

BioPhys

SPRING

BioPhys Spring 2026

25th International Workshop for Young Scientists

Book of Abstracts

28th–29th May 2026

Prague, Czech Republic

25th

EDITION



CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

***25th International Workshop for Young Scientists
“BioPhys Spring 2026” - BOOK OF ABSTRACTS***

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SPRING

*25th International Workshop for Young Scientists
“BioPhys Spring 2026”*

BOOK OF ABSTRACTS

to be held
**on 28th–29th May 2026 in Prague
Czech Republic**



Ministry of Agriculture
of the Czech Republic

*BioPhys Spring 2026 is held under the auspices
of the Minister of Agriculture, Ing. Martin Šebestyán, MBA*



Czech University
of Life Sciences Prague

*and under the auspices of prof. PhDr. Michal Lošťák, Ph.D.,
Rector of the Czech University of Life Sciences Prague*



Ing. Martin Šebestýán, MBA
ministr zemědělství

uděluje

z á š t i t u

25. ročníku akce

**„International Workshop for Young Scientists
BioPhys Spring 2026“**

*konanému ve dnech 28.–29. května 2026
na České zemědělské univerzitě v Praze*

A handwritten signature in blue ink, appearing to read 'Šebestýán'.

Praha, březen 2026



prof. PhDr. Michal Lošťák, Ph.D.

rektor České zemědělské univerzity v Praze

uděluje

ZÁŠTITU

nad akcí

**„BIOPHYS SPRING 2026
25th INTERNATIONAL WORKSHOP
FOR YOUNG SCIENTISTS“**

V Praze dne 6. března 2026

Co-organizers:



Dear friends and colleagues,

It is our privilege and great pleasure to invite you, on behalf of organising institutions – the Czech University of Life Sciences Prague (Czech Republic), together with Slovak University of Agriculture in Nitra (Slovakia) and Hungarian University of Agriculture and Life Sciences, Gödöllő (Hungary), Institute of Agrophysics of Polish Academy of Sciences, Lublin (Poland), Institut Teknologi Nasional Bandung (Indonesia) to participate in the 25th International Workshop for Young Scientists "BioPhys Spring 2026" to be held in Prague on 28th – 29th May 2026.

The workshop is oriented on the deeper insight into the physical processes occurring in biological, agricultural and food systems. The workshop combines two basic tasks of international meeting: the exchange of professional experience and integration of young people from different countries. We cordially invite young scientists to participate in the BPS 2026 Workshop and to present results of your research in application of physical methods to agriculture, biology and/or life sciences.

The workshop is organised as an open English spoken event. Two page abstracts of contributions will be published in the Proceeding of Abstracts of the BPS 2026 Workshop. It is my pleasure to invite you to spend a few days of May 2026 in a friendly atmosphere between young people in Prague.

Martin Libra

Chairman of the Organising Committee

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Rapid Five-Year Repowering of Photovoltaic Power Plants in Demanding Climates

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Keywords: photovoltaics; repowering; revamping; reliability; insulation resistance; wet leakage; dew; delamination; polydimethylsiloxane (PDMS); circular economy; PV waste

Photovoltaic (PV) plants are typically assessed using ~25-year financial horizons and 25–30-year module performance warranties. However, experience from demanding climates shows that actual lifetimes can be shorter and that dry-condition insulation tests may underestimate risks under wet operation. In such cases, repowering after roughly five years can restore energy yield and reduce operational faults, but it also creates repeated waves of waste and increases manufacturing demand. This study synthesizes evidence on moisture-induced insulation loss, backsheet degradation, and delamination-driven failure escalation and complements it with a transparent 30-year scenario comparing module replacement every 5, 10, and 30 years. The findings suggest that humidity-dependent ground-impedance deterioration, frequent inverter trips, delayed morning start-up, and shutdown risks can emerge within about five years at challenging sites, while dry testing may fail to capture these issues. In a severe scenario, five-year repowering requires six full module sets over 30 years, significantly increasing waste volumes and pressure on manufacturing and recycling systems. Therefore, PV sustainability assessments should reflect the effective repowering interval rather than nominal warranties. Promising solutions include repowering-ready, disassemblable module designs, such as those using soft PDMS gel encapsulation.

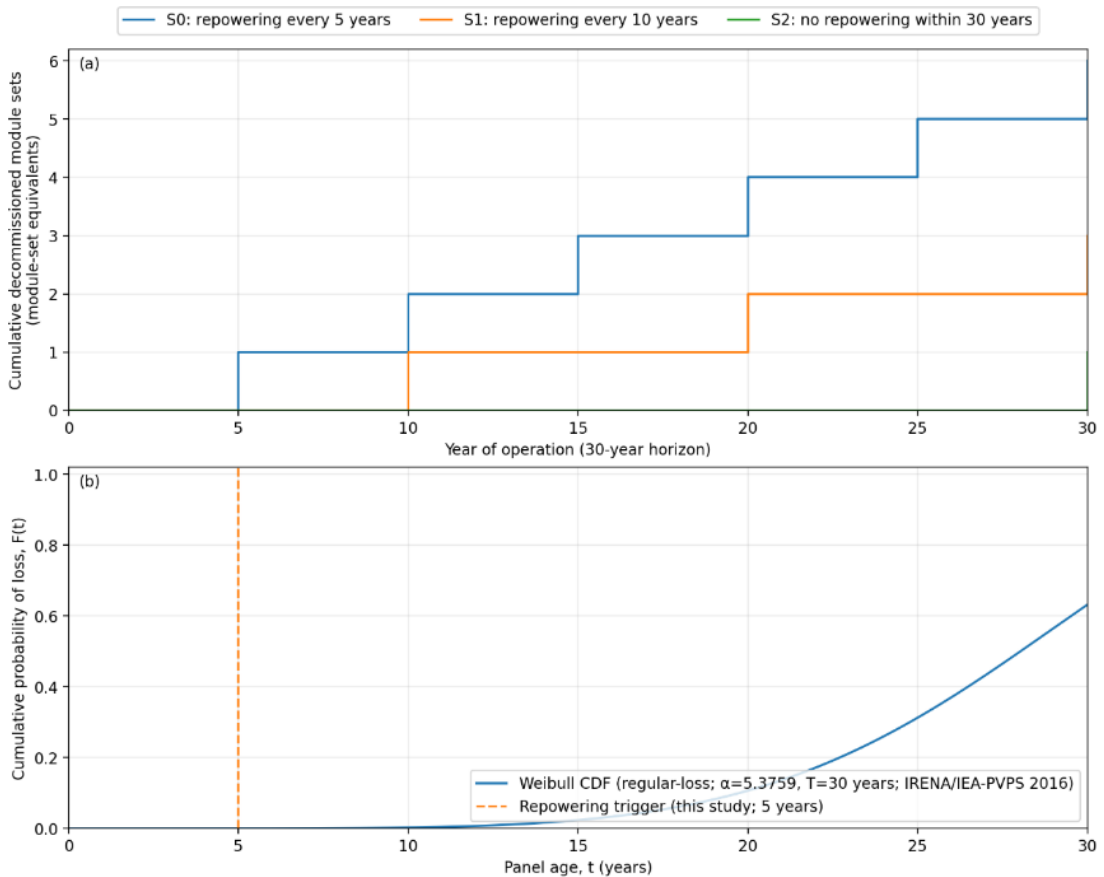


Fig. 1. (a) Weibull-based reference curve with the repowering trigger used in S0 (5 years, dashed line). (b) Stylized cumulative waste over 30 years expressed in module-set equivalents, with step increases at replacement event years [2]

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Housing technologies and their effects on welfare and health in growing rabbits

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Keywords: welfare, housing systems, enrichment, social stress, bone quality

Housing technologies are among the most important factors influencing welfare, health status, and behavioural expression in growing rabbits reared for meat production. Increasing societal pressure for welfare-friendly production systems has stimulated research focused on alternative housing technologies, environmental enrichment, and group housing systems. This contribution aimed to summarise the effects of selected housing technologies on behavioural, physiological, and health-related welfare indicators in growing rabbits.

Flooring systems represent a key technological factor directly affecting locomotion, hygiene, resting comfort, and foot health. Available studies indicate that plastic slatted floors generally improve behavioural comfort and reduce the occurrence of foot lesions compared with wire flooring systems, while simultaneously maintaining acceptable hygienic conditions. In contrast, litter-based systems may increase contamination and hygiene-related risks under intensive production conditions.

Multilevel systems and elevated platforms increase usable space and support locomotor activity and behavioural diversity. Rabbits housed in pens or systems equipped with platforms showed improved skeletal development, including greater bone mass and fracture resistance. However, these systems were also associated with increased aggression, injury prevalence, and hygienic challenges or under unstable social conditions.

Environmental enrichment technologies, particularly gnawing sticks and mirrors, modified behavioural expression and reduced some abnormal and frustration-related behaviours. Gnawing objects decreased bar biting and cage manipulation, whereas mirrors increased exploratory activity, especially during early growth stages. Nevertheless, physiological stress responses to

enrichment remained inconsistent and strongly dependent on housing and management conditions.

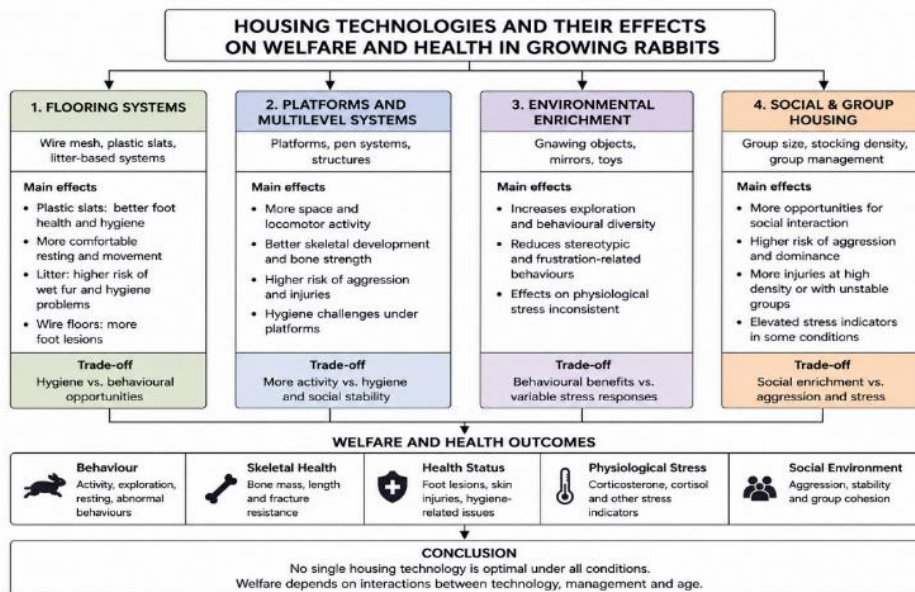


Figure 1. The effect of housing technologies on rabbits' welfare and health

The reviewed evidence demonstrates that no single housing technology can fully optimise rabbit welfare. Technologies improving locomotion and behavioural expression may simultaneously increase aggression, social stress, or hygiene-related risks. Welfare-oriented rabbit production, therefore, requires balanced housing technologies that integrate flooring design, space allowances, environmental enrichment, and appropriate social management in relation to animal age and production stage.

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Integrated Sustainability and Corporate Social Responsibility: The Strategy and "Living Laboratory" of the Czech University of Life Sciences Prague

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Keywords: Sustainability Strategy 2025+, ESG Reporting, Blue-Green Infrastructure, Biodiversity, UI GreenMetric, Circular Economy

The Czech University of Life Sciences Prague (CZU) has firmly established itself as a national leader and a significant international actor in the field of sustainable development. In 2025, the university defended its first-place ranking in the Czech Republic in the UI GreenMetric World University Rankings among more than 1,700 participating institutions. This achievement reflects the successful implementation of the **Sustainability Strategy**, which integrates environmental, social, and economic responsibility into five key pillars: governance, research/education, operations, social cohesion, and external partnerships.

As a Social Responsibility Manager, this presentation details how CZU navigates the transition from theoretical goals to measurable impacts. A central component of this transition is the university's commitment to **ESG (Environmental, Social, and Governance) transparency** and the preparation for reporting in accordance with the Corporate Sustainability Reporting Directive (CSRD). Governance at CZU is further supported by the **HR Award** for excellence in research management and a robust **Gender Equality Plan** (project AGRIGEP), which fosters diversity and wellbeing within the academic community.

From a biophysical and operational perspective, the CZU campus serves as a **"living laboratory"** for climate change adaptation. With 75 % of the 43.7 - hectare campus consisting of green space, the university has

implemented extensive **blue-green infrastructure** (BGI). Key technical achievements include the operation of 15 rainwater retention systems, 9 buildings with green roofs, and the generation of 74,836 kWh of solar energy in 2025 from on-site photovoltaic systems. These measures are complemented by systematic biodiversity monitoring and the restoration of migration corridors and pollinator habitats.

Furthermore, CZU emphasizes **circular economy principles**. In 2024, the university ecologically processed 3,542 kg of e-waste, resulting in significant savings in primary raw materials and CO₂ emissions. Social innovation is driven by the **Point One incubator**, which currently supports over 30 ESG and "green" startups, and the unique **Food Pavilion**, which bridges the gap between agricultural technology and sustainable food processing for the public.

This presentation concludes that CZU's success lies in its holistic approach — combining cutting-edge technical infrastructure with a strong social mandate — thereby providing a scalable model for sustainable institutional management in the 21st century.

The 4th generation university: How to Implement it in the Energy Field on the Visegrád Four+ Partnership

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Keywords: scientific exchanges, entrepreneur activities, societal impact

The partnership and collaboration of Institut Teknologi Nasional Bandung (ITENAS Bandung) – Indonesia, and 4 (four) universities in the Visegrád Four (V4) countries, i.e., Czech University of Life Sciences Prague (CZU) – Czech Republic, Slovak University of Agriculture in Nitra (SUA) – Slovakia, Institute of Agrophysics – Polish of Academy Sciences (IA-PAS) – Poland, and Hungarian University of Agriculture and Life Sciences (MATE) – Hungary, have been implemented and have a long history, especially in view of scientific exchanges. This great collaboration was initiated by the partnership between ITENAS Bandung and MATE, which was established in 2007. Furtherly, the partnership between ITENAS Bandung and four universities in the Visegrad Group can be claimed as the Visegrád Four+ (V4+) partnership (in point of view ITENAS Bandung side).

It's fact that in line with trends digitalization and automation of industrial processes through the integration of advanced technologies like the internet of things (IoT), artificial intelligence (AI) and machine learning, big data, cloud computing and analytics, etc., the university transformation was moving tremendously at the moment (relates to the 4th industrial revolution).

The 4th generation universities (The 4GU) can be defined as the role of higher education in an increasingly complex world. Moving beyond education and research, the 4GU mostly focuses on entrepreneurship, innovation ecosystems, and deep engagement with industry and society. The idea is that these global universities embrace local innovation with the aim of tackling societal challenges and driving regional economic growth (TU/e, 2024). In the implementation level, the 4GU combined some aspects such as teaching, research, knowledge exchange, and entrepreneurial activities, directly under the same umbrella, rather than as separate umbrellas. In this term, collaborative partnerships to drive sustainable growth and have an impact on the societal/environments, are really important (Rusirawan et al., 2025).

In this work, some topic discussion about how to implement the 4th generation university will be elaborated, especially on the university itself and how to increase the ecosystem collaboration on the thematic field energy. Past and current works (include research activities) will be evaluated as collaborative partnership elements and conduct to the characteristics of the university generation.

