials are cheaper. If more than 10-12% humid wood is used for constructions, then there is a high possibility that it will be deformed. Possibilities are very limited to bend the wooden material [1; 2]. Even though some sources recommend using wooden constructions for mounting gypsum wallboards, it is better to avoid it as the possibility for cracks is several times higher. Wood has a characteristic feature to expand or shrink depending on the surrounding meteorological conditions (humidity and other parameters). Highly qualified electricians and carpenters have to be used in order to prepare wooden constructions, create holes properly for installing communication networks and wiring [2]. Wooden constructions are rarely used for gypsum wallboards mounting, for example, it could be used for low complexity simple projects [5].

The method of glueing gypsum wallboards is an alternative for a traditional 'wet' plastering and is often called 'dry' plastering. The advantages of this method are the following: a quicker process; only a little amount of water gets indoors; overall costs are relatively low. The disadvantages of this method are the following: it cannot be used for the ceiling; it is not recommended for heavy types of finishing with glueing tiles or sandboards on it; heavier types of shelves or other loads cannot be attached. Also, fire resistance and sound insulation parameters are not improved [3].

All things considered, it is clear that using metal constructions is the most practical way of mounting gypsum wallboards compared to other methods due to better physical qualities: fireproofing, acoustic and others.

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# OPPORTUNITIES AND PROBLEMS OF TILT-UP TECHNOLOGY IN THE CONSTRUCTION OF INDUSTRIAL BUILDINGS

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The Tilt-Up construction technique was invented and developed in the United States in around 1905. This method became very popular after World War II [1]. It is currently most widely used method in the northern United States, as well as in other countries such as Australia, New Zealand and others. It is also used in Klaipėda district in Lithuania.

The Tilt-Up construction work method is a method whereby building elements (walls, columns) are formed on a construction site and then tilted to the vertical position with a crane and braced into the designed position [1].



This method of construction technology requires the installation of a reinforced concrete casting surface near the building footprint on top of which forms for concrete elements are built. If there is no possibility to install the casting surface, then the building floor must be installed. Once a form for a building element has been built, all the necessary inserts of the element (for lifting, supporting, trusses, etc.) are placed and the form is filled with concrete. When the concrete is cured, the product is tilted up with the crane and placed in the design position. After being positioned

vertically, the reinforced concrete structures are temporarily secured with rods until they are joined to other supporting structures (roof, floor) [2]. The Tilt-Up construction technology is mostly used for the construction of low-rise storage buildings.

The Tilt-Up construction technology has many advantages: construction in one place; no transportation costs; no dimensions limitation; a fast construction process; less need for skilled labourers. The main disadvantage of this method is that internally installed thermal insulation can only be done with special thermal insulation materials also lacking in versatility, which is not ideal for complex buildings. However, with the Tilt-Up method, the internal insulation of the element is not the only insulation solution; three-layer panels (concrete on the outside as well as the final finishing layer / thermal insulation / concrete-bearing element) can also be formed. Such panels are being used in America and England already.

When designing buildings (or parts) that are subject to energy performance requirements, additional insulation of the structure is required. With Tilt-Up technology, thermal insulation is installed internally, which is why protecting walls against condensation of water vapour is essential. This can be achieved by correctly calculating the thickness of the thermal insulation and by selecting diffusely conductive materials (Eco wool, mineral slabs, etc.) [3].

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**SOCIAL SCIENCES: ECONOMICS, MANAGEMENT AND ADMINISTRATION**

# **TAXES AND TAX INDUCEMENT IN THE AGRICULTURAL SECTOR IN LATVIA**

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The study analyses the situation of personal income of tax payers which include sole traders, individual farms, farms and fishing communities whose turnover (revenues) from their economic activities in the previous tax year does not exceed the sum of 300,000 euros, as well as any other natural person engaging in an economic activity whose revenue is gained from agricultural production. The research used the monographic method, analysis, and synthesis.

There are seven taxes whose applications vary and have a significant impact on the employees in the agricultural sector. For instance, on submission of the Tax Return, no personal income tax is calculated for profits up to 3000 euros, and, similarly, agricultural subsidies and subsidies for rural development are exempt from the personal income tax [1]. There are significant differences when calculating compulsory social insurance contributions - social contributions in the amount of 5% for pension insurance must be made once a year considering the annual overall financial situation (in general, on a quarterly basis, considering each month individually). In order to reduce the financial burden in the agricultural sector, the excise duty on labelled diesel, used for agricultural production, is calculated in the amount of 15% of the standard rate provided that certain requirements are met). Considering that at the same time more than one tax inducement may be applicable in the agricultural sector, the financial result and tax contributions deviate significantly from general cases.

These calculations may lead to profits varying even more than ten times under equal operational conditions in general cases (revenues, the number of employees, etc.). The results of profit, obtained from the economic activity, may also vary by several thousand euros, but there is a great variation as to the amount of compulsory social security contributions and the personal income tax. The tax inducement is aimed at improving the financial state sector, but it cannot be seen in an unequivocal manner. The law stipulates that the economic activity of the payers of the personal income tax, when keeping registers of the revenues and expenditures in a simple recording system, may be done by the farmer himself.