Acknowledgements:

The synopsis of this scientific work is presented in the workshop as one of the partnership implementations between Institut Teknologi Nasional Bandung (Indonesia), Slovak University of Agriculture in Nitra (Slovakia), Institute of Agrophysics – Polish of Academy Sciences (Poland), Czech University of Life Sciences Prague (Czech Republic), and Hungarian University of Agriculture and Life Sciences, Gödöllő (Hungary).

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Agricultural landscape and climate – is there a connection?

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Keywords: solar radiation distribution, vegetation cover, evapotranspiration

The sun is the main source of energy for life on Earth and drives number of natural processes. Solar radiation entering the upper layers of the Earth's atmosphere is characterized by the so-called solar constant, the average value of which reaches 1367 W m^{-2} . However, when passing through the atmosphere, the radiation flux is significantly weakened. The total intensity of radiation falling on the Earth's surface is referred to as global solar radiation. In Central Europe, reaches values of up to 1000 W m^{-2} under clear summer skies, while under high cloud cover its intensity drops to low tens of W m^{-2} . And what happens to this radiation on Earth and how is it transformed? The distribution of solar radiation on the Earth's surface can be expressed using the so-called radiation and energy balance (Fig. 1).

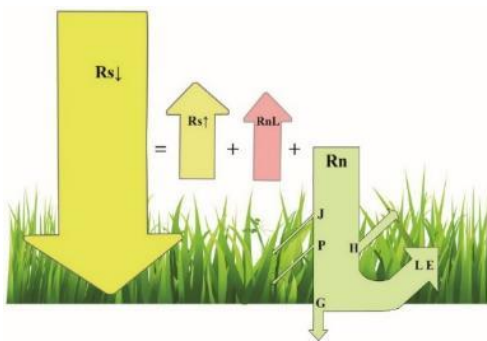


Fig. 1 Scheme of the radiation balance of a vegetation. The main fluxes can be measured with a netradiometer: short-wave incident solar radiation ($R_{s\downarrow}$), reflected short-wave solar radiation ($R_{s\uparrow}$) and long-wave radiation emitted by the earth's surface into the atmosphere (R_{nL} = net long wave radiation). The "rest" consists of the so-called net radiation (R_n), which in vegetation is mainly bound to water evaporation as latent heat of evaporation (LE), partially heats the surface (H = sensible heat) and the soil (G = ground heat flux). A very small proportion of solar energy (at most 1%) is bound to biomass (P) through

photosynthesis and heats the biomass of the vegetation (J). (modified, Huryna et al. 2014, Ryplová et al. 2025).

Land cover plays a key role in the distribution of solar energy. By managing vegetation and water, humans change the way how solar energy is converted. The distribution of solar energy falling on the Earth's surface is different in landscapes covered with green vegetation that is supplied with water (forests, wetlands) and in drained landscapes without vegetation cover (ploughed fields, paved surfaces). The energy balance of these areas on a sunny day can vary by hundreds of W m^{-2} , with the key factor being the ratio between sensible heat (H) and latent heat of evaporation (LE). Plants and solar radiation are primarily associated with the process of photosynthesis. However, less than 1% of the solar energy is consumed for photosynthesis, while 40–50% is consumed for evapotranspiration, which is mediated by plants. Evapotranspiration performs a dual thermoregulatory function in the landscape: while evaporation and transpiration cool the surface, the subsequent condensation of water vapor releases heat, which contributes to equalizing temperature gradients.

The atmosphere dampens the flux of long-wave radiation (heat). The main role is played by water and its content in the atmosphere (up to 4 %), which changes. Changes in the content of water vapor in the atmosphere are reflected in the input of solar energy (cloudiness) and the flux of heat from the earth's surface to the atmosphere. These processes can be measured, explained and understood using the laws of physics. Due to rapid phase changes, the greenhouse effect of water vapor is not modelled, therefore its influence on the climate is more or less neglected and underestimated. The water content in the atmosphere also plays a crucial role in protecting agrosystems, for example in Central Europe, where condensation processes and increased air humidity during the spring months mitigate radiative cooling and reduce the risk of crop damage by late frosts. However, its content has been decreasing in the (at least) last decade (cloudiness is decreasing), the greenhouse effect is decreasing, which is reflected in the increased flux of longwave radiation from the surface to the atmosphere and the increase in global radiation (Wild 2009; Pokorný et al. 2023; Jirka et al. 2021).

The main fluxes of solar energy distribution on the Earth's surface can be measured directly using telemetry meteorological stations. The distribution of solar radiation in the landscape is also related to the surface temperature. The surface temperature is a characteristic that indicates the way of solar radiation dissipation on the Earth's surface. It can be deduced from it which component

of heat will prevail - whether sensible heat, which heats the environment (manifested as a high temperature) or latent heat, which is consumed for water evaporation and therefore cools the environment (manifested as a low temperature). Physically, this is the radiation temperature, which is the result of the radiation of each body/surface (driven by Stefan-Boltzmann law). Systems for detecting thermal electromagnetic radiation can be used to measure the surface temperature. Either classic thermal imaging cameras (ground measurements, aerial or UAV carriers) or scanning systems on satellite carriers.

So how can the agricultural landscape influence the climate? Land cover plays a key role in the distribution of solar energy. Farmers and foresters farm 85% of the Czech Republic and determine what happens to solar energy. If solar energy is not used to convert water into vapour, it turns into heat. Warmed air accelerates the evapotranspiration and landscape drainage. On the contrary. In the landscape, we need to maintain water natural (not hot air driven) evaporation for its cooling and have many cool condensation areas for the formation of clouds and precipitation. Lower evapotranspiration does not compensate for the moisture deficit of the area, but on the contrary leads to intensive overheating of the landscape. Fields change their surface temperature depending on the type and condition (phenological phase) of the crop. Growing crops are cooled by evapotranspiration, while harvested fields without catch crops are overheated (to more than 50 °C) because they are not cooled by water evaporation. A harvested field in a hot summer has a similar temperature to an asphalt surface (Hesslerová et al.2013). These overheated areas in the landscape are a source of warm air upward movement that further dries out the landscape, and condensation and precipitation do not occur over them. The ability to “thermoregulate” decreases significantly with the degree of maturity of the crops, and after harvest, the agricultural landscape becomes one of the causes of drying out. To give you an idea of how much energy is involved. For the evaporation of 1 l of water at 20 °C, 2450kJ \approx 0.68 kWh is consumed. If 1 liter of water evaporates from 1 m², 0.68 kWh of solar energy is consumed, and no sensible heat is released. In August, approximately 14,000 km² of land (18% of the territory of the Czech Republic) is harvested, on which evapotranspiration decreases. A decrease in evapotranspiration per km² of 1 mm/day means that 1,000,000 liters of water will not evaporate and 0.68 GWh of energy will be released into the environment in the form of heat. In the case of all harvested fields, we have a value of 9,520 GWh. And if we add that we are losing 11 ha of agricultural land per day, which is being turned into built-

up areas of shopping zones, or we are losing large areas of forest, we have even higher numbers (Ryplová et al. 2025).

Through appropriate landscape management, the distribution of incident solar radiation can be effectively influenced, by enhancing the latent heat of evaporation at the expense of sensible heat. Land cover and the implementation of water retention measures are key tools for the active regulation of the energy balance of the territory. They serve as an effective mechanism for mitigating local and regional climate fluctuations and stabilizing the temperature regime of the landscape.

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PV panels deposited on agricultural land after the end of life: ecological consequences

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Keywords: photovoltaic waste, agrivoltaics, agricultural land sealing, PV panels recycling

Ground-mounted photovoltaics are increasingly deployed on agricultural land, including agrivoltaic concepts. In practice, damaged modules from repowering are sometimes stored on-site for prolonged periods, creating localized vegetation suppression and land-stewardship concerns that are rarely quantified. We deal with two anonymized case studies from Czech Republic (nominal capacities 0.861 MWp and 1.109 MWp; commissioned 2010 and 2009; repowered 2022 and 2021) where cracked backsheets and/or broken front-glass modules were stacked and stored directly on grassland within PV parcels. Using GIS delineation on orthophotos supported by field photographs, we quantified land area (19,560 and 22,100 m²), PV panel area (plan-view; 4,960 and 5,080 m²), and Stored PV module area (plan-view storage footprint; 109 and 100 m²). Stored module counts were estimated from visible stacks (\approx 1800 and \approx 2000 modules). Using a conservative mass range of 18–25 kg/module, stored masses were \sim 32–45 t and \sim 36–50 t, respectively. Although storage footprints were $<$ 1% of Land area, they create persistent “dead zones” on agricultural land and concentrate tens of tonnes of material directly on soil. We are looking for regulatory and economic barriers to timely removal in the context of circular-economy goals [1] and for practical reporting indicators for repowering projects on agricultural land: A_{store} (m²), N_{store} (pcs), M_{store} (t), storage duration, condition class, and storage interface.

We interpret on-site storage on farmland as a practice–policy gap relative to EU WEEE circular-economy goals and recommend minimal, low-cost reporting indicators (A_{store} , N_{store} , M_{store} , storage duration, condition class, and storage interface) to make the issue visible and actionable in

repowering projects. Increasing capacities for recycling of PV panels after the end of their life is necessary [2].



Fig. 1. PV panels deposited on agricultural land after the end of life.

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The new model for predicting PV power plant electricity production based on weather forecast

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Keywords: photovoltaics, machine learning, neural network

This study presents a hybrid deep learning framework, integrating Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) layers, for high-precision short-term photovoltaic (PV) power forecasting. While the CNN component identifies local spatial features and short-term meteorological correlations, the LSTM layer effectively captures long-term temporal dependencies and seasonal periodicities. The model was integrated into a web-based application [1] and validated during a two-year operational period (2024–2025). Utilizing high-resolution numerical weather prediction data from the Open-Meteo service, the framework demonstrated superior predictive accuracy for horizons of 24 to 72 hours (see Fig. 1 as an example). Our findings highlight the model's capacity to facilitate retrospective performance analysis by comparing theoretical versus actual yields. Given the volatility of European spot market pricing, this predictive tool offers significant economic utility for plant operators by optimizing grid integration and energy trading strategies.

The results provide a practical framework for the operational planning and optimization of PV systems. By improving the reliability of energy supply forecasts, this work offers direct economic benefits in the estimation of spot prices [2] and the stabilization of distribution networks within the renewable energy sector.

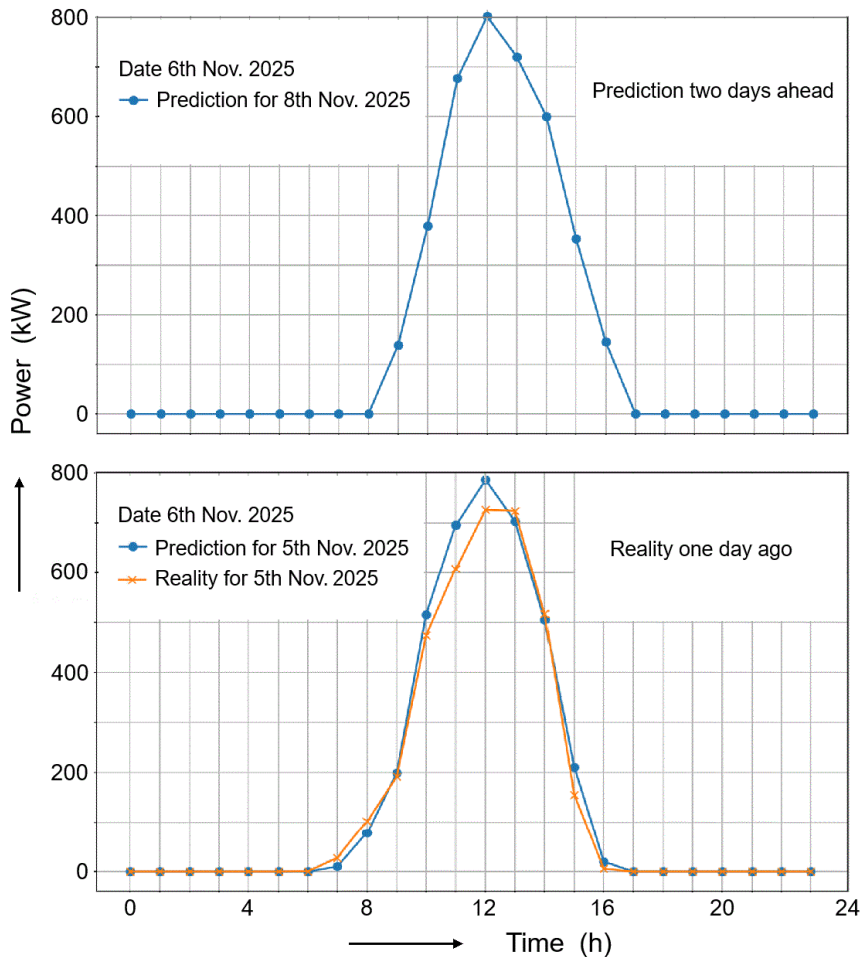


Fig. 1. For the date 6th November 2025, the predicted power for two days ahead and reality one day ago.

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Statistical Evaluation of Photovoltaic Panel Degradation in the Czech Republic

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Keywords: photovoltaics, photovoltaic panel, degradation, pyranometer

The amount of incoming solar radiation has a fundamental impact on the actual power output of photovoltaic power plants (hereinafter PV power plant). Solar irradiance exhibits temporal variability. In the short term, this variability is primarily caused by seasonal weather-related effects. In the long term, the dominant influences on solar radiation intensity are changes in the solar constant and overall climate change. The panels of PV power plants undergo degradation over time due to weather conditions and other factors, which reduces electricity production [1]. When examining data on the power output of real PV power plants, however, this experimentally proven degradation is usually not detectable. This may be caused both by changes in the amount of incoming solar radiation and by consistent maintenance and replacement of the originally degrading components. However, maintenance records are usually unavailable; therefore, it was necessary to make maximum use of the available climatic data and compare them with electricity production data.

Within the conducted study, data were collected from a total of 130 PV power plants in the Czech Republic. The obtained time series range in length from 3 months to 15 years. Detailed analysis was performed only on data from those PV power plants for which sufficiently long continuous time series of at least 8 years were available. The collected data were paired (see Fig. 1) with official monitored data from nearby pyranometers operated by the Czech Hydrometeorological Institute (hereinafter CHMI). The primary criterion for the calculations was to identify the maximum correlation between the CHMI pyranometer data and the PV power plant output on a month-by-month basis.

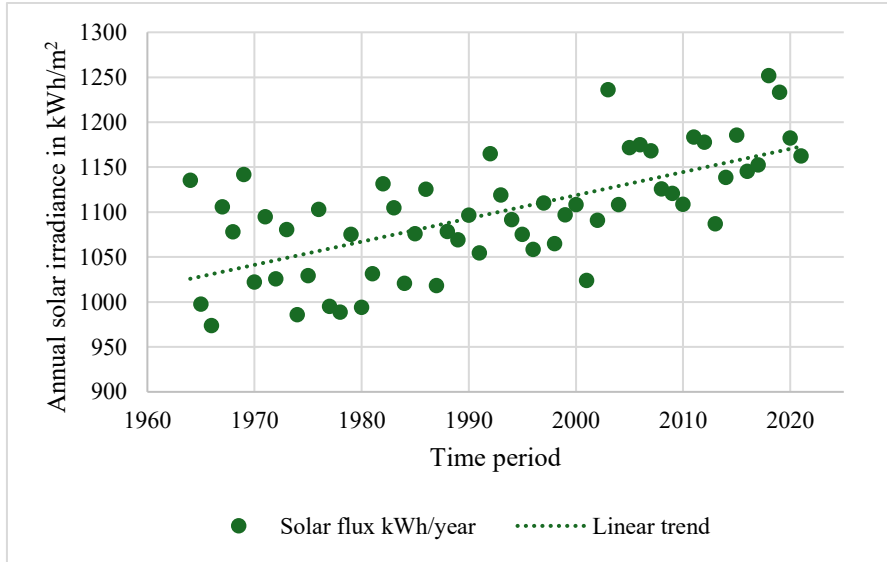


Fig. 1. Annual totals of incoming solar irradiance at the Hradec Králové meteorological station in the years 1964–2023, expressed in kWh/m². (Values from leap years were adjusted using the 365/366 ratio.).

The results indicate that panel degradation is statistically insignificant for most of the examined photovoltaic power plants. This is inconsistent with experimental data obtained from panels installed under controlled conditions. Therefore, raw production data from commercial projects cannot be readily used to determine the actual lifetime of future PV power plant projects.

Given that energy generation through photovoltaic power plants will continue to play a key role in addressing major challenges such as climate change, global warming, and air pollution [2], considerable attention should be devoted to this issue.

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New Czech hop varieties as a response to climate change in hop cultivation

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Keywords: beer quality, climate change, hop, new hop varieties

Hop cultivation in the Czech Republic, particularly in the traditional Saaz region, faces increasing challenges associated with climate change. Rising temperatures, irregular precipitation patterns, prolonged drought periods, and increased frequency of extreme weather events significantly affect both yield stability and the qualitative parameters of hop cones, especially alpha bitter acids and essential oils. Long-term observations reported by the Hop Research Institute in Žatec indicate a gradual decline in yields and increased variability in brewing quality under recent climatic conditions (1, 2).

Traditional Czech varieties such as Saaz are highly valued for their fine aroma profile, but they are also sensitive to water stress and high temperatures. As a response, breeding programs have focused on developing new Czech hop varieties with improved stress tolerance while maintaining desirable brewing characteristics. Among these, varieties such as Eris, Pluto, Ceres, and Saaz Shine represent a new generation of hops combining higher resistance to drought and diseases with stable yields and distinctive aromatic profiles (3).

Our study evaluates the agronomic and technological potential of these new varieties under changing climatic conditions. Data from experimental plots and pilot cultivation trials were combined with brewing tests conducted in cooperation with Research and Teaching microbrewery Suchdolský Jeník. The results indicate that the new varieties achieved higher stability of yields under drought conditions, with an increase in water use efficiency on the order of 10–20% compared to traditional varieties. Furthermore, a lower reduction in yield under heat stress conditions was observed, typically by 15–25% relative to standard cultivars. These findings are consistent with previously reported

trends in hop breeding and climate adaptation (1, 3). At the same time, sensory analysis of experimental batches beer confirms their suitability for modern brewing applications, including both traditional lager production and innovative beer styles.

The incorporation of new hop varieties into practical brewing demonstrates an important pathway for adapting the hop sector to climate change. Recent studies further emphasize the urgency of these adaptation strategies, reporting projected declines in hop yields by 4–18% and reductions in alpha acid content by up to 20–31% under future climate scenarios (4). Additionally, the increasing frequency of compound drought and heat events has been identified as a key factor negatively affecting both yield and quality in major European hop-growing regions (5). These findings highlight the importance of combining varietal innovation with optimized agronomic practices, including irrigation management and climate-resilient cultivation systems. Future research will focus on optimizing cultivation practices, irrigation strategies, and further evaluation of brewing performance under industrial conditions.

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A Review of Modular Solutions for Robotic Manipulators in Agriculture

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Keywords: robots, distributed control, modularity, edge computing, griculture 4.0

Using robotic manipulators for only seasonal tasks poses an economic risk due to the fixed capital costs of the hardware. The limited deployment period during harvest extends the return on investment. To ensure an economic return, robotic platforms must be deployed for multiple purposes through the interchange of end-effectors for agrotechnical operations at various plant growth stages [1]. Task diversification, including selective harvesting, localized spraying, and pruning, requires physically exchanging end-effectors with different load-bearing capacities and stiffness parameters.

This variability defines the technical parameters of the connecting interface. The industrial standard for mechanical joints ensures kinematic positioning and allows the passage of electrical power and pneumatic pressure. However, environmental resilience is limited in agricultural applications. Biological stress, temperature fluctuations, dust, and humidity degrade the reliability of standard industrial connectors, necessitating specialized, sealed interfaces [3]. Furthermore, processing data from integrated sensors (e.g., RGB-D cameras and strain gauges) requires the end effector to operate in edge computing mode. Shifting computational capacity to the end tool reduces network latency and limits the computational load on the manipulator’s central control system. [4].

The distributed architecture of modular manipulators requires high data throughput and temporal determinism. Processing images directly on the tool requires a real-time data connection. Deploying control based on visual servoing enables adaptive responses to dynamic agricultural environments. However, the practical implementation of this method is hindered by the closed

architecture of traditional manipulators. Industrial robot controllers act as an intermediate layer, blocking direct access to the robot's joint control loops. They receive kinematic instructions with latency, which prevents high-frequency path corrections. Overcoming this limitation requires transitioning to open control architectures. The connection of the manipulator's physical and computational layers requires the use of industrial buses like EtherCAT [2]. Frameworks are used for the temporal synchronization of distributed sensors and control agents. The standard is the ROS 2 system, which natively implements Data Distribution Service middleware and provides Quality of Services guarantees [4].

However, current practice lacks a standardized architecture for connecting end-effectors using the "plug-and-work" method. Safe system reconfiguration requires a defined sequence of mechanical locking, electronic tool identification, automatic loading of kinematic and dynamic parameters, and initialization of software nodes, eliminating the need for programmers to modify robot code [2]. However, developing effectors in isolation without a unified communication layer requires manual intervention in the code. This process prolongs machine downtime and reduces operational reliability [1, 2].

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The effect of the indoor environment in poultry fattening halls on the productivity of poultry

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Keywords: microclimate, temperature-humidity index (THI), poultry performance

The quality of the indoor environment in poultry houses directly determines not only the welfare of animals, but also their performance and the overall economic profitability of the fattening process. This work focuses on assessing the impact of heat stress on animals through the temperature-humidity index (THI), which serves as a key indicator for quantifying heat stress [1]. This work aims to analyze the connection between the indoor environment and poultry productivity and well-being to find new ways for optimizing technical solutions for poultry houses. Furthermore, the study explores the potential of using these findings to improve real-time monitoring systems and precision microclimate control. The main goal is to enhance animal well-being while supporting the sustainable development of modern livestock production through advanced technological integration.

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Targeted applications of liquid substances in plant nutrition

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Keywords: targeted application, plant nutrition, injection fertilization, CULTAN, winter wheat

Current agriculture is undergoing a period of adaptation. Farmers are currently facing both environmental challenges and the need to adapt to legislative changes and restrictions. In particular, agriculture within the European Union is under increasing pressure to reduce the application of chemical substances. These factors, together with many others, lead farmers to seek new technologies or to reintroduce older ones that may contribute to reducing application inputs. The issue addressed by this research is the amount of applied fertilizers and the costs associated with them. In the case of injection fertilization, the main benefit lies in the potential reduction of nitrogen fertilizer inputs and in more efficient nitrogen utilization by plants [1].

This research evaluates the results of a field experiment in which injection application of the liquid nitrogen fertilizer DAM 390 (see Fig. 1) was used within a single field to a depth of up to 7 cm. This method of application is based on the principle of localized nitrogen placement into the soil, which is described in the literature in connection with CULTAN technology [2]. For evaluation, data from injected fertilizer doses ranging from 50 to 250 l·ha⁻¹ were compared with conventional spray application at a dose of 130 l·ha⁻¹. During crop evaluation, plant samples were collected successively and subjected to chemical analysis. These analyses showed an increasing content of nitrogen compounds in the plants; at the first assessment, a higher nitrogen content was observed in the sprayed variant, but in the following assessment some of the injection-treated variants were evaluated more favorably in terms of nitrogen content. Yield parameters were then assessed both during the pre-harvest crop evaluation and at harvest itself. The results showed that, under the conditions of the monitored field, yield increased in the plots treated by injection at doses ranging from 100 to 250 l·ha⁻¹ (see Tab. 1). In terms of

achieved yield, the variant with a fertilizer dose of 200 l·ha⁻¹ appeared to be the most effective. The results therefore indicate that injection application of DAM 390 fertilizer may represent an effective alternative to conventional spray fertilization under the observed conditions.



Fig. 1. Bednar NEVEON injection applicator.

Tab. 1. Yield assessment of the harvest from the studied plots

DAM rate (L/ha)	Dry yield (t/ha)
50 (Neveon)	6,239
100 (Neveon)	6,506
150 (Neveon)	6,527
200 (Neveon)	6,686
250 (Neveon)	6,385
130 (Sprayer)	6,279

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Enhancing municipal solid waste management in Douala through system analysis and sustainable strategies

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Keywords: Municipal solid waste management, material flow analysis, circular economy, urban sustainability

A large share of rapidly growing African cities struggles with inefficient municipal solid waste management (MSWM) systems. Our evaluation of the MSWM system in Douala shows that, despite a long-standing public-private partnership with Hygiène et Salubrité du Cameroun (HYSACAM), waste services remain incomplete and uneven. Douala, with an estimated population of 3.5-4.2 million, generates about 1,500-2,700 tonnes of waste per day (0.7-1.10 kg per capita). However, only about 50-60% of this waste is formally collected by HYSACAM, with significantly lower coverage in peripheral areas. As a result, uncollected waste accumulates in drains, wetlands and informal dumps, increasing environmental and health risks.

Our study combines quantitative surveys, field observations, stakeholder interviews and material flow analysis to assess system performance. The results show that only 5-10% of waste is recovered, mainly by informal recyclers working under unsafe conditions, while the majority is disposed of at the PK10 landfill, which is expected to reach capacity within 5-7 years. The waste stream is dominated by organic material (50-65%), which accelerates decomposition, odour generation and leachate formation under tropical conditions [1]. Field observations clearly demonstrate that insufficient collection capacity and weak infrastructure lead to visible waste leakage, flooding and pollution of water sources (Fig. 1). Similar patterns have been reported across Sub-Saharan Africa, where rapid urbanisation outpaces service delivery [2]. It is evident that the current system structure reduces overall efficiency and increases long-term environmental costs (Fig. 2). We therefore propose a 3-5 year improvement roadmap based on integrated sustainable

waste management and circular economy principles. The next step of this research will focus on implementing and testing this roadmap in practice, particularly through source separation, composting of organic waste and integration of informal recyclers to improve system reliability and sustainability.



Fig. 1. Polluted water source with visible waste deposits, demonstrating how insufficient collection causes blockages and flood risk.

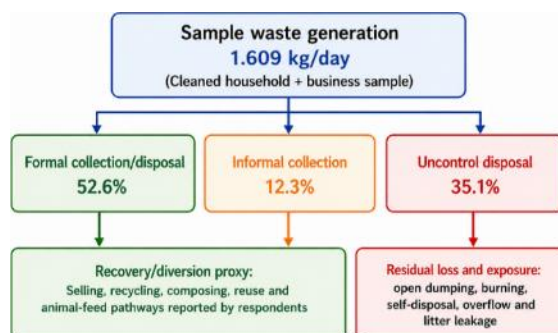


Fig. 2. Simplified material flow analysis of the cleaned survey sample.

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Compression Properties of Biocomposites

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Keywords: biocomposites, compression, modulus of elasticity

Contemporary mechanical evaluation of biocomposites encompasses tensile, flexural, and impact resistance assessments, with systematic investigation of interfacial shear strength properties to establish structure–property relationships (Chougala et al., 2025). These investigations reveal complex viscoelastic responses characterised by frequency-dependent storage and loss moduli, with differential modulus values demonstrating strain-dependent behaviour patterns and enhancement factors exceeding 3.5 in optimally formulated systems (Paulsingarayar et al., 2025).

Prism samples of biocomposites were measured by compression on a testing machine developed at UEAIF TF SPU in Nitra. A force sensor with a max. range of up to 1000 N and an accuracy of 0.4% and a distance sensor with an accuracy of 1% were used. Compression was performed at a loading speed of 10 mm.min⁻¹. The differential modulus of elasticity was determined from the linear portions of the loading curves according to Young's law of elasticity, calculated as the slope of the tangent to the differential sections of the stress-strain curves.

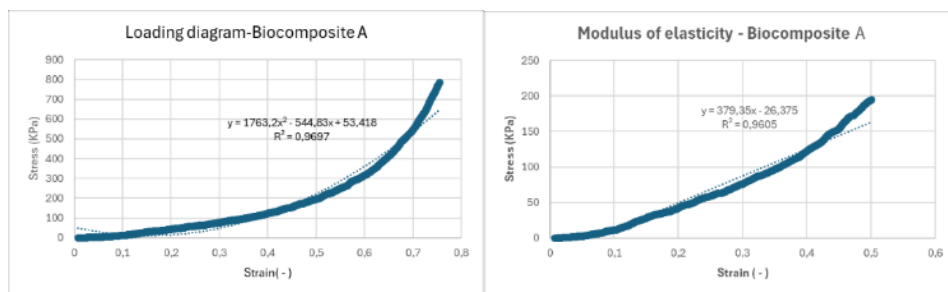


Fig. 1 Loading diagram of Stress on Strain for Biocomposite and determination of differential modulus of elasticity

Table 1 presents the differential modulus values for the Biocomposite at various deformation ranges.

Table 1 Differential moduli of elasticity in dependence on deformation range.

Deformation Range (%)	Differential Modulus (kPa)	R ² (-)
0-10	166.75	>0.98
10-30	319.54	>0.98
30-50	587.87	>0.98
0-50	379.35	>0.96

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Quality attributes of green peas for IQF freezing

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Keywords: green peas, IQF freezing, physical properties, quality evaluation

Green peas (*Pisum sativum* L.) are among the key raw materials for the frozen food industry, and the quality of the final product depends primarily on harvest timing, processing speed and the stability of storage conditions. Processing peas into a frozen product involves a chain of interconnected operations – reception and grading of raw material, cleaning, blanching, rapid cooling, dewatering, IQF freezing, packaging and storage at temperatures around $-18\text{ }^{\circ}\text{C}$ – which collectively determine texture, colour, microbiological stability and overall technological quality of the product [1,2]. The aim of this contribution is experimental evaluation of the physical, thermophysical, mechanical and microbiological properties of green peas for the optimisation of their technological processing, with a focus on identifying critical points within this chain and options for implementing optimisation measures in real freezing practice.