Considering all the kinds of the tax inducement, this process may seem complex and difficult to understand, that is why farmers often need services provided by a consultant or an accountant. The process of receiving the tax inducement should be less complex to deliver the desired results for the farmer himself/herself, the national tax policy, and the sector as a whole [2]. It is likely that, instead of various kinds of the tax inducement, a separate tax or a combination of taxes may be more appropriate for the farmers. Although the accounting is done in a simple recording system, the amount of forms and their recoding is complicated. To reduce the burden of the amount of forms, compulsory social security contributions in the amount of 32.15% could be done once a year simultaneously with the social contributions in the amount of 5% for pension insurance and the annual statement of income. The tax inducement in the agricultural sector is necessary; however, an accurate and fair tax policy must be simple and easy to comprehend for its application to provide the desired results.

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# EVALUATION OF BUSINESS INTELLIGENCE AND DATA WAREHOUSE IMPLEMENTATION IN BUSINESS

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Information technologies and the availability of data are slowly becoming the cornerstones of successful businesses in the modern age. Business Intelligence (BI) is a term that describes technologies and processes for gathering, storing and analysing data to improve decision making in business [1]. A Data warehouse (DWH) holds historical and metadata information of organizations. It acts as a central repository where integrated information can be queried and/or analysed [2] and is an important part for a successful BI system.

BI and DWH can have many benefits and can offer a lot to businesses looking for a business performance advantage in the information age. Some of these benefits include KPI analysis, data visualization, data querying, data mining descriptive analysis of business data and others [3]. The BI market worldwide has increased by 7.3% in 2017, with revenues of 18.3 billion and it is expected to reach 22.8 billion by the end of 2020 [4]. However, despite this, many organizations fail to successfully use and implement BI systems [4].

Therefore, the aim of this study is to analyse how successful the BI and DWH systems are in the SJSC “State Real Estate” (VNI) and the JSC “Latvia's State Forests” (LVM), and what these businesses have gained or lost since the system implementation.

Both of these businesses have comparatively advanced IT/IS architecture, with many IS and other solutions for both business operating processes and business support processes and high budgets for IT and finance analysis departments. Both businesses have implemented both BI with DWH using the industry standard (data source to DWH to BI).

However, there are some differences in BI usage between these two businesses. First of all, LVM has adopted BI at a higher level than VNI, with more BI users and more use-cases of successful BI solutions. LVM also has more BI solutions concerning operating processes, while VNI has spent most of its resources in BI solutions in support processes. LVM also invest more in employee training in the usage of BI.

Both businesses generally report that BI systems as a whole have made both operating and support processes either faster, cheaper, or require less work. Also, both businesses voice their concerns with employee unwillingness to adopt new technologies, a lot of employees need a certain level of convincing to use BI in their daily work. This factor is more important than it seems, as higher management is more willing to invest in a system that is more frequently used [1]. Considering this, the higher management of both VNI and LVM generally show support in the advancement for these systems.

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# **THE ANALYSIS OF EMPLOYEE MOTIVATION IN "RIMI LATVIA", LTD.**

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Employee motivation has been extensively studied in numerous academic researches, as it affects the company's successful operation and competitiveness. Motivated employees tend to perform quality work and are responsible for the results of their work, so they are the greatest value of the company [1]. The aim of the research is to study and evaluate which motivators stimulate the employees of the company "Rimi Latvia", Ltd. to work and what motivating factors the employees lack [2].

Based on the findings that there is a close link between motivation and a company's financial performance, the empirical study uses such quantitative research methods as profit/loss analysis, analysis of turnover, salary and other financial indicators. As to the qualitative research methods, an employee survey was used, which takes a closer look at employee motivation based on F. Herzberg's theory. The survey assessed employee satisfaction / dissatisfaction with working conditions (motivation and hygiene factors), which directly affect employee motivation [3].

Within the framework of the research, 72 employees of "Rimi Latvia", Ltd., Jelgava hypermarket have been interviewed, which makes up 54% of the total number of the employees of the store. According to the results of the survey, it can be concluded that 20% of the surveyed employees are dissatisfied with their work, which indicates that work duties are performed to a lesser extent; moreover, 25% of the company's surveyed employees are dissatisfied with the remuneration received, which means that they feel financially undervalued. The highest level of employee satisfaction was found in relations with colleagues - 64%. Rimi employees are also satisfied with security (62%), which, in their point of view, is largely related to the importance of sustainable development and cooperation among companies. Only 43% of the employees are satisfied with working conditions and 35% are partially satisfied with them, 50% of respondents are dissatisfied with the company's policy. The most dissatisfied employees are those with benefits and bonuses (53%), which mean that this type of motivation is not clear to them. In addition, 67% of respondents are dissatisfied with their career progress, so management needs to rethink its personnel policy in the career development of its staff.

The proposals by the authors are the following: a number of measures are needed to increase employee motivation. 1) The company's employees should be offered a higher position before an open external competition for a vacant position is held; 2) The company should continue to support employee education, focus more on measures to promote employee satisfaction and motivation; 3) The company should establish a clear and transparent information statement about the granting of benefits and bonuses. This may enhance the credibility of the employees and clarify which activities can be remunerated; 4) the company should also develop a system of competence development, which will be able to promote the quality of skills of the employees, as well as to increase their motivation, thus creating career opportunities for their employees.