Results showed dimensional homogeneity; the mean equivalent grain diameter was 7.36 mm and approximately two-thirds of the grains fell within the 7–8 mm size classes. A smaller proportion consisted of grains < 6 mm and only a minimum exceeded 8 mm, which confirms harvesting at a relatively uniform maturity stage. The mean grain mass was 0.338 g and the thousand grain weight reached 218 g, values typical of peas intended for freezing. This size homogeneity supported uniform blanching and IQF freezing. The moisture content of fresh peas was 76.9% (w.b.), i.e. dry matter represented roughly one fifth of the mass. After blanching, moisture increased to 78.9% and, following dewatering and freezing, decreased to 75.8%. Upon thawing, a mass loss of 3.8% was recorded, indicating a stable tissue structure, limited leakage of cell sap and good retention of both mass and sensory quality. The hardness of fresh peas was 18.58 N, decreasing to 12.77 N after blanching and

to 10.8 N after freezing and thawing, which documents gradual softening due to combined thermal and freezing effects. The maximum deformation under compression reached 30.09% and Young's modulus decreased from 0.822 MPa to 0.541 MPa; peas remained sufficiently firm for handling while being sensorially acceptable in terms of softness. At 20 °C, thermal conductivity was $0.560 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$, while at -18 °C it increased to $1.338 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$, reflecting the higher proportion of ice in the frozen state. Thermal diffusivity was $0.143 \times 10^{-6} \text{ m}^2\cdot\text{s}^{-1}$ in the unfrozen state and $0.479 \times 10^{-6} \text{ m}^2\cdot\text{s}^{-1}$ when frozen. The mass-specific heat capacity decreased from 3.69 to $1.98 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$. These parameters are crucial for designing blanching and freezing regimes, especially in the temperature range associated with the phase change of water. Microbiology – The count of mesophilic aerobic microorganisms in raw peas was $5.21 \text{ log CFU}\cdot\text{g}^{-1}$, decreasing to $4.65 \text{ log CFU}\cdot\text{g}^{-1}$ after washing and to $2.32 \text{ log CFU}\cdot\text{g}^{-1}$ after blanching. After freezing and three months of storage at -18 °C , the count stabilised at $2.14 \text{ log CFU}\cdot\text{g}^{-1}$, indicating maintenance of an already reduced microflora. Coliform bacteria were $< 1.0 \text{ log CFU}\cdot\text{g}^{-1}$ after blanching, and yeasts and moulds reached $1.76 \text{ log CFU}\cdot\text{g}^{-1}$ after storage. The period immediately after harvest and the pre-blanching stage proved to be the most microbiologically critical [3], while blanching was the key operation for reducing microbial load.

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Agrivoltaics as a Strategic Response to Climate Change and Land-Use Challenges in Slovakia

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Keywords: agrivoltaics, climate change, global warming,

Climate change poses one of the greatest threats to Slovak agriculture. Long-term analysis of data from 65 meteorological stations (1961–2020) and predictive modelling in ArcGIS confirm a significant and accelerating warming trend across Slovakia. The situation is most critical in the fertile lowlands (Danubian and East Slovak Lowland), where the number of tropical days (≥ 30 °C) is rising rapidly, with projections exceeding 36 such days per year by the 2050s. These changes will substantially increase heat stress on crops and livestock, alter agro-climatic zoning, and threaten the productivity and sustainability of conventional agriculture. Agrivoltaics (see fig. 1) offers a highly effective solution to these challenges. By combining electricity generation with agricultural production on the same land, it enables partial shading that reduces thermal stress, improves the microclimate, protects against hail and excessive evapotranspiration, and simultaneously contributes to the fulfilment of renewable energy targets. Slovakia has considerable untapped potential for agrivoltaic deployment. Currently, approximately 450 utility-scale ground-mounted PV power plants with a total installed capacity of around 550 MW occupy roughly 1 100 ha of agricultural land. Transforming these existing plants into agrivoltaic systems would bring substantial benefits:

- Maintaining the current installed capacity of 550 MW while using agrivoltaic structures would require only an additional 220 ha (total 1 320 ha), as agrivoltaics typically require about 2.4 ha per 1 MW [1].
- Alternatively, converting the existing plants on the current 1 100 ha area would still allow approximately 458 MW of capacity while enabling continued agricultural use (crop cultivation, grazing, or permanent grassland) on the same land. This dual-use approach would significantly reduce land-use conflicts, maintain or even increase food production, and

accelerate the achievement of national climate and energy goals with minimal additional land consumption. The developed smart application further supports this transition by enabling long-term prediction of energy balance for different agrivoltaic categories (according to DIN SPEC 91434), PV technologies, and installation methods, while incorporating local climate projections and temperature effects. In conclusion, intensifying climate change makes the large-scale implementation of agrivoltaics in Slovakia not only advantageous but strategically necessary. It represents a practical, synergistic solution that simultaneously addresses climate mitigation, adaptation of agriculture to rising temperatures, efficient land use, and energy security.

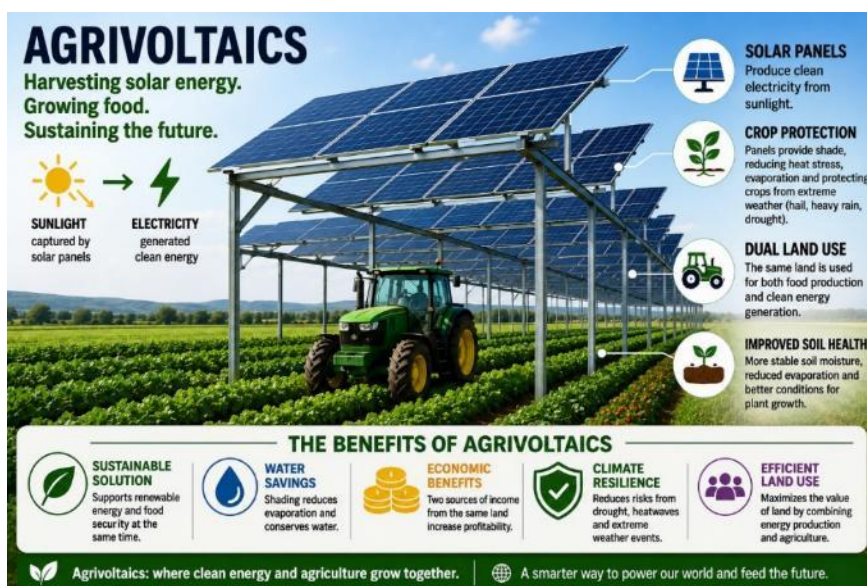


Fig. 1. Agrivoltaics principle

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Comparative Effects of Wet and Dry Ageing on Physicochemical and Sensory Properties of Rabbit Loin

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Keywords: meat quality, meat flavour, rabbit meat, vacuum-ageing

To assess the effects of post-mortem ageing method (wet vs. dry) and duration (7 or 14 days) on physicochemical and sensory properties of the *longissimus thoracis et lumborum* (LTL) muscle, fifty 90-day-old male Hyplus rabbits (PS19 × PS40) were slaughtered. Thereafter, 40 carcasses, with a mean carcass weight of 2126 ± 316.1 g, were allocated to wet ageing (vacuum-packaged deboned muscles) or dry ageing (intact carcass) for 7 (D7) or 14 days (D14) (n = 10 per treatment). Significant treatment effects were observed for L*, a* and b* values of the meat colour, moisture, and protein content (Table 1). Intramuscular fat content ranged from 6.5 g/kg in meat wet-aged for 14 days to 10.4 g/kg in meat dry-aged for 7 days. Ash content ranged from 11.9 g/kg on day 1 to 14.2 g/kg in meat dry-aged for 14 days. Malondialdehyde (MDA) content ranged from 0.36 mg/kg on day 1 to 0.81 mg/kg in meat dry-aged for 7 days.

After 14 days of ageing, wet-aged LTL muscle received higher scores for juiciness (P = 0.013) and abnormal flavour intensity (P = 0.027), while dry-aged meat scored higher for roasted flavour (P = 0.011) and overall acceptance

($P = 0.037$). These findings support previous conclusions that, as in other species, dry ageing enhances meat flavour attributes relative to wet ageing (1, 2). The observed changes are likely related to protein degradation by aminopeptidases and peptidases during ageing, which increases free amino acid content and contributes to flavour development and tenderization (3).

Table 1: Effect of post-mortem ageing on physiochemical characteristics of *longissimus thoracis at lumborum* muscle of rabbits

	Day 1	Day 7		Day 14		SEM	P-value
		Wet ageing	Dry ageing	Wet ageing	Dry ageing		
Weight muscle (g)	100.7	103.3	102.5	95.2	91.6	4.25	0.248
pH ₄₈	5.63	5.61	5.74	5.63	5.69	0.044	0.223
Colour L*	60.08 ^b	63.70 ^a	60.20 ^b	65.61 ^a	58.94 ^b	0.76	<0.001
a*	-0.86 ^b	-0.35 ^b	-0.30 ^b	1.44 ^a	0.70 ^a	0.27	<0.001
b*	10.86 ^{bc}	11.01 ^{bc}	10.18 ^c	13.77 ^a	11.73 ^b	0.334	<0.001
WB shear force (N/cm ²)	24.50 ^a	16.67 ^b	18.09 ^b	14.82 ^b	15.89 ^b	1.401	<0.001
Cooking loss (%)	17.82 ^{ab}	15.99 ^{ab}	12.12 ^b	19.27 ^a	12.74 ^b	1.64	0.013
Moisture (g/kg muscle)	257.8 ^b	256.1 ^b	260.2 ^b	257.5 ^b	297.6 ^a	2.85	<0.001
Protein (g/kg muscle)	231.2 ^b	227.8 ^b	230.6 ^b	228.9 ^b	262.7 ^a	2.63	<0.001
IMF (g/kg muscle)	7.6 ^{ab}	8.9 ^{ab}	10.4 ^a	6.5 ^b	9.2 ^{ab}	0.83	0.019
Ash (g/kg muscle)	11.9 ^b	12.1 ^b	12.2 ^b	12.3 ^b	14.2 ^a	0.179	<0.001
MDA (mg/kg)	0.36 ^d	0.41 ^{cd}	0.81 ^a	0.53 ^{bc}	0.58 ^b	0.035	<0.001

^{a,b,c} Values with different superscripts differ at $P < 0.05$; IMF: intramuscular fat; MDA: Malondialdehyde

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Farmers’ adoption of waste-to-energy valorisation: A gendered perspective on circular economy pathways for sustainability transitions in Nigeria

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Keywords: Agricultural residues, Renewable energy, Gender dynamics, Technology adoption behaviour, Biomass utilisation practices

Energy poverty and environmental degradation remain pressing challenges in sub-Saharan Africa, where reliance on traditional biomass drives deforestation, greenhouse gas emissions, and health risks [1, 2]. Rice, a staple for millions, generates significant by-products that often harm the environment when burned or discarded [3, 5]. Valorising these by-products through renewable energy offers a promising pathway toward sustainable energy transitions and circular economy practices [4, 6]. Yet little is known about farmers’ awareness of and willingness to adopt such practices, particularly from a gender perspective, in sub-Saharan Africa.

This study analyses these dynamics in Nigeria, using data from a survey of 150 rice farmers and explicitly accounting for gender differences in access, roles, and decision-making. The results reveal a significant gap in the adoption of these practices: although 70% of respondents are aware of the potential for value addition, only 47% are willing to adopt them. This reluctance is due to alternative uses: one-third of farmers use straw as animal feed, and 30% resort to open-air burning.

Bivariate probit regression analysis identifies educational attainment, household size, and livestock ownership as significant determinants ($p < 0.05$). Notably, an ‘education paradox’ exists: higher levels of formal education increase awareness but reduce willingness to adopt this technology because of perceived financial risks and high initial investment costs, which range from US\$800 to US\$1,200 for basic biogas units. Although 94% of the sample consists of men, reflecting patriarchal land ownership systems, the study highlights a fundamental disparity: women, as the primary managers of energy use, bear the brunt of the costs of traditional fuels (US\$0.26–0.75/kg for firewood) and indoor air pollution, yet they lack the decision-making power needed to adopt alternatives.

The results also indicate that rice husks, with an untapped energy potential of 410-570 GWh per year, offer a more viable commercial option than straw. To bridge the 23% gap between awareness and adoption, the study recommends gender-sensitive awareness campaigns, subsidies to offset technology costs, and promotion of agricultural briquettes, which are economically competitive at US\$ 0.16/kg. Promoting the valorization of rice by-products through renewable energy can strengthen Nigeria’s energy security, reduce environmental degradation, and support equitable and sustainable transitions within a circular-economy framework.

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ThinkTogether: An Open-Source Conference Management System for Configurable Review Workflows, Auditability, and Deterministic Exports

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Keywords: conference management system, peer review workflow, configurable review forms, workflow auditability, open-source scholarly infrastructure

Peer review is a core governance mechanism of scholarly communication, yet the systems that support conference operations often assume standardized workflows that do not reflect the policy and organizational diversity of real venues. In practice, conference organizers must handle discipline-specific evaluation rubrics, multiple tracks with different review policies, heterogeneous participant roles, deadline exceptions, and the need to reconstruct decisions when process integrity is questioned. These requirements make conference management not merely an administrative task, but a socio-technical problem involving workflow governance, accountability, and reliable production of downstream artifacts.

We present ThinkTogether, an open-source web-based conference management system designed for configurable, auditable, and operationally robust conference workflows with possibility of future AI integration. Rather than maximizing feature breadth, the system prioritizes mechanisms that are repeatedly critical in real conference settings: explicit role-aware permissions, deadline-driven state transitions, structured handling of extension requests, versioned submission history, and deterministic export views for print and archival use. The central design objective is to support small organizing teams with limited technical capacity while preserving transparency and inspectability of policy-relevant process decisions.

The system is implemented as a server-rendered web application with a conventional layered architecture in which domain models encode workflow constraints, request handlers enforce permissions and transitions, and templates provide stable cross-device access and predictable performance. Its core domain includes conference editions, sections or tracks, submissions, reviews, submission versions, extension requests, and scheduling entities. A key architectural principle is that policy-bearing decisions are represented explicitly in the data model rather than being hidden in interface conventions. This makes workflow state, timing, visibility rules, and exception handling inspectable and reproducible across conference iterations and makes the application robust for maintaining agenda.

The main contribution of ThinkTogether lies in combining a stable governance structure with configurable review semantics. Conferences often need to modify review instruments across tracks, paper types, or yearly editions, yet uncontrolled flexibility can reduce comparability and weaken process consistency. ThinkTogether addresses this tension by keeping the review representation structurally stable while allowing sections to configure the visibility of review fields for specific paper types. This mechanism enables rubric adaptation at the configuration level without forking application logic, while preserving a consistent representation suitable for monitoring, aggregation, and export.

ThinkTogether also treats exportability as a first-class requirement. Conference operations routinely depend on stable paper packets, review summaries, and meeting materials for offline chairing, archiving, and publication workflows. By combining print-oriented export views with versioned submission snapshots, the system supports deterministic artifact generation and reduces the risk of last-minute inconsistencies. In addition, audit and messaging primitives support post-hoc reconstruction of actions and consistent participant communication, including linkage between outgoing email and in-application notifications.

Overall, ThinkTogether advances the claim that, for conference management, configurability, auditability, and export determinism are more consequential than maximal feature breadth.

Universities at a Crossroads: AI, Students, and the Future of Higher Education

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Keywords: artificial intelligence (AI); higher education; AI in education; Future of universities; Student perceptions; Career preparation; Future skills; Digital transformation

Artificial intelligence is beginning to reshape not only the way students study, but also how they think about work, skills, and the purpose of university education itself. As AI tools become part of everyday academic life, universities face growing pressure to redefine their role in a rapidly changing digital environment.

This presentation will introduce original findings from a survey conducted among several hundred Czech students enrolled in the *Science and Society* course at CZU, where students actively participate in the research process. The contribution explores how students perceive AI, how often they use it, what opportunities and risks they associate with it, and whether universities are prepared for these changes.

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Influence of microclimate and physiological condition of Norway spruce on mycorrhizal development

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Keywords: mycorrhiza, root, Norway spruce, drought, microclimate

Forest trees and ectomycorrhizal fungi form mutually beneficial relationships that enhance tree resistance to both abiotic and biotic stress, improve water and nutrient uptake efficiency, and are fundamental to the functioning of forest soil ecosystems. However, ongoing climate change—particularly the increasing frequency and intensity of drought events—poses a significant threat to this important interaction. This is especially relevant for Norway spruce (*Picea abies*), a keystone species in Czech and Central European forestry.

The theoretical component of this research investigates how microclimatic and physiological conditions of spruce influence the development of mycorrhizal associations, with particular focus on the responses of *Picea abies* and its associated fungal communities to drought. Fieldwork was conducted on experimental plots at the University Forest Enterprise near Kostelec nad Černými lesy, Czech Republic, where drought conditions were simulated using roofing (see fig. 1). Tree growth, transpiration flow, and soil water potential were monitored for trees in both roofed and control plots. Soil samples were collected from selected trees and analysed for mycorrhizal and root parameters, including the density of active and inactive mycorrhizal tips, root dry mass, and soil pH. Throughout the growing season, fungal fruiting bodies were surveyed monthly and categorised by trophic type. Statistical testing, modelling, and multivariate analyses were used to evaluate relationships among the measured variables, with emphasis on the effects of roofing on active mycorrhizal tip abundance, tree physiological traits, and fungal community composition.

Results indicate that roofing-induced drought stress led to significant changes in both mycorrhizal and root parameters, specifically a decrease in active and an increase in inactive mycorrhizal tips, an increase in fine root biomass (see fig. 2), a decline in the physiological condition of spruce, and a reduction in fungal species richness.



Fig. 1. Spruce trees under artificial roofing in one of the research plots.

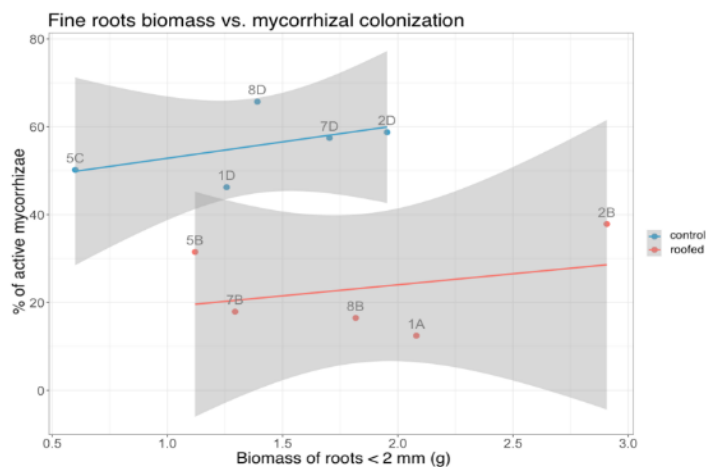


Fig. 2. Fine root biomass (< 2 mm) vs. mycorrhizal colonization.

Fluorescent Timers Uncover Real-Time Dynamics of Viral Gene Silencing Suppressors

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Keywords: transient expression, RNAi, fluorescent timers, PTGS

Plant transgenesis faces a serious obstacle that often prevents the proper expression of newly introduced transgenes. This phenomenon, known as post-transcriptional gene silencing (PTGS), functions as a plant defense mechanism against the entry of foreign nucleic acids, typically of viral origin [1]. Such limitation can be mitigated by co-expression of viral suppressors of PTGS, as some plant viruses have evolved strategies to suppress PTGS and thereby enhance their replication. Our aim is to characterize the effect of selected suppressors on transient gene expression over time, as well as to evaluate the phenotypic responses of *Nicotiana* spp. to their introduction.

Progressive changes in gene expression can be effectively studied using fluorescent timers. Their advantage lies in the gradual shift of emitted fluorescence from blue to red as a result of chromophore maturation [2]. In the case of viral suppressors, this approach enables us to evaluate their effect on PTGS suppression during their cytoplasmic co-expression.

This preliminary study focused on design, expression and visualization of gene constructs containing PTGS suppressors (Fig. 1). These were cloned into pDGB3a2 plasmids (GoldenBraid assembly) and introduced into several genotypes of *Nicotiana* spp. through *Agrobacterium*-mediated transformation. Based on qualitative analysis of plant phenotypes, suitable alternatives to the p19 protein, which triggers rapid necrosis in the infiltration zone of *N. tabacum* as early as 2 dpi, were sought. At the same time, the gene expression

of fluorescent timers during co-infiltration with viral PTGS suppressors was indirectly quantified by measuring the intensity of their emitted fluorescent signal. Modifications of gene constructs aimed at optimizing their transient expression will be the subject of future experiments.

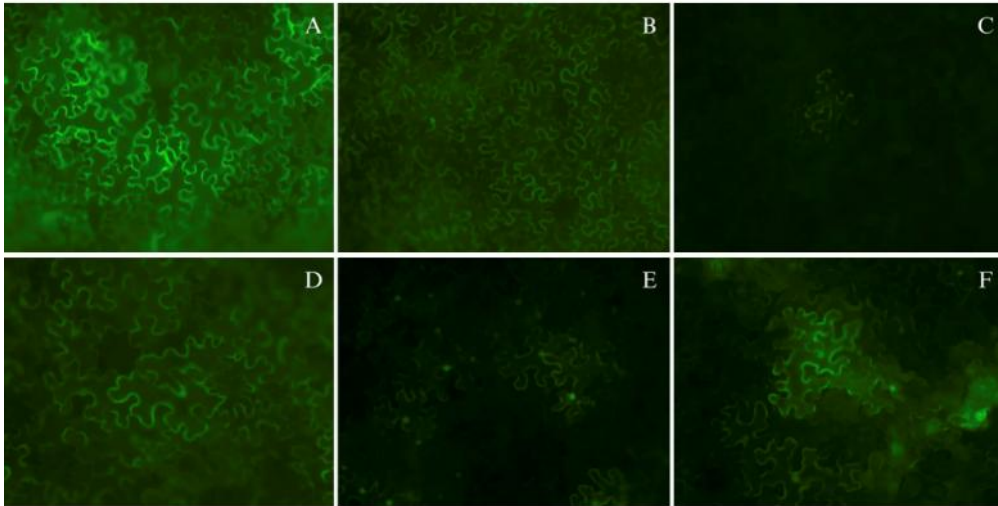


Fig. 1. Viral suppressors of PTGS transiently expressed in *Nicotiana benthamiana* Hc-Pro genotype at 2 dpi. A) NSs, B) ORF2b, C) Hc-Pro, D) p19, E) p23, F) V2.

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Monitoring and comparison of the rheology properties of selected mineral and ecological oils

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Keywords: density, viscosity, oil

This work deals with study of physical properties viscosity and density of selected mineral and ecological oils. Viscosity and density of materials change with the temperature. Dynamax Chainsaw oil VG 100 is a high-quality oil designed for lubricating chainsaws, preventing them from being damaged or jammed. Dynamax Chainsaw oil VG 100 is enriched with a special additive that ensures better adhesion of the oil to the chain, thereby minimizing oil losses. Baupro Bio Oil is high-performance (lubricating) oil for chainsaws. Plant-based, ecological, biodegradable, 98% biodegradable within 21 days.

Viscosity is a key fluid property in the analysis of liquid behavior and flow characteristics near solid boundaries. The presented data were obtained through measurements conducted using a Brookfield DV2T laboratory viscometer. Density measurements were carried out with a Mettler Toledo DM40 densimeter. Both physical properties were evaluated over a temperature range from 20 °C to 100 °C. Viscosity and density of materials are temperature-dependent. The differing influence of temperature on the viscosity of liquids and gases is associated with variations in their molecular structure. In most liquids, both viscosity and density decrease as the temperature increases.

Dynamic viscosity is decreasing exponentially with increasing temperature. The exponential dependency for each sample was obtained in accordance with Arrhenius equation Tab. 1 a). Measurement results of density of oils are presented on Tab. 1 b). Density nonlinearly decreases with temperature of oil. Experimental results have shown that temperature is one of the essential factors which has an influence on material properties.

Tab. 1. a) Dynamic viscosity dependencies on temperature, b) Density dependencies on temperature

a)

Sample	Regression equation	Determination coefficients
Dynamax VG 100 Chainsaw oil	$y = 673,47e^{-0,042x}$	$R^2 = 0,9979$
Baupro bio olej	$y = 108,54e^{-0,026x}$	$R^2 = 0,9981$

b)

Sample	Regression equation	Determination coefficients
Dynamax VG 100 Chainsaw oil	$y = -0,0005x^2 - 0,5865x + 902,01$	$R^2 = 0,9999$
Baupro bio olej	$y = -0,0004x^2 - 0,6446x + 932,15$	$R^2 = 0,9999$

Acknowledgements:

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Some questions about modern dairy cow welfare evaluation equipment

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Keywords: cubicle, smart agriculture, welfare

The monitoring of lying behavior [1] in dairy cows is an important tool for assessing welfare, health, and productivity in modern free-stall systems, as reduced lying time often indicates discomfort or health problems.

Ultrasonic sensors emerge as a promising low-cost and non-invasive solution for detecting occupancy in lying boxes, enabling continuous real-time monitoring even in the challenging environment of barns. Current research also highlights the high potential of combining ultrasonic sensors with machine learning methods, which improve the accuracy of behavior classification and the system’s robustness against noise and interference [2].

This contribution presents an evaluation of machine learning metrics regarding the impact of information accuracy from the ultrasonic signal, analyzed as amplitude versus distance. The scikit-learn 1.8.0 software library was used. The data were proportional normalized to 0-1 value interval.

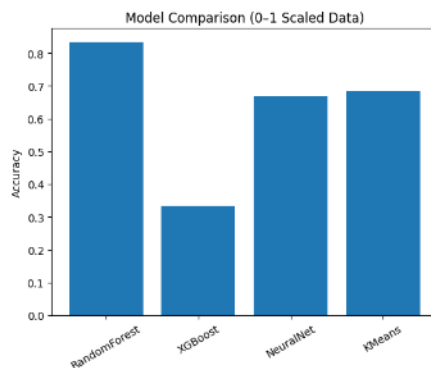


Fig. 1. Selected ML models accuracy values

Acknowledgements:

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Electrical properties of flaxseed

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Keywords: electrical properties, flaxseed, Agram

Electrical properties of plant grains and seeds can be used in many areas but are most often used in studying their moisture content (1). We used these properties when detecting moth infestation. The flaxseeds of genotype Agram were grown at the Agritec Plant Research, Ltd., Šumperk, Czech Republic. The colour of seeds was brown and were intended for application in the food industry.

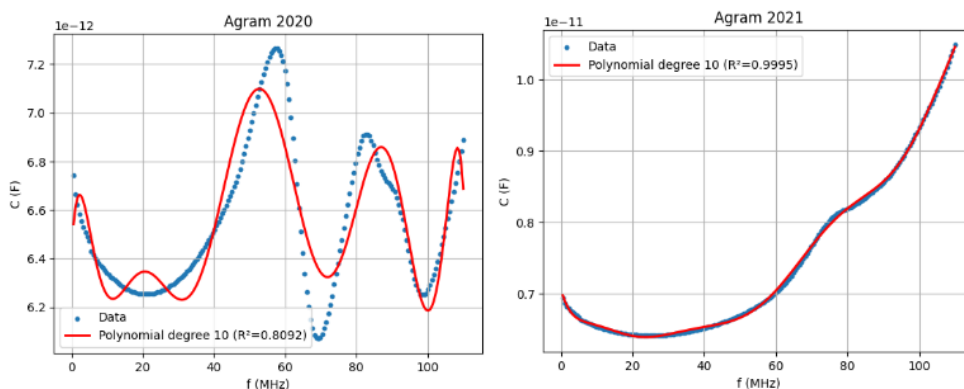


Fig. 1 Frequency dependencies of capacity for genotype: Agram (2020) on the left; Agram (2021) on the right

As regression function, we used polynomial equation of 10 degree with regression coefficient 0.8092. On the curve occurs the oscillation, what is caused by destroying of seeds by moths. The material has become significantly inhomogeneous (2).

$$C = 1.757 - 2.707 \frac{f}{f_0} - 15.920 \left(\frac{f}{f_0}\right)^2 + 11.383 \left(\frac{f}{f_0}\right)^3 + 34.9 \left(\frac{f}{f_0}\right)^4 \\ - 11.718 \left(\frac{f}{f_0}\right)^5 - 30.171 \left(\frac{f}{f_0}\right)^6 + 4.537 \left(\frac{f}{f_0}\right)^7 + 11.019 \left(\frac{f}{f_0}\right)^8 \\ - 0.597 \left(\frac{f}{f_0}\right)^9 - 1.424 \left(\frac{f}{f_0}\right)^{10}$$

where $f_0 = 1$ MHz and coefficients of equation are in pF.

Unlike the 2020 seeds, the 2021 ones were healthy, and this is also evident based on the course of the graph (Fig. 1). The bend in the curve at 75 MHz could have been caused by ionic or bipolar polarization in seeds.

Acknowledgement

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Relative Humidity Effects on PA6 Composites

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Keywords: additive manufacturing, wear, tensile strength, relative humidity

Polyamide-based composites produced by additive manufacturing are increasingly used in engineering applications because of their low density and favorable mechanical properties [1]. However, PA6 materials are hygroscopic and moisture absorption significantly affects their tribological and mechanical behavior [2, 3]. This study evaluates the influence of relative humidity on abrasive wear resistance and tensile properties of 3D-printed PA6 composites.

Three materials were investigated: pure PA6, glass fiber reinforced PA6 GF30, and carbon fiber reinforced Onyx. Samples were produced using fused filament fabrication with parallel and perpendicular layer orientations. Relative humidity conditions of 33%, 65%, 85%, and 97% RH were created using saturated salt solutions. Abrasive wear tests were performed using a Pin-On-Disk device, while tensile tests were carried out according to ISO 527.

The results demonstrated a clear dependence between increasing relative humidity and increasing abrasive wear for all tested materials. For PA6, the most significant increase in mass loss occurred between 85% and 97% RH, where the wear increased by approximately 10.3% under a pressure of 0.32 N·mm⁻². Tensile strength decreased with increasing humidity, with a strong correlation coefficient of $R^2 = 0.9331$. In contrast, elongation showed high variability and no clear dependence on humidity.

PA6 GF30 exhibited the highest sensitivity to humidity changes at lower moisture levels. The largest increase in mass loss occurred between 33% and 65% RH, reaching approximately 12.2%. Mechanical testing revealed considerable variability in tensile properties due to the heterogeneous composite structure.

Onyx exhibited the lowest overall mass loss and therefore the best wear resistance. However, at 97% RH the difference in mass loss between parallel and perpendicular layer orientations reached 36%. Tensile strength decreased significantly with increasing humidity ($R^2 = 0.911$), while elongation increased with higher moisture content.

The results confirm that environmental humidity significantly affects both tribological and mechanical properties of PA6-based composites manufactured by additive technologies. The findings highlight the importance of considering humidity exposure and layer orientation during material selection for applications operating in abrasive or humid environments.

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Effect of Expansion Vessel Placement on the Controllability of a Hydraulically Driven Sprayer

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Keywords: sprayer, expansion vessel, hydraulic drive, flow control, pressure fluctuation

Precise application of agrochemicals is a key requirement in modern precision agriculture, where stable flow control is essential for minimising chemical waste and environmental contamination [2]. In hydraulically driven sprayers — powered by the tractor's hydraulic oil circuit — piston pump-induced pressure fluctuations represent a significant obstacle to reliable flow control. Although such pumps are commonly equipped with integrated pulsation dampers, these may prove insufficient under variable operating conditions [1]. Expansion vessels placed externally offer a practical complementary solution; however, their optimal placement has not been systematically investigated. A further consideration is chemical resistance: membrane-type vessels risk degradation when exposed to aggressive pesticide formulations, making a membrane-free design without pre-charge pressure an attractive alternative whose performance has not yet been characterised.

This study experimentally investigates the effect of expansion vessel placement on pressure stability and flow controllability. Two configurations were compared: upstream (before the sensors) and downstream (after the sensors). Pre-charge pressure was varied from 0 to 5 bar across three engine speeds (600, 800, and 1000 rpm), yielding 36 measurement conditions. Repeatability was assessed through 40 controlled measurements at 800 and 1000 rpm for each placement.