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# **PROCESS OF PRODUCTION CONCENTRATION IN LATVIAN FARMS**

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The concept of concentration of production is the production of goods in large enterprises with large production resources. The concentration of production in agriculture is characterized by an increase in land, means of production, labor and production [1]. According to data from the statistics, the number of economically active holdings in Latvia decreased by 48% between 2007 and 2016. Despite the fact that the overall number of holdings has been declining, average production and average milk output have been increasing thus making farming more efficient. The aim of the study is to clarify the impact of the production concentration process on the efficiency of farm production.

The concentration of production in agriculture is achieved by two methods: extensive and intensive. With the development of entrepreneurship in the agricultural sector, production growth is achieved by increasing the area of agricultural land on an unchanged technological basis. Conversely, the intensive production concentration method increases the yields per hectare of cultivated land, that is, increases crop yields and increases farm animal productivity and production efficiency [2]. The concentration of production in agriculture is based on centralization - the consolidation of several small enterprises into one larger enterprise, intensification - in this case increasing agricultural production with constant agricultural land, and specialization - increasing the production of certain types of products based on the availability of technologies [3].

Concentration of production is observed in Latvian agriculture. In the cereals sector, production is concentrated in large farms. In 2018 farms cultivating 300 and more hectares of cereals occupied almost half of the total grain crop area structure which was 45.1%. Cereal yields were significantly higher in large farms than in small farms. In 2018 farms growing cereals in areas of 300 and more hectares had an average cereal yield by 1.1 tons higher per hectare than farms growing cereals in the areas from 5.00 to 10.00 ha. There is concentration of production in the dairy industry, but the dairy industry is still fragmented. In 2018, 31.3% of the total number of dairy cows in Latvia were in farms with 1-5 and 10-19 dairy cows. The dairy farming sector has been reducing the number of small farms and increasing the number of large farms. From 2003 to 2016, the number of farms with up to 50 dairy cows has decreased by 4050 farms, while the number of farms with 50 and more dairy cows has increased by 74 farms.

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# **NATIONAL IDENTITY AND PATRIOTISM. THE TWO ROMANIAS: THE DIASPORA AND THE RESIDENT POPULATION**

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The research outlined in this paper is called "National identity and patriotism. The two Romanias: the diaspora and the resident population" and treats precisely these two phenomena, the national identity and the patriotic one, caught in the study by revealing the meanings that they possess in the vision of all Romanians: those who live and work inside the borders, and those who emigrated and formed the diaspora community abroad.

The word "patriotism" comes from the Latin etymological point of view and can be characterized as loyal to the sovereign. The most basic description of patriotism is defined as the loyalty of the group to its members and to the land they share in life [1]. The origins of national symbolic attachment can be found in nineteenth-century America, when the Stars and Stripes, the National Anthem and the Oath of Faith were recognized for the symbols and rituals of national unity [2]. In the specialty literature, the concept of national identity is usually approached from a micro-sociological perspective and refers to the reporting of individuals to the nation they belong to [3].

Some of the objectives of the research, presented succinctly, are as follows: the measurement of the patriotism level perceived by Romanians in the country and in the diaspora, the measurement of the level of Romanian national identity felt by the Romanian citizens, the identification of how diaspora is related to the homeland and to the Romanian communities abroad.

This survey was based on a quantitative data interpretation model, the tool used in data collection being the online questionnaire. As a case study of a complex and dispersed sample, a sociological inquiry was made by creating an electronic questionnaire built on the Google Forms platform. The data collection period was represented by April and May of 2019. The sample of this sociological survey is represented by 412 persons who are at least 18 years old, who have Romanian citizenship and who live inside or outside the Romania's borders.

The results of this study show that the majority of Romanians declare themselves as being patriots at an average level, followed in top by the ones at a big level and the ones declared patriots at a very high level. The most cited reason why Romanians are proud of their nationality are the beauties and riches of the country. Large differences were recorded between residents and diaspora regarding the duty of participation in the vote process and the level of attachment to the country, with the diaspora being more reluctant in this subjects than the residents. Those living in the country implement the Romanian identity practices to a considerably higher extent than the diaspora. The very big majority of respondents think that Romania is going in a wrong direction, with half of the diaspora saying there is no wish for a return in the mother-country.

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# **INFLUENCER ENGAGEMENT IN BRAND COMMUNICATION**

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In social media, the term “influencer” is being mentioned more and more frequently, as well as how and how much they influence a brand reputation and popularity. The topic of this research study is important because people, who use social media, encounter influencers advertising brands on a daily basis, therefore it is important to understand, if they are overdoing it or bringing attention to a product, which they truly support, and what methods they use to advertise. The aim of this research is to find out how influencers from Latvia use the social media “Instagram” to advertise a brand. An influencer can be described as a person who has outstanding popularity and a loyal fan base, who has put her/his trust in what she/he does or says. They can represent areas, such as a healthy lifestyle, travelling, food, beauty, fashion, and others [1]. A person is more likely to buy a product that his/her relatives or colleagues suggest, rather than what a sponsored post by a brand is advertising. Using this logic, brands try to advertise their products using the help of influencers [2].

To carry out this research study, 3 methods were used: literature analysis, analysis of 50 Latvian influencer social media “Instagram” posts and the graphic method that was used to show the obtained results in charts. The main research question was: “How do Latvian influencers use the social media platform “Instagram” to advertise a brand?” The study was carried out in Latvia, Riga from November 2019 until the beginning of January 2020, starting with collecting information from literature resources and research studies done on similar topics. Then 50 different Latvian influencers from the social media “Instagram” were chosen, and the contents of their posts were analysed. The analysis was done considering their engagement in brand communications during each month. The analysis of these profiles was done in the “Microsoft Excel” programme, and the data was included in 2 tables. Afterwards the results were depicted by graphs focusing on the most significant questions for the research. Finally, conclusions were drawn and proposals were made for the influencers’ engagement in brand communication.