Results consistently demonstrated that upstream placement yields superior damping. Steady-state pressure swing was low and stable across all pre-charge levels (0.12–0.33 bar), while downstream produced markedly higher oscillations (0.18–0.61 bar). Peak transient pressure at start-up was dramatically lower upstream (≤ 0.51 bar) versus downstream (≤ 5.17 bar), and

stabilisation time was shorter across all conditions. The membrane-free variant at 0 bar pre-charge achieved comparable damping performance, confirming it as a chemically robust and simpler solution for agrochemical applications.

These findings confirm that upstream placement decisively improves pressure stability in hydraulically driven sprayers. The membrane-free configuration at 0 bar pre-charge is recommended as a practical and durable design choice. Future work will integrate these results into a model-based variable-rate flow control strategy.

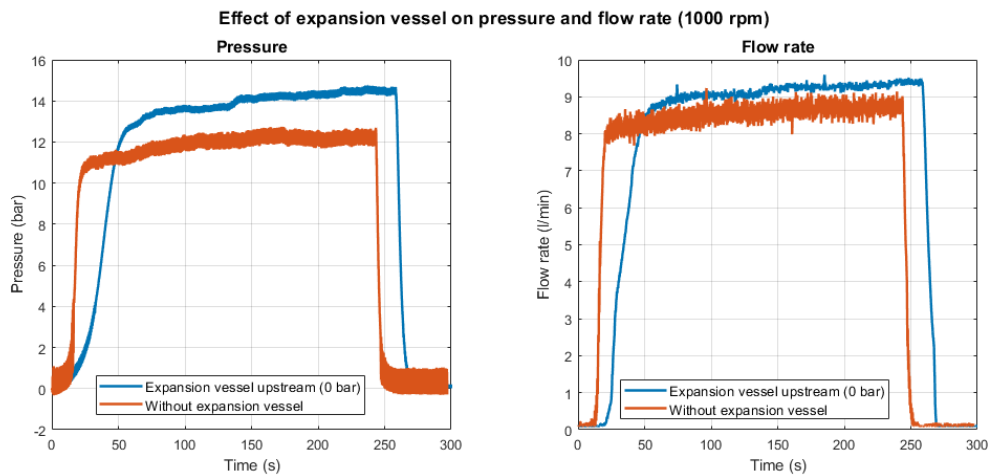


Fig. 1.

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Path planning algorithms for robotic fruit harvesting in obstructed environments using neural networks

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Keywords: algorithms, robotic arm, fruit harvesting

Modern agriculture faces a critical shortage of manual labor, driving the demand for automated harvesting systems. While robotic manipulators have advanced, the primary challenge remains efficient fruit picking in complex agricultural environments where branches, leaves, and structural supports act as obstacles. Current robotic systems often struggle with the dexterity required to reach fruit deep within the canopy without damaging the plant or the robot itself. The aim of this study is to develop and evaluate a hybrid DRL-based path planning algorithm for robotic fruit harvesting in densely obstructed environments. The proposed system enables autonomous navigation through dense foliage while minimizing collision risk.

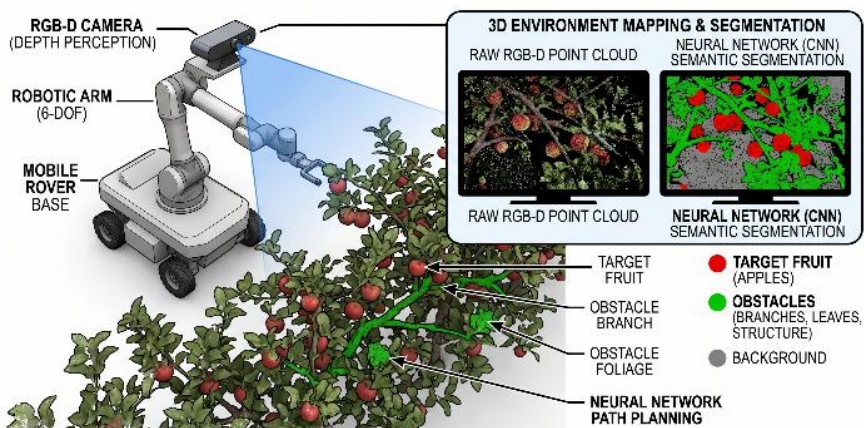


Fig. 1. Target object detection and obstacle identification using 3D vision and neural networks.

The system utilizes RGB-D cameras to create a 3D point cloud of the harvesting area. This process is visualized in Fig. 1, which illustrates the real-

time segmentation of target fruit and the identification of surrounding obstacles using a Convolutional Neural Network (CNN). We implemented a Deep Q-Network (DQN) that trains the arm to find the collision-free trajectory. Unlike traditional geometric algorithms, the neural network learns to detect and avoid collisions and adjust the arm’s joints dynamically. A detailed view of the control architecture and the planned arm trajectory in a simulated orchard environment is shown in Fig. 2. The framework was evaluated in a ROS2/Gazebo simulation environment using a 6-DOF robotic manipulator. Simulation results demonstrated a 23% reduction in collision events compared to conventional RRT-based planning methods. The proposed framework may improve autonomous harvesting efficiency in highly obstructed agricultural environments.

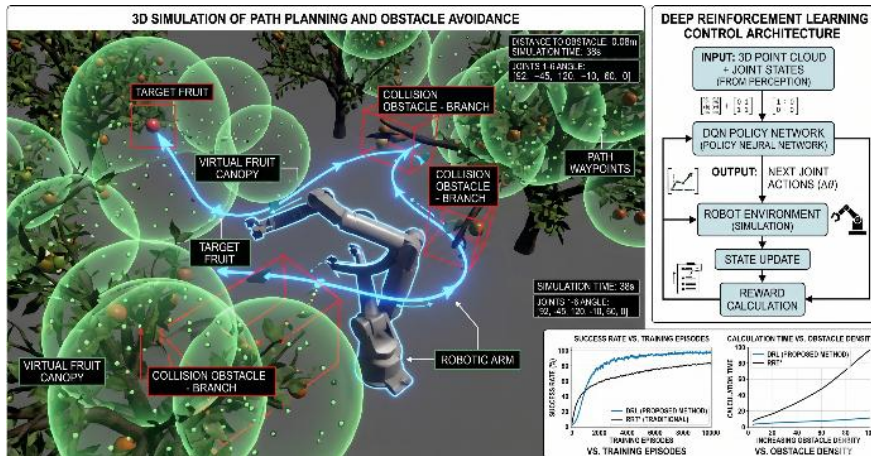


Fig. 2. Simulation of robotic arm path planning in an obstructed environment.

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Efficient Plant Stem Localization via a Depth-Triggered Two-Stage Pipeline

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Keywords: precision agriculture, deep learning, depth-triggered segmentation

Plant phenotyping is a crucial aspect of precision agriculture as it provides insights into plant health, status and productivity. For specific tasks such as tomato harvesting, accurate localization of the plant stem is essential, as it enables automated measurement of traits such as stem diameter and growth angle. However, instance segmentation models are computationally demanding, limiting their deployment in real-time applications [1].

YOLO-based architectures offer a flexible framework supporting both object detection and instance segmentation tasks. While segmentation variants provide detailed output, they introduce additional computational overhead compared to standard detection models. This trade-off motivated the exploration of a two-stage pipeline operating on the output of an RGB-D camera. As the robot traverses a crop row, an object detection model first runs continuously to localize regions of interest from a distance. Once a detection occurs, the corresponding depth channel is used to estimate the robot's proximity to the target. When the estimated distance falls below an empirically defined threshold of 0.4 m, the pipeline switches to an instance segmentation model, providing the precise stem localization required for manipulation.

In our experiment, we trained YOLOv26m for detection and YOLOv26m-seg for instance segmentation on a dataset of 547 RGB-D images (416 general-view and 131 close-up images) with 80/10/10 train/validation/test split, consistent with the experimental setup in [2]. The detection model (67.9 GFLOPs) was trained on general-view images only, while the segmentation model (121.2 GFLOPs) was trained on close-up images, reflecting the intended deployment conditions of each stage. A unified segmentation baseline was additionally trained on the full mixed dataset for reference. Results on a consumer-grade GPU (NVIDIA RTX 4090) show that the detection stage

achieves 1.3 ms per image compared to 2.2 ms for the segmentation baseline, representing a 34% reduction in inference time for scenes where close-up segmentation is not required. The segmentation stage, activated only when the depth camera threshold is exceeded, achieves a mask mAP₅₀ of 72.0% on close-up imagery.

Our findings suggest that decoupling detection and segmentation into a depth-triggered two-stage approach offers a practical strategy for improving inference efficiency, supporting real-time deployment in greenhouse environments.

Acknowledgements:

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Reducing Simulation Count in Fuzzy Controller Optimization via Design of Experiments Strategies

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Keywords: Design of Experiments, Response Surface Methodology, Fuzzy Controller Optimization

Optimization of Mamdani fuzzy controllers for mobile robot trajectory tracking requires evaluating numerous parameter combinations through simulation [1]. This study compares systematic sampling strategies (factorial designs, Central Composite Designs, regular grids) against Latin Hypercube Sampling (LHS) [2], combined with polynomial response surface models of varying complexity, to determine how far the simulation count can be reduced without compromising optimum quality [3]. A differential-drive robot tracking a reference trajectory was simulated in MATLAB/Simulink. The fuzzy controller was parameterized by approach angle (10° – 90°) and target distance (1–10 m), yielding a full factorial grid of 90 simulations as the reference. A poly43 model fitted to all 90 points achieved $R^2 = 0.990$ and 0.987 , with the joint optimum at 32.5° and 1.0 m.

As shown in Tab. 1, DoE strategies consistently outperformed LHS, with the gap widening dramatically under the poly43 model where LHS-15 collapsed to negative R^2 . LHS also exhibited high variance across repetitions ($\sigma = 5$ – 16°), making it unreliable for engineering use. The extended CCD with 21 points shifted the optimum by only $+2.7^{\circ}$, representing a 77% reduction in simulations with less than 1% accuracy loss. Notably, systematic point placement proved more important than sample size alone.

Tab. 1. Summarization of the performance of all tested strategies

Strategy	N	Model	RMSE Treg	R ² Treg	RMSE Area	R ² Area	Opt. shift angle	Opt. shift dist.
3 ² Factorial	9	poly22	2,880	0,9051	0,102	0,9616	+17.2°	+4.5 m
CCD-like	9	poly22	2,880	0,9051	0,102	0,9616	+17.2°	+4.5 m
Extended CCD	21	poly22	2,685	0,9175	0,090	0,9700	+6.4°	-0.0 m
Grid 5×5	25	poly22	2,562	0,9249	0,090	0,9697	+4.7°	-0.0 m
Grid 3×4	12	poly22	3,403	0,8676	0,105	0,9595	+17.3°	+4.5 m
Grid 3×3	9	poly22	2,880	0,9051	0,102	0,9616	+17.2°	+4.5 m
LHS-10 (mean)	10	poly22	3,726	0,8378	0,125	0,9396	+10.5°±7.1°	+0.9±1.8 m
LHS-15 (mean)	15	poly22	3,216	0,8793	0,107	0,9568	+6.4°±8.5°	+1.0±1.8 m
LHS-20 (mean)	20	poly22	3,063	0,8908	0,101	0,9618	+6.6°±5.5°	+1.1±1.9 m
3 ² Factorial	9	poly43	<i>Insufficient points</i>					
CCD-like	9	poly43	<i>Insufficient points</i>					
Extended CCD	21	poly43	1,232	0,9826	0,075	0,9794	+2.7°	+0.0 m
Grid 5×5	25	poly43	1,157	0,9847	0,080	0,9766	+12.7°	+1.1 m
Grid 3×4	12	poly43	<i>Insufficient points</i>					
Grid 3×3	9	poly43	<i>Insufficient points</i>					
LHS-15 (mean)	15	poly43	7,509	-0,0463	0,758	-2,2250	+16.1°±16.2°	+2.7±2.0 m
LHS-20 (mean)	20	poly43	3,030	0,8810	0,246	0,6751	+15.1°±13.3°	+2.1±2.1 m
REFERENCE	90	poly43	1,040	0,9895	0,066	0,9865	0°	0 m

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The Use of Thermal Analysis by Investigation of Polymers

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Keywords: thermal properties, TG, DSC, insulator polymer

Thermogravimetric and differential scanning calorimetry are mostly using methods on the quality control. It provides us with basic information about evaporation of volatile constituents, oxidative or thermal decomposition and heterogeneous chemical reactions or enthalpy of process [1].

For this experiment, were used new and old samples of the same materials. Specifically, it is a cable type CYKY-O 3x1.5 mm² sample of EPDM (Ethylene-propylene rubber) and PU (polyurethane) materials. To determine thermal stability, the thermogravimetric analysis methodology was chosen with a heating rate adjustment of 10 °C/min from 25 °C to 900 °C in a nitrogen environment.

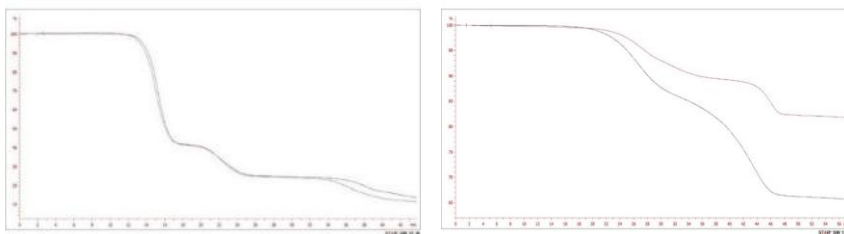


Fig. 1. Degradation of the polymer on termogram TGA (left – EPDM, right – PU).

Thermal degradation is note in Fig. 1 (left) that approximately three stages constituted the thermal decomposition process of the commercial EPDM rubber. The specimen started to decompose around 280 °C [3]. The same method were used to investigate the thermal stability of PU, with the lower, black curve showing the old sample. In the second part of the curve, the inflection point of this phase was reached at 453 °C. This means a

decomposition temperature 26 °C lower than for the new sample, which strongly suggests a loss of thermal stability. The glass transition was recorded in Figure 2. and observing the changes of EPDM at the thermal interface of our devices, no transitions corresponding to this modification were observed. The glass transition curve of polyurethane (PU) obtained by DSC analysis shows characteristic points at glass transition temperatures (T_g) starting at 64.86 °C, indicating the transition of the material to an amorphous state. The glass transition curve of the polyurethane (PU) samples used does not appear, indicating that the material loses its amorphous polymer character.

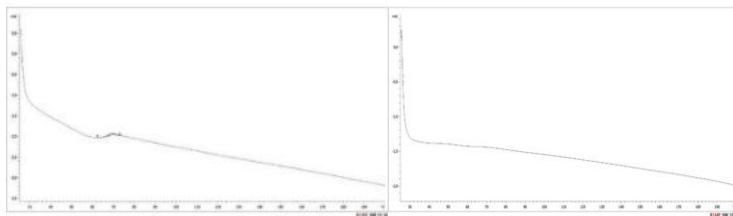


Fig. 2. Comparison termogram DSC between new (left) and old (right) sample.

Thermal examination of the samples was set based on the characteristic properties of the materials investigated and showed visible changes in only one sample. However, they indicate suitable methods for examining the wear of the sample, within the available thermal range. The amount required is not more than 10 mg of sample, which allows the analysis of even accidental material loss by montage or another handling.

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Experimental Setup for Measuring Electric Parameters of Power Grid Using OPC UA

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Keywords: OPC UA server, measuring system, Industry 4.0

Monitoring electrical parameters in low-voltage distribution systems is an important method for obtaining data on energy consumption and also helps to verify the quality standards of the electricity distributed through the grid. Current techniques and tools for collecting and analyzing big data include various approaches implemented in IT and OT (Operational Technology) environments. Data collection and analysis tools are a key element of Industry 4.0, which integrates advanced digital technologies into manufacturing processes. Data is the crucial element of this transformation, providing the information necessary to optimize processes, increase productivity, and reduce operating costs. The OPC UA server ensures robust, flexible data exchange and efficient control of industrial applications. The proposed hardware platform and software solution based on OPC UA allows monitoring of low-voltage power distribution systems. In addition to monitoring energy consumption, the system provides power quality data for further processing and analysis. The solution reduces the time required for potential network diagnostics and increases the reliability of the measurement system. Experimental measurements showed that the proposed solution is precisely accurate, with a relative measurement error of 0.17% compared to comprehensive reference systems.

In terms of technical implementation, it is possible to deploy a digital system for monitoring the distribution network using open communication standards [1]. The proposed solution is based on the use of a B&R X20BC008U OPC UA server and a B&R X20AP3121 measurement module (see Fig. 1). In the future, research will focus on implementing non-intrusive load monitoring algorithms [2] for the power grid, which will provide data on

the consumption and electrical parameters of individual load connected to the grid without the installation of other sensors.

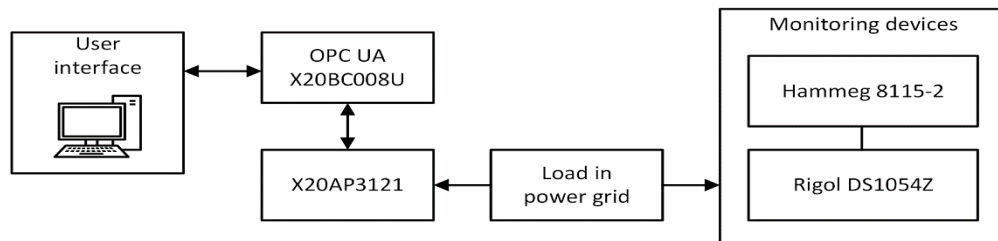


Fig. 1. Experimental setup of proposed system .

Acknowledgements:

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Evaluation of heat energy loss of buildings using image processing algorithms and thermal camera

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Keywords: infrared radiation, thermal camera, heat loss

Ensuring the energy efficiency of buildings requires an accurate evaluation of heat losses, which are often difficult to calculate due to missing or inaccessible technical data about the structure. While traditional thermographic measurements provide visual information about surface temperatures, they often lack direct data on the actual power loss. This thesis addresses the evaluation of heat energy loss in buildings by employing image processing algorithms in combination with thermal camera data to quantify these losses.

The theoretical part focuses on the general characteristics of infrared radiation, the Stefan–Boltzmann law [1] and heat transfer mechanisms [2]. The resulting radiated energy of a body is proportional to the fourth power of its absolute temperature. The corresponding formula is expressed as:

$$E_0 = \varepsilon \cdot \sigma \cdot T^4 \quad (1)$$

Where E_0 is total emission power, $W \cdot m^{-2}$, ε is emissivity, σ is Stefan - Boltzmann constant, $5,67 \times 10^{-8} W \cdot m^{-2} \cdot K^{-4}$, T is temperature, K.

We utilized the EasIR-2 thermal camera for data collection. The core of the research involved developing a specialized program designed to detect radiated energy losses from thermal images. This program allows for the setting of scale dimensions and the selection of specific areas, such as walls or windows, to calculate the radiated power ($W \cdot m^{-2}$) and total power (W) based on input temperatures and emissivity [3]. The application (Fig.1) displays the user interface of the developed program, showing a thermal image of a building with calculated values for wall area, emissivity settings, and the final radiated

power output. The results demonstrate that the program is effective for analyzing energy losses in buildings with flat or gabled roofs. Future research will focus on expanding the software's capabilities to include various other roof types and system complexities.

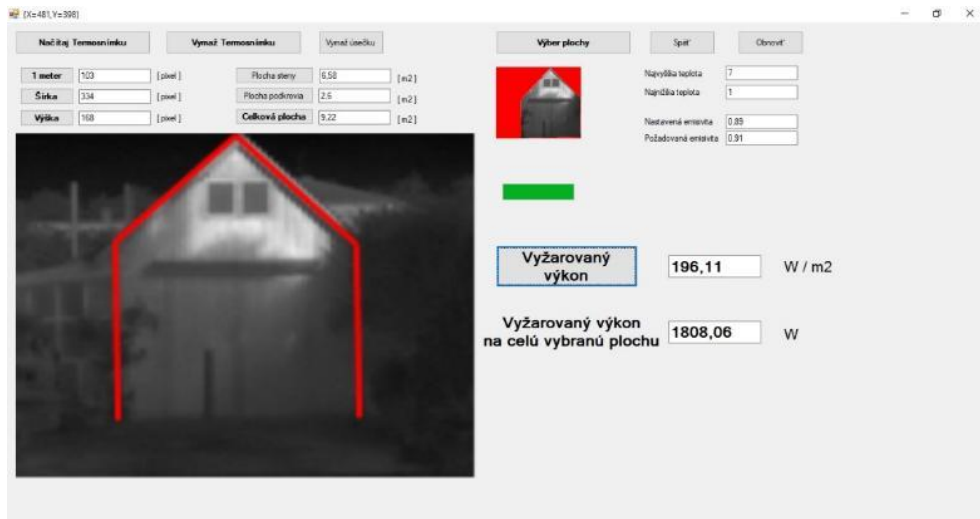


Fig. 1. User interface of the developed application with thermal image of a building, calculated wall area and final radiated power output

Acknowledgements:

This research was supported by 15-GA-SPU-2024 Research of physical properties of composite and technical materials using machine learning methods and was supported within scientific project by KEGA grant No. 012SPU-4/2026.

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Explainable Machine Learning Method Applied in Research of Electric Properties of 3D Printable Material

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Keywords: machine learning, 3D printing, explainable AI

Additive Manufacturing (AM) offers significant potential for the sustainable development of manufacturing processes within the framework of Industry 4.0. Despite the widespread industrial use of Additive Manufacturing (AM) for electrical insulation components, predicting the electrical characteristics and physical parameters of AM-produced polymer materials remains a highly complex challenge. This study presents the application of machine learning in the classification of EIS data for engineering materials in the field of additive manufacturing. The aim is to interpret more accurately the impedance characteristics of a material with improved resistance to mechanical stress, which was exposed to an increased temperature of 180°C during testing at specified time intervals from 0 to 100 minutes. In this study, we suggested and compared various machine learning models, in particular the Support Vector Machine (SVM) method and eXtreme Gradient Boosting (XGBoost). Standard metrics were used to evaluate performance, along with the SHapley Additive Explanations (SHAP) approach, which was used to analyze the impact of input parameters on the outputs of individual models. The results show the XGBoost model achieved higher classification accuracy (0.946 ± 0.003) than the SVM model (0.870 ± 0.022), as indicated by the impedance characteristics. An analysis using the SHAP method revealed that the most significant interaction effect among the model input parameters is found between impedance and phase shift.

The integration of machine learning into the analysis of the physical properties of materials presents a current research trend. In the domain of additive manufacturing, the knowledge of electrical parameters is particularly

crucial, as it is directly related to the growing use of 3D-printed materials in sensor technology [1, 2]. The tested XGBoost and SVM models with a polynomial kernel (see fig. 1) exhibit similar distributions of SHAP values for the frequency and impedance parameters. It was confirmed that the sensitivity of the models to changes in measured frequency and impedance is highly significant in classifying samples into individual classes. Further research will focus on optimizing the parameters of machine learning models and improving the accuracy of explainable AI results.

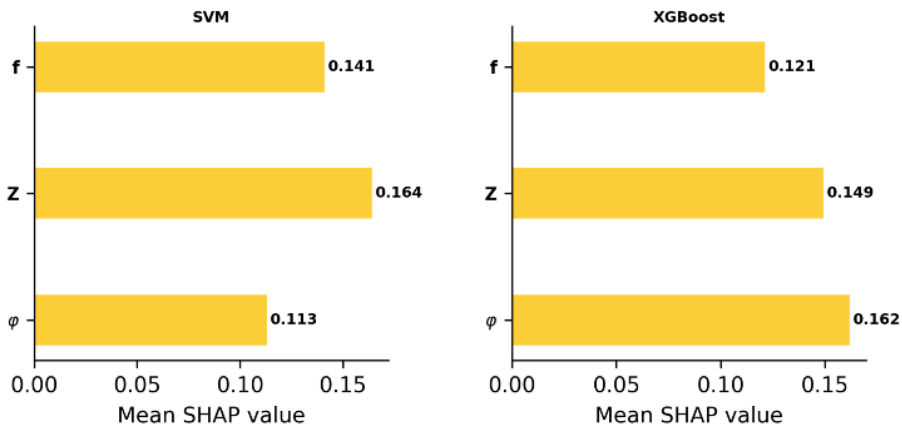


Fig. 1. Mean SHAP values of tested models.

Acknowledgements:

This research was supported by: 15-GA-SPU-2024 Research of physical properties of composite and technical materials using machine learning methods.

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Why Open Science? A practical introduction for early career researchers

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Keywords: Open Science, FAIR principles, research assessment reform

Open Science is rapidly moving from an aspirational ideal to a structural condition of academic work. Funders increasingly require data management plans, research assessment is being reformed to recognise a wider range of outputs and practices, and institutions are signing transformative agreements that change how and where we publish. For early career researchers, this shift can feel like one more compliance burden on top of an already demanding workload. This talk argues the opposite: that engaging with Open Science early is one of the most pragmatic investments a early career researchers can make in their own career.

Drawing on the UNESCO Recommendation on Open Science (UNESCO, 2021) and the FAIR Guiding Principles (Wilkinson et al., 2016) as anchoring frameworks, the presentation introduces Open Science not as a single act of "going open" but as a set of everyday practices distributed across the research lifecycle: planning data before collecting it (creating Data management plans), keeping open and well-documented lab or analysis notebooks, depositing preprints, choosing publication venues with open access routes, and sharing code and data in trustworthy repositories with persistent identifiers. Each of these is framed in terms of immediate, personal benefit - saving time when a reviewer asks for the dataset two years later, recovering one's own work after a project pause, increasing citations and collaboration opportunities, and building a portable record of contributions that travels with the researcher across institutions and borders.

The talk also situates these individual practices within the broader transformation of research assessment, with brief reference to the Coalition for Advancing Research Assessment (CoARA) and the ongoing move away from journal-impact-based evaluation toward recognising the quality and openness

of research practices themselves (CoARA, 2022). The aim is to leave participants with a clear sense of why Open Science matters for them personally, what they can start doing this week, and where to look for institutional support.

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Solar Thermal Energy in Transition

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Keywords: renewable energy, hybrid systems, solar collectors, thermal capacity and yield

Solar thermal energy, as a renewable and sustainable energy source, has attracted increasing attention in recent years due to its significant potential to mitigate climate change and reduce dependence on fossil fuels. This paper provides a comprehensive overview of the key characteristics and current status of solar thermal technologies, with particular emphasis on recent advancements, existing challenges, and future opportunities.

The global situation is analysed based on the main topics discussed at two major international conferences: the Solar World Congress (SWC 2025), organised by the International Solar Energy Society in Fortaleza, Brazil, and the EuroSun 2026 Solar Conference, to be held in Freiburg, Germany. In addition, insights from the most recent publications in the field [1–2] are incorporated to ensure a well-rounded perspective on current developments.

The key thematic areas of solar thermal energy, including solar buildings and architecture, industrial process heat, solar thermal collectors, solar heating and cooling systems, energy storage solutions, solar-assisted district heating and cooling, large-scale applications, and market trends.

Fig. 1 illustrates the evolution of global solar thermal capacity and energy yield between 2000 and 2024, based on data from the IEA Solar Heating and Cooling Programme (June 2025). By the end of 2024, the cumulative installed solar thermal capacity reached 544 GWth, corresponding to approximately 777 million square metres of collector area. The associated annual energy yield was 443 TWh, equivalent to 47.6 million tons of oil and resulting in savings of approximately 153.5 million tons of CO₂ emissions.

Accordingly, a slight decrease of around 3% in installed capacity was observed compared to the previous year. This decline can be partly attributed to the conservative estimation of collector lifetimes (15–25 years), which is typically shorter than actual operational lifespans. In addition, there is increasing competition from alternative technologies.

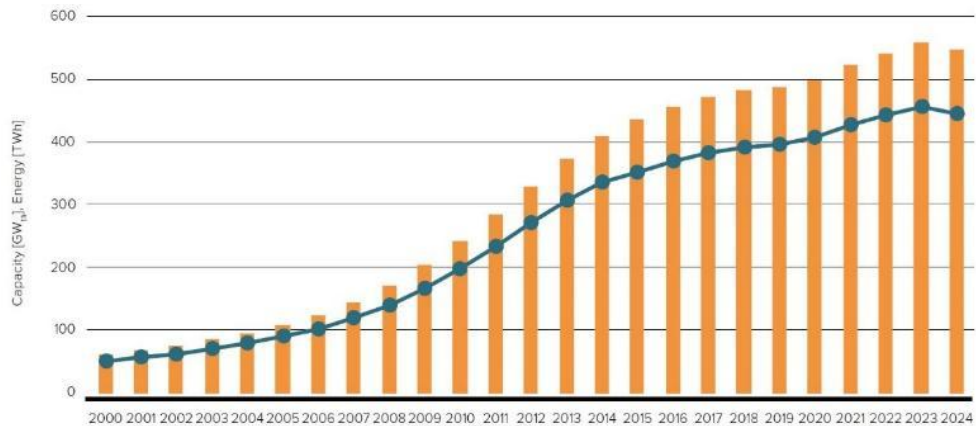


Fig. 1. Global solar thermal capacity and energy yield (2000-2024)

The leading countries in newly installed solar thermal capacity include China, Turkey, the United States, Brazil, and Germany. Notably, evacuated tube collectors accounted for more than 50% of newly installed systems.

Key challenges and opportunities in the sector include the development of efficient storage solutions, improved integration with other energy technologies, cost reduction, and evolving market dynamics. Overall, recent advancements highlight the strong potential of solar thermal energy to play a pivotal role in the transition towards a sustainable and low-carbon energy future.

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Engineered Living Materials: How Synthetic Biology Is Challenging Materials Science

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Keywords: engineered living materials, synthetic biology, information-processing materials

Living systems process information continuously. They sense, process information, and adapt to their environment with a level of sophistication that no synthetic material can currently replicate. Synthetic biology may offer a path toward changing this. By implementation of biological modules (e.g. transcription factors, CRISPR effectors, optogenetic switches, and enzymatic cascades) into engineered circuits, we can now embed sensing, logic, computation, and actuation directly into material structures [1].

Two strategies have emerged in this field. Biohybrid materials integrate synthetic molecular switches and gene circuits into polymeric or hydrogel matrices, producing systems that detect defined inputs and generate programmable outputs without requiring living cells. ELMs go even further by incorporating genetically programmed cells into structural scaffolds. This allows us to create materials that grow, self-repair, and execute complex biological computations autonomously in response to various signals [2, 3].

These approaches are defining the design principles of a new generation of information-processing materials. Their applications range from autonomous biosensing and closed-loop drug delivery to self-regulating and sustainable material systems. We discuss the key challenges ahead as the field moves from proof-of-concept to deployable technologies.