As for the results, all of the influencers represented more than one area. The highest number of all the analysed influencers, which is 36, represent the area of their daily lifestyle; therefore posts about what they are doing daily, celebrations, their family etc., prevail, and 25 influencers represent fashion. Most of the posts were made during December, which were 15 posts on average. Only 482 of 2769 posts made during these 4 months were dedicated to advertising a brand. The most used hash tag on the advertisement posts was the Latvian hash tag #sadarbība, which was used in total of 175 times on different posts, followed by #ad, which was used only 37 times.

The main conclusions are that during this 4 month period Latvian influencers posted only 2-3 advertisement posts on average, which is not a big amount and means that these influencers are not ambitious to maintain their fan base. This also proves that money is less important to them than giving their followers the content they are there for, which also explains why so many of these influencers love to share how they spend their every day.

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# HOMO ECONOMICUS MODEL AND ITS DEFICIENCIES FROM THE PERSPECTIVE OF BEHAVIORAL ECONOMICS

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The main purpose of the research is a description of the homo economicus model and successive comparison and addition of knowledge of behavioral economics. In the theoretical-empirical part, the emphasis is placed on the benefits of behavioral economics, which represent a response of shortcomings of mainstream economics through a more realistic model of human. The practical part is devoted to the analysis of economics experiment, whose goal is to prove that people violate selected assumptions of the homo economicus model and confirm the concept of limited rationality.

Main theoretical assumptions of human economic behavior are not compatible with real human behavior. This is mainly because the assumptions of human behavior within the homo economicus model, as traditional economics claims, are burdened with reductionism, determinism and mathematization. This gave rise to the assumption of strict rational behavior of *homo economicus* and therefore expecting of human behavior in this way, in general. In behavioral economics the main emphasis is on the concept of bounded rationality approach. The main thoughts like prospectus (value) theory, property effect, mental accounting, problem of master and administrative, role of heuristics or cognitive distortion and many others are included in the comparison with orthodox theoretical homo economicus model. There are not only microeconomic but also macroeconomic impacts of detection of behavioral economics. The way how to use behavioral economics in real economic policy is diverse.

The experiment was conducted with two groups: the first group with students from Faculty of Economics and the second one with students from high school without economic focus. The sample was selected on the basis of experiments made by many representatives of behavioral economics. The modified thought experiment was based on a modification of selected surveys made by Richard H. Thaler. There was one assignment with two parental problems: the first problem was devoted to the perception of fairness and the other problem was devoted to the phenomenon known as the Asian disease. In both cases the groups reacted in a similar way and it was shown that the intervention performed in one of the tested groups eventually led to the confirmed hypothesis: that people have limited rationality and behavioral economics approach is important to understanding why sometimes people behave in different way and why many economic models with predictions cannot work accurately in real word – because they don't include the biggest power of our behaving (what J. M. Keynes called the *animal spirit*).

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# PROBLEMATIC ASPECTS OF REAL ESTATE TAX IN LATVIA

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In 2018, the real estate tax (RET) in Latvia (LV) in municipal budgets accounted for 8% of all tax revenues and, compared to the neighbouring countries, they are by 65% higher than in Lithuania (LT) and by 287% higher than in Estonia (EE) [1, 2, 3].

The aim of the work is to develop proposals for the improvement of the legal basis of RET, using the experience of the neighbouring countries LT and EE. To achieve the goal, the following tasks were set: to study the theoretical basis of RET, to analyse the legal basis of RET in Latvia, Lithuania and Estonia, to analyse the regulations and income from RET in 3 municipalities of Kurzeme region, and to analyse the problematic aspects of RET in Latvia. The RET base in the Baltic States is different, the most significant difference is that in Estonia only land is taxed, the rate corridor in Latvia and Lithuania is similar (LV 0.2-3.0%, LT 0.5 - 4.0%), but in Estonia the rates are set by the municipalities. Comparing the benefits of RET in the Baltic States, it can be concluded that social groups at risk of poverty are more supported in LV. LT puts more emphasis on tax reliefs for agricultural activities, unlike LV, low-income and needy people are exempted from the tax in general, but EE benefits are granted to specific land units and exempt from tax are the owners of residential houses whose land under the building does not exceed 1500 m<sup>2</sup>, and in less populated areas -20,000 m<sup>2</sup>.

In all Baltic States, the principle of progressivity is applied to RET. In LV and LT it is depending on the cadastral value, but in EE- on the municipality. The biggest difference in LV, compared to the neighbouring countries, is that the tax-free minimum is not applied to residential houses (EE has a relief for land under a residential house). Basically the rates of RET does not differ significantly, in LV the highest applicable rate is 3%, LT 4% and in EE 2.5%. Comparing the significance of RET in 3 municipalities of Kurzeme region it can be concluded that the largest share of revenue in the budgets of municipalities is made up of personal income tax (Kuldīga 86%, Talsi 88% and Saldus 86%). RET makes up a smaller share (Kuldīga 14%, Talsi 12% and Saldus 13%). However, the correlation between municipal tax revenues and RET are close (Kuldīga 0.96, Saldus 0.94, Talsi 0.97), which indicates that RET forms a significant part of local government revenue. At Saldus and Kuldīga municipalities, the largest tax debtors are households, at Talsi municipality, in terms of the amount - legal entities, but in terms of the number - households. The types of benefits are different in each municipality and there is no uniform methodology for granting benefits, the amount of relief is from 25% to 90% of the calculated amount of taxes.

In order to improve the real estate tax, the Ministry of Finance would recommend introducing a minimum payment amount -the same as in LT and EE, so that when the status of a poor or low-income person is lost, the tax savings do not have to be repaid and the population does not get into additional debts. The government should first carry out the territorial reform, to freeze the cadastral values for another year and only then implement the draft law on the Ministry of Justice to be able to assess correctly changes in municipal budgets. Municipalities should establish RET administration process and methodology for granting benefits.

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# EVALUATION OF PERSPECTIVES AND LIMITATIONS ON TELEWORK

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Nowadays it is very easy to do many tasks remotely, but despite this many companies are still reluctant to implement such practices. This reluctance can partly be explained by inconclusive, unclear and contradictory conclusions. The results obtained from this research could be useful for companies that are planning to implement teleworking practices in their organization.

Although the potential benefits of teleworking have been widely considered [1], precise trends are difficult to define for a number of reasons. Firstly, the benefits and costs of working remotely are usually viewed from the employees' point of view rather than from employers'. And secondly, there is a disagreement about the forms of work organization that can be attributed to telework because of the lack of a common definition of telework.

Miniaturization of technologies, maximization of data processing capacity and telecommunication integration have helped to develop the concept of teleworking [2]. The greatest advantage of such work model is the reduction of time spent traveling to the office [3]. Traffic jams are reduced because employees no longer have to travel to the main office building to perform their job duties. Work can be done from a "virtual office" that provides business anytime, anywhere. While this increased flexibility can benefit the employer, the employee, and even society as a whole, not only the benefits but also the disadvantages of such work need to be considered before implementing any telework plan.

Managers may be hesitant to adopt teleworking practices as this affects their ability to assess and control the productivity and commitment of employees [4]. In addition, companies need to be aware that when employing workers remotely, they will still need to invest money in information and communication technologies and their maintenance in order to be able to work remotely. Of course, one cannot forget about developing appropriate policies to ensure the protection of company resources [5].

While telecommuting is not suited for everyone or the specifics of each job, given today's tight economic situation, business executives should pay more attention to cost control and the benefits of telecommuting rather than focusing on its disadvantages.

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# **THE IMPORTANCE OF DEVELOPING SOFT SKILLS FOR JOB PLACEMENT**

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Nowadays there are a lot of disputes on professional competence. However, it becomes more obvious that a person needs to obtain not only hard skills but also soft skills for building a successful career. Nevertheless, some studies show that there is an imbalance between the education system and the labor market, and, as a result, employers' requirements for soft skills do not match what students learn [1]. Thus, the aim of our research is to investigate the relevant soft skills that are essential for the labor market.

In order to determine the students' opinion on the importance of soft skills in the modern world and on the supposedly most important skills in any profession, the study was undertaken. As the method of collecting the data we chose a survey which was conducted among the final-year students of different universities in Saint-Petersburg in December 2019. For the accuracy of the results, a sample was made of five courses such as medicine, linguistics, economics, engineering and computer science.

Speaking of the outcome of the survey, we may note that the majority of the respondents (52%) considered that the leading skill for them is the ability to learn which correlates with the tendency of lifelong learning. Such skills as responsibility, critical and structural thinking and decision making were also highlighted as the most important ones in any career. The survey revealed that currently not only soft skills are important, for most professions the priority is still given to professional knowledge (hard skills), for instance, medicine and computer science.

The analyzed skills stand out in many studies as the most important, which indicates sufficient awareness of students in this matter, as well as the need for soft skills in general.

Considering the obtained results, we plan to focus on the methodology for the formation of soft skills for future workers, taking into account the market needs. Furthermore, we intend to aim the activities at creating the methodology for developing essential soft skills that will allow final-year students to boost their professional knowledge.

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# **EVALUATION OF NON-BANKING LOANS AND CREDITS IN THE FINANCIAL MARKET IN THE CZECH REPUBLIC**

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This research is dealing with the issue of non-banking loans and credits in the financial market in the Czech Republic. Many people ask themselves how it is possible that people need to borrow money from non-banking companies even if they have an occupation. This research is focused on the topic in terms of macroeconomics. It means that it is looking for a connection between the number of non-banking loans and credits in the Czech Republic and macroeconomic indicators – unemployment rate and growth of GDP of the Czech Republic.

The research is analysing data of numbers of non-banking loans and credits, unemployment rate and growth of GDP from 2008 till 2018. It is reasonable to start with 2008 because in that year one of the biggest economic crises started. Thus, we can analyse when economic cycles have some influence on the number amount of non-banking loans and credits. On the base of econometric analysis, the unemployment rate was found to affect the number of non-banking loans and credits in the Czech Republic.

The econometric analysis has proved: if the rate of unemployment increases, the amount of non-banking loans and credits increases, too. It means that if people have lost their jobs, they have lost their income. Thus, they have to find some new “money sources”. A “regular” bank does not lend them money (because they do not have any income and the bank does not trust them), and they have to ask those non-banking companies and borrow money there, requesting a higher interest rate. If people cannot find a new job, they are not capable to repay their loans, but they need money. Usually they borrow money from other non-banking companies. People are “imprisoned” in a never-ending circle. The final step is insolvency, and people usually lose all their properties. It is a problem resulting in other problems. Creditors do not get their money back, and they are not able to meet their obligations. This is a serious problem for whole economy. As we know, the unemployment rate is higher during any economic crisis. It means that economic cycles affect the number of non-banking loans and credits, but indirectly. We could say that first the economy decreases, then the unemployment rate increases, and because of that the number of non-banking loans and credits increases as well.

Now the question is, “What should we do, if we know that during a crisis the amount of those kinds of loans and credits is increasing?” Educating people in the financial area is required because a big number of people who lost their jobs used to have good income, but they were not able to save some money for the situation of unemployment. We assume the amount of a six-month salary would be enough, in case they have lost the job. Six months are also given in the analysis because in the Czech Republic, on average, people find a new job during a six month period. If people have lost their jobs, they will be able to survive at least 6 months without any need to borrow money, and they could focus on looking for a new job.

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# INTEGRATED LCA AND LCC METHOD APPROACH IN VALUATION OF SUSTAINABLE BUILDING

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Nowadays, we are increasingly confronted with environmental, economic and social challenges. Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs [1], which is viewed from an ecological, economic and social point of view. and all dimensions are equally relevant. This is an extremely important topic, especially in the construction sector, which consumes a considerable amount of raw materials and has a significant environmental impact that will be even more pronounced in the future due to climate change and increasing scarcity of resources[2].

During construction process in the decision-making phase, the choice of a technical solution for a project is often based on an economic assessment of different alternatives and investment costs, excluding long-term maintenance costs, the component life, and environmental impact. One of the solutions that would reduce overall energy consumption and CO<sub>2</sub> emissions in the industry and would be the most cost effective in the long term is integration of sustainable building guidelines into the construction processes [3].

The application of Life Cycle Assessment (LCA) method in the construction industry is used during the decision-making phase [4] as a means of improving the design of a building, eg., material and technology selection, and specific design criteria [5]. It is a powerful tool, but LCA method has several limitations, because it does not take into account the economic aspect of construction project implementation [6]. In order to strengthen the application of LCA in the construction sector, which would promote the principles of sustainable construction, a more comprehensive assessment of the environmental and economic performance of a building should be carried out, integrating both - environmental aspects (LCA method) and Life Cycle Costs (LCC).

The integrated LCA and LCC method application offers the main starting point for construction sustainability and makes it possible to compare different solutions in deciding on the long-term most economical and environmentally friendly solution.

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# **CROWD FUNDING PLATFORM DEVELOPMENT TRENDS IN THE BALTICS**

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The crowd funding industry has grown rapidly worldwide over the last decade, with an increase in both the number of platforms and supporters, mainly due to the opportunities created by the IT industry development and other changes in society habits. With the development of the industry all over the world several platforms have also appeared in the Baltic States. Some of the platforms even have successfully proven themselves as leaders within certain crowd funding models in the entire European Union. The rapid development of crowd funding industry in the European Union and the Baltics has provoked various discussions about the general legal order of the sector and has also revealed various risks, as a result of which the further industry development could be different and limited [1].

The authors have proposed a hypothesis that the rapid development of the crowd funding industry in the Baltic States is related to successful operation of certain crowd funding models and platforms which have successfully expanded its operations in Europe.

The theoretical framework of the research study is based on the analysis of statistical data, expert interviews, and scientific articles.

The results of the research have supported the hypothesis that the Baltic States revenue and overall growth is mainly due to the impact of debt-based crowd funding “Peer To Peer” platforms [1; 2]. The fast debt-based model growth in the European Union has been achieved mainly due to the lack of platform regulation in Latvia and Estonia. The platform growth has raised many questions regarding investment safety. The Baltic platform experts, mentioned in the authors’ research study, have stated that with the appearance of economic problems many of these platforms could be in trouble. Lithuania is the only country in the Baltics which has implemented a national crowd funding law in 2016. Although the growth has been slow, the platform participants are more protected due to the regulation that platforms must get an operating license. Another reason why the debt model has grown fast is the fact that one of the most popular models of financing which many people and business need usually more than once. Due to these facts, other models of crowd-funding platforms potentially still have space to grow in the Baltic States.

In order to form and unify the fast-growing crowd funding industry in the European Union and protect all stakeholders, the European Parliament and the Council of Europe should not delay the further development of regulation and it should be implemented not later than the year 2021.

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# **THE DEVELOPMENT OF GLOBAL BUSINESS SERVICES SECTOR IN LATVIA**

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Shared services and outsourcing are different sourcing strategies through which processes are transferred to an entity within an organisation or external provider that can be located anywhere [1] thus trying to identify suppliers that could deliver best possible services at the lowest possible total cost [2]. Historically main sourcing decisions have been made to access high quality, skills and capabilities for lower costs [3], but nowadays these actions are evolving and considered of having a value-adding significance as well [4]. This has mostly changed the way large organisations are working and private as well as public sector can benefit from this by being able to provide services much faster and more cost-efficiently [4]. Shared services and outsourcing are part of global business services (GBS) sector in Latvia and has reached the turnover around 300 million EUR in 2018 [5]. As this sector is considered of not being well known in public, the aim of this study is to identify the development of GBS sector in Latvia. According to the data provided by the Investment and Development Agency of Latvia (LIAA) there are more than 50 GBS centres in Latvia with 15 000 employees, and the most common functions they provide are IT, Finance & Accounting and Customer service. Latvia is still considered as having a low market saturation in GBS sector which is viewed as an attractive reason for investors to choose Latvia as a potential location for their GBS centre [6] as well as favourable business environment, educated workforce, geographic location etc. [5]. The Investment and Development Agency of Latvia has been working with GBS sector companies and inviting them to choose Riga as a place for GBS centre and Riga has already been recognized internationally as the emerging GBS location in Europe at the CEE Shared Services & Outsourcing Summit & Awards event in 2019 [6]. Due to the fact that GBS sector contributes to the economy of Latvia as well as business environment by providing a salary that is above the average in the country, modern offices, international business environment and overall good working conditions [7], several steps should be considered on how to facilitate this sector and promote the development of already existing GBS centres in Latvia.

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## **EDUCATION**

# **EXPLORATORY LEARNING IN THE FRAMEWORK OF THE NWE INTERREG PROJECT FOOD HEROES**

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Fulda University is a subpartner of the North-West-Europe Interreg project Food Heroes 2016 – 2020 (2). Food Heroes will improve resource efficiency through designing innovative solutions to reduce food waste in German region Spessart, especially from regional male chicken and male young goats. The students participated in the sensory analysis of food sciences project during the whole time. Different students worked respectively for three semesters in the project with varying tasks.

The project work over three semesters was/is strongly geared to a general sensory aim of Food Heroes and the principles of project work (3). The supervisors formulated the special aim, supervised the students and controlled the results. The students made the project task structure, set the framework requirements and planned the process – first roughly and later detailed with milestones. According the project management they structured the contents, teamwork, capacities, dates and costs, arranged duties, e.g. always changing leadership of the weekly meetings and minutes writing. For the sensory tests a hedonic acceptance test (1) was used after a sensory and hygienic training and a pre-test (4).

The students learned in practice the project management over three semesters with all parts of a professional project. They had to document continuously their tasks on a moodle platform, present the results in a poster session with the principles of a scientific poster and advertise students for a follow-up project within Food Heroes, but with another aim. In the end a report including three semesters and self reflections must be written. They learned to plan a sensory test, prepared stewed young goat meat in a test kitchen, organised the sensory test in the sensory laboratory of the university, designed the special questionnaire and evaluated the questionnaire (n = 68).

The exploratory learning for a special goat product was combined with manifold facets of the project work and sensory experiences in a sustainable regional and international project context. The specific sensory results will be presented on Eurosense 9/2020 in Rotterdam.

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# **ELEMENTS OF THE DIGITAL LEARNING ENVIRONMENT AND AGE PSYCHOLOGICAL CHARACTERISTICS OF THE TARGET AUDIENCE**

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Today, the educational paradigm is undergoing certain changes. Some of the most important changes are taking place in the design of the educational process through active implementation of online learning. According to the Digital Learning Environment Manifesto, "Old pedagogical theories wake up to find themselves in a completely new environment" [1].

We posed the following questions: how to involve older students (16-18 years old, juvenile age) in the digital learning environment so that the online learning process is both useful and interesting for them? What elements of the digital learning environment should be used? To answer these questions, the main socio-psychological and age characteristics of older students were analyzed [2] to explain some elements of online learning in the digital learning environment that correspond to our target audience.

As a result of the analysis, the following data were obtained. In the frame of online learning, it is necessary to organize the communication with both experts-teachers and peers. According to the characteristics of the target audience (older students, 16-18 years old, juvenile age), communication with peers is of great importance for the development of personality in adolescence. In addition, in communication, older students learn the life and work of adults. In addition to communication within the frame of online learning, it is important to organize reflection for students, since for older students, mental neoplasm is a deep reflection, which means paying attention to the products of one's own activity and their rethinking. The highest level of cognitive activity (according to Benjamin Bloom's taxonomy) is the level of assessment and creativity [3], and in the educational process it is very important to rise to this level. In the digital learning environment at the moment, the access to the level of assessment and creativity can be organized by introducing tasks for peer-assessment. The task may be in the form of an essay, case, project, etc. To increase the motivation for students to take the course, it is important to think over a system of badges that the student will receive for studying elements.

In conclusion, in order for the information to be better perceived by the target audience, it should be personality-oriented. We should take into account the age psychological characteristics of the target audience. Online learning tools are proposed in accordance with the age psychological characteristics to increase the effectiveness of the educational process and improve the perception of information by students.

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# **STUDENTS' MOTIVATION TO STUDY AT THE NATIONAL PLATFORM OPEN EDUCATION**

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In the modern education system, as in other spheres, significant qualitative changes are inevitable; the reason for these transformations is the development of various interactive technologies and their increasing influence on various spheres of human activity [1-3].

Peter the Great Saint Petersburg Polytechnic University has been actively developing Electronic information-educational environment (hereinafter EIEE), therefore this research was designed to study engineering students' motivation when working in EIEE "Open Polytech" and their attitude towards e-learning in general. The purpose of the research was to identify the level of students' awareness of e-learning and their main motivation to study online. The object of research was Peter the Great Saint Petersburg Polytechnic University students. The subject of the research was students' attitudes to e-learning and motivation to study online.

The characteristics of the sample are the following: 126 students from Peter the Great Saint Petersburg Polytechnic University took part in the study: 92.1% of full-time students, 6.3% of part-time students and 1.6% of evening students, of which 42.9% were women and 57.1% were men.

The results of the obtained data show that the respondents perceive the idea of studying a particular material through e-learning calmly, with interest, without negative emotions. The experience of e-learning of students indicates that the respondents regularly use e-resources in their training, while only 32.7% of the respondents have completed only one or two online courses. We can also identify a number of advantages of using electronic resources in training, which were highlighted by the results of the survey, namely: the ability to get access quickly to the useful information, while managing their time. However, we should not forget about the limitations that should be worked on: these are difficulties in getting feedback, limited opportunities for communication and the lack of external control, which was important for the respondents. In conclusion, the main motivation to complete the course for students is the programme of the university, which indicates a high level of responsibility of the university when designing online courses, since in the future students will start from the initial experience of learning online courses.

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# QUALITY OF *HYDRANGEA MACROPHYLLA* DEPENDING ON THE OVERWINTERING METHOD

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In Latvia, the overwintering can be critical for *Hydrangea macrophylla* flower buds. Latvian flower growers use different overwintering methods to get flowering plants for the next year.

The quality of overwintering of the *Hydrangea macrophylla* based on the overwintering methods used was studied. The purpose of the research was to evaluate the survival and development rate of the flower buds of *H. macrophylla* depending on the wintering method. Experiments were carried out at Latvia University of Life Sciences and Technologies in four different environments, each with a different temperature. *H. macrophylla* pots were placed in the following environments during the experiment: a greenhouse with no artificial heating, a cellar with the temperature control and an outdoor garden, in which the hydrangea root system was buried. Half of the outdoor pots were left unprotected, while the other half was covered with the garden fabric. In order to evaluate the effects of differing environments on the hydrangeas, ten buds were taken from each location. Their growth development, the stage of flower bud development and the level of reduced sugars in the *H. macrophylla* were determined three times during the overwintering period: when green leaves had fallen off in autumn, in the middle of overwintering and when the first *H. macrophylla* plant started [1,2]. Based upon the results, there was actually a relatively little variation in the rate of flower bud development between these different locations. During the overwintering time the reduced sugar level decreased in all *H. macrophylla* plants no matter which environment the plants were held in. The cause of this lack of diversity is most likely due to the abnormally high temperatures during the winter. Due to this condition, it cannot be claimed that the results accurately portray the actual effects of different overwintering methods in Latvia.

## References

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# DIVERSITY OF VIRULENCE BETWEEN AND WITHIN *BOTRYTIS* SPECIES

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The *Botrytis* species complex of *B. cinerea*, *B. fabae*, *B. fabiopsis* and *B. pseudocinerea* are the causal agents of chocolate spot – one of the most severe faba bean diseases [1]. The fungi of the genus *Botrytis* have a large morphological diversity between and within the species [2], which can possibly affect also their virulence. The aim of this research was to determine the rate of mycelium growth on medium for different *Botrytis* species that are causal agents of chocolate spot in Latvia, as well as the virulence of these isolates on faba beans in controlled conditions.

An isolate collection was created from infected faba bean leaf and seed samples during 2014–2016. The species of genus *Botrytis* (*B. cinerea*, *B. pseudocinerea*, *B. fabae*, and *B. fabiopsis*) were identified by molecular-genetic methods [1]. Pure cultures of pathogens were obtained on potato dextrose agar and purified using isolation of hyphal fragments. Isolates were incubated at 20 °C with a 24-h dark cycle. An experiment on *Botrytis* isolate growth rate was made with four replications, and the growth rate (in mm) of *Botrytis* colony diameter was recorded after 24 h, 48 h, and 72 h. Isolate pathogenicity tests were run with two variants (A – injured faba bean leaves; B – non-injured faba bean leaves) in four replicates. Infected leaf area (%) was determined after 24 h and 72 h. The composition of isolated *Botrytis* species was determined using morphological and molecular methods. A one-way analysis of variance was performed by using R free software.

The research demonstrated a significant ( $p < 0.001$ ) difference between the species' growth speed in the medium: *B. fabiopsis* was the fastest growing species – on average 0.753 units, followed by *B. fabae* – 0.655 units, *B. pseudocinerea* – 0.588 units, and *B. cinerea* – 0.449 units. Virulence tests ( $p < 0.001$ ) on non-injured leaves after 72 h showed *B. pseudocinerea* was the most virulent *Botrytis* species of faba beans – with the average infected area of 15.57%, followed by *B. fabae* – 13.93%, *B. cinerea* – 11.69%, and *B. fabiopsis* – 2.73%. The variant with injured faba bean leaves after 72 h yielded similar results: *B. pseudocinerea* had the biggest infected leaf area – 32.69%, *B. fabae* – 26.70%, *B. cinerea* – 25.55%, and *B. fabiopsis* – 9.28%. Out of all researched species only *B. fabiopsis* had more significantly different virulence on injured leaves than that of other three species while there was no significant difference between them. On non-injured leaves, the virulence of *B. fabiopsis* significantly differed from that of *B. pseudocinerea* and *B. fabae*, while the virulence of *B. cinerea* did not significantly differ from that of other species.

The research data yielded interesting results, however, additional data and experiments are required to make final conclusions about genus *Botrytis* diversity and virulence between and within species on faba beans.

## References

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