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***In vitro* micropropagation of snowdrop species (*Galanthus plicatus* M. Bieb.) and their importance in biodiversity conservation**

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Keywords: *Galanthus* sp., conservation, micropropagation

The snowdrop (*Galanthus* spp.) is a genus of perennial herbaceous plants in the Amaryllidaceae family, valued both for its ornamental qualities and for its ecological and pharmacological importance [3]. *Galanthus plicatus* M. Bieb. is a rare species listed in the Red Book of the Republic of Moldova as an endangered species. In the country, it is found in only one location – in the vicinity of the commune of Capaclia (Cantemir District), on the northern border of its range [5]. Outside of Moldova, it grows in Dobrogea (Romania) and Crimea. In this context, the use of modern plant biotechnology techniques, particularly *in vitro* culture, takes on particular importance for the conservation and propagation of these species [1].

The basic Murashige and Skoog medium [4], used for the *in vitro* initiation of the species, included macro- and microelements, chelated iron, and MS vitamins at standard concentrations (100%), supplemented with myo-inositol (150.0 mg/L), glycine (2.0 mg/L), sucrose (30.000 mg/L), and the pH was adjusted to 5.8, the optimal value for the growth and development of the explants. To induce bulblet proliferation, the Murashige & Skoog (MS) basal medium was used, tested in combination with two specific cytokinins: BAP (6-benzylaminopurine) and 2-iP (6-isopentenyladenine). The experiment aimed to evaluate the morphogenetic response of the explants at concentrations of 0.5, 1.0, 1.5, and 2.0 mg/L for both growth regulators. Another important phase is bulb growth and maturation, which was carried out on MS medium with a higher sucrose concentration of 60 g/L and the addition of naphthaleneacetic acid (NAA). As a much more stable and persistent synthetic auxin, NAA acted directly on cell expansion. Its effect was manifested by a significant increase in bulb diameter and fresh weight (from 0.15, 0.17, 0.25 to

1.0 grams). NAA stimulates the polar transport of carbohydrates toward the base of the plant, thereby forcing the thickening of the bulb scales.

Diameter growth phase (16 weeks): The bulbing induction stage, carried out on a medium containing NAA and 60 g/L sucrose, was doubled in duration, totalling 16 weeks (two subcultures of 8 weeks each). This extension of the exposure time to auxins and high osmotic stress was essential to ensure the massive transfer of carbohydrates to the storage organ, resulting in bulbs with significantly larger diameters and enhanced nutrient reserves. Final maturation phase (8 weeks): The final stage took place over the next 8 weeks on MS medium without growth regulators. In total, the protocol from the initiation of bulbils on inoculated explants until the production of mature bulbs spanned a period of 40 weeks, ensuring the complete and vigorous development of the biological material.

Acknowledgements: *The research was carried out within the collaboration program between the scientific diaspora and research and innovation organisations of the Republic of Moldova (ReBRAIN), under the project titled “Biotechnological Innovations for the Conservation of Rare Plant Species in the Era of Climate Change”, project code: 25.80013.7007.06RE, funded by NARD.*

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Innovative solutions in the solar thermal energy storage

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Keywords: solar energy, heat, energy storage

The active utilization of solar energy is a promising solution for meeting humanity’s growing energy needs in an environmentally responsible manner. Within this framework, this work focuses on thermal energy storage of thermal storage, which is closely linked to solar thermal power generation, and reviews the challenges and current solutions based on a literature analysis.

The study examines the challenges of three types of thermal energy storage: sensible, latent, and thermochemical heat storage, and discusses potential solutions based on case studies.

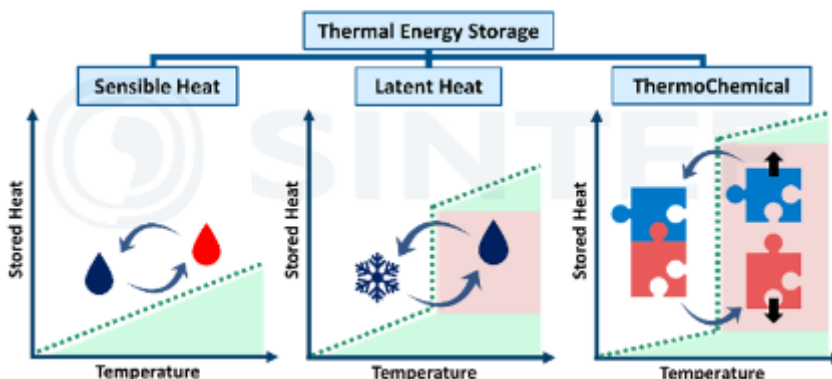


Fig. 1 Heat storage methods [1].

In sensible heat storage, the work presents results obtained using novel heat storage materials, such as graphene and nanomaterials. It also discusses recent developments in traditional storage media, including water, rocks, and

molten salts. Latent heat storage can achieve higher energy density than sensible heat storage. The relatively low thermal conductivity can be improved through encapsulation (mainly micro- or nanoencapsulation) and the use of highly thermally conductive additives (carbon nanotubes, nanoparticles) [2]. Numerous studies deal with the increase in efficiency due to the effect of various additives, but it can be said that a real breakthrough solution suitable for mass application is not yet in sight.

Even thermal energy storage systems that utilize promising thermochemical reactions for seasonal storage also face significant challenges. Hybrid systems and modular thermal energy storage offer promising pathways for the development of this field.

Modeling is also important in the field of thermal storage, as it aims in selecting thermal storage materials, understanding the processes involved in thermal storage, and optimizing those processes. Smart solutions have become essential for the design and operation of modern systems in this field as well; integration into smart systems and the application of AI methods (neural networks, fuzzy logic, metaheuristic methods) in forecasting, optimization, and intelligent system control are now essential for new systems [3]. The limited availability of high-quality datasets is a key reason why AI is primarily implemented in this field in a hybrid form, in collaboration with specialists in the field. Digital solutions are now absolutely essential.

The presentation supports the above conclusions by presenting the results of typical literature examples.

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Atmospheric pressure and liquids- physical experiments

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Keywords: hydrostatics, atmospheric pressure, flow, Bernoulli law, experiments

Among the mainly theoretical presentations we should like to show the interesting side of Physics, that is the reason why we started several years ago to have experimental presentations. We would also go on with this tradition this year with the Physics of liquids which is very essential for the Engineering, and for the biological systems as well.

At the beginning, some experiments about hydrostatics are planned to be presented. With the pressure of the liquids, which changes much faster as the air pressure with the height because of their higher density, the effect of the increased and decreased pressure can be shown. Although, there are some special equipment for pressure decrease (e.g. vacuum pumps), similar results can be achieved by other tricky ways as well, as it will be demonstrated. The atmospheric pressure is an enormous pressure, but we got accustomed to it, but if it changes very big forces can develop, as it will be demonstrated.





If the medium starts moving, it causes change in the pressure as it is described by the Bernoulli law. This law gives the background for numerous surprising experiments, which will be demonstrated mainly with air stream, instead of liquid, as the realization is much simpler.

In biological systems viscosity determines the flow, on this field the most interesting materials are the so called Non-Newtonian mediums, where the viscosity of the medium is depending on the speed of the deformation. During our experiments we will demonstrate this behavior with starch, or to be more exact, with starch solution. In the very end (if our time schedule makes it possible yet) some experiments about the surface tension is planned to show.

We hope that these experiments will give an enjoyable way to meet with the physics.

Acknowledgement

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Enhancing photovoltaic/thermal system performance using phase change materials and fins

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Keywords: thermal performance, hybrid nanofluid circulation, heat transfer, electrical performance

The photovoltaic-thermal (PV/T) system is an innovative solar energy technology that can generate both electrical and thermal energy. With the growing global energy demand, solar-powered air conditioning, particularly hybrid solar cooling systems, has emerged as a promising alternative to conventional fossil-fuel-based cooling technologies [1]. Experimental measurements were conducted on two PV/T system configurations and compared against a reference PV module to assess their performance using PCM and fins [2].

To improve thermal performance, 50 fins of varying surface areas were uniformly attached to a copper plate using Sn99Cu1 solder, ensuring high thermal conductivity and structural stability. Aluminium pouches (40 × 50 × 24 mm) were incorporated as thermal storage and enclosure units.

Fig. 1a illustrates the impact of these configurations on PV cell temperature. The reference module ($T_{c, \text{ref}}$) exhibited the highest operating temperature due to the lack of thermal regulation. Conversely, both the finned copper ($T_{c, \text{fin}}$) and PCM-integrated ($T_{c, \text{pcm}}$) configurations maintained significantly lower and more stable temperatures throughout the day. Through improved dissipations, the finned copper structure reduced the temperature. Meanwhile, the PCM-based design stabilised the temperature by absorbing excess heat during the melting process, effectively buffering midday

temperature spikes. The close alignment of $T_{c, \text{fin}}$ and $T_{c, \text{pcm}}$ suggests that both methods provide comparable levels of thermal regulation [2].

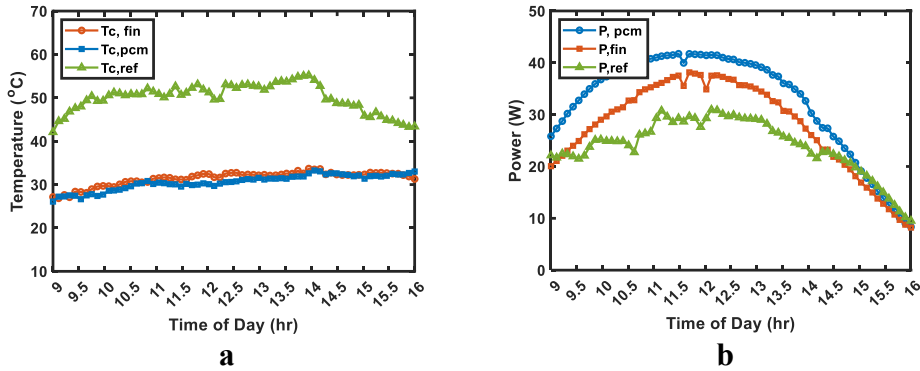


Fig. 1. Comparison of fin and PCM configured PV module: a) cell temperature, b) power generated

Fig. 1b presents the experimental power output of the PV modules. The reference module (P_{ref}) exhibited the lowest performance, with midday reductions caused by elevated cell temperatures and the absence of cooling. Its power output dropped to approximately 25.5 W at midday. In contrast, the finned copper configuration (P_{fin}) and the PCM aluminium configuration (P_{pcm}) achieved substantially higher power outputs, confirming the beneficial role of heat extraction and thermal buffering [2].

Acknowledgment:

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Assessment of a 3.3 kWp STPV system under real operating conditions

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Keywords: 4e analysis, photovoltaic technology, energy production, seasonal effects, sustainability

Photovoltaic (PV) systems, particularly semi-transparent photovoltaic (STPV) technologies, offer a promising solution for sustainable energy generation while enabling multifunctional applications. Based on five years of operational data (2017–2021) gathered in Gödöllő city, Hungary, this study presents a thorough 4E (energy, exergy, economic, and environmental) analysis of a 3.3 kWp STPV system [1]. The final goal is to assess the system's sustainability and long-term performance under actual climatic conditions.

To provide a comprehensive understanding of system performance, the methodology combines energy and exergy analysis with economic assessment and environmental impact assessments. The findings demonstrate that seasonal variations greatly affect the system's energy production, with higher outputs during times of higher solar irradiation. While the economic evaluation shows the system's viability during its operational lifetime, energy analysis reveals the intrinsic inefficiencies connected to energy conversion processes. Additionally, the environmental evaluation shows that the STPV system can lower carbon emissions compared to traditional energy sources [2].



Fig. 1. Integrated 4E analysis framework for STPV system

Overall, the results show that STPV systems, especially in building-integrated applications, might be an efficient and sustainable energy solution. The thorough 4E framework provides a quantitative framework for improving system design and assisting in the adoption of renewable energy.

Acknowledgments

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Effect of discrete square fin on the performance of a solar drying system

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Keywords: Solar collector, fin design, energy efficiency, drying chamber

Solar drying systems are an effective and environmentally friendly method for drying agricultural products, with significant potential for widespread application [1]. Numerous studies have focused on improving the efficiency of solar drying systems to enhance their economic viability. Adding fins to the absorber plate is a common heat transfer enhancement technique, which increases the heat transfer area and intensifies convective heat exchange, thereby improving the collector energy efficiency and overall drying performance of the system [2].

This study aims to experimentally investigate the effect of installing rectangular fins on the absorber plate on the performance of a solar drying system. The experimental setup for the solar drying system is shown in Fig. 1.

The solar drying system mainly consists of two different single-pass solar air collectors, two drying chambers of identical dimensions, a fan, and a supporting base, all connected by ducts. The solar air collectors are oriented south-facing and installed at an optimal tilt angle of 45° to the ground [3]. The air collector is constructed with a wooden frame, and its main components include a transparent plastic cover and a copper absorber plate. The drying chamber is built using 5 cm thick extruded polystyrene (XPS) panels, which provide good thermal insulation. Trays are arranged inside the drying chamber to provide stable support for the drying materials.



Fig. 1. Solar air collectors with different fin orientations

During the experiment, three trays were placed in the drying chamber, and the drying material consisted of apple slices with an initial weight of 900 g. This study evaluates the effect of rectangular fins on the performance of the solar drying system by analysing various performance parameters.

Acknowledgments

This work was supported by the Stipendium Hungaricum Program and by the Doctoral School of Engineering Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

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Comparative Study of MPPT Techniques in Photovoltaic Systems

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Keywords: PV system, MPPT, P&O, optimization

Photovoltaic (PV) systems are significantly affected by variations in solar irradiance and temperature, which lead to continuous changes in the maximum power point (MPP) and reduced energy conversion efficiency. To address this limitation, Maximum Power Point Tracking (MPPT) techniques are employed to ensure optimal operation under dynamic conditions.

This study presents a comparative analysis of conventional and advanced MPPT methods, including Perturb and Observe (P&O), Incremental Conductance (IC), fuzzy logic-based control, and Particle Swarm Optimisation (PSO). A PV system model incorporating an MPPT controller and DC–DC boost converter was developed in MATLAB/Simulink (Fig. 1) and tested under rapidly varying irradiance conditions [1].

This comparative work indicates that conventional techniques exhibit limitations such as oscillations and slower dynamic response, whereas advanced approaches improve stability and tracking performance. In particular, the modified PSO algorithm demonstrates superior performance, achieving fast convergence, reduced oscillations, and enhanced stability under transient conditions (Fig. 2).

The results presented in the presentation highlight the effectiveness of optimization-based MPPT techniques in improving the efficiency and reliability of photovoltaic systems operating in real-world environments.

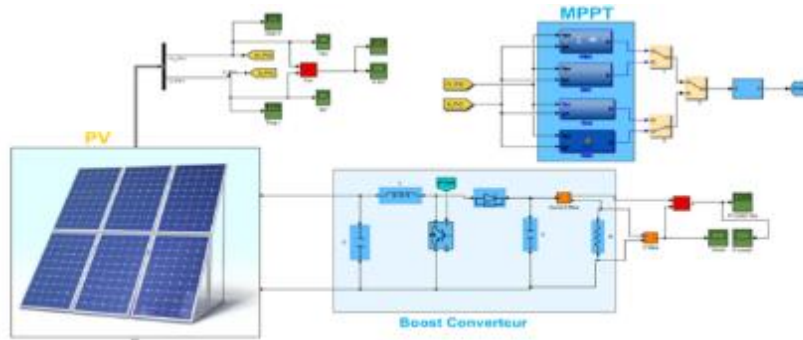


Fig. 1. Simulink model of the photovoltaic system with MPPT and DC–DC boost converter.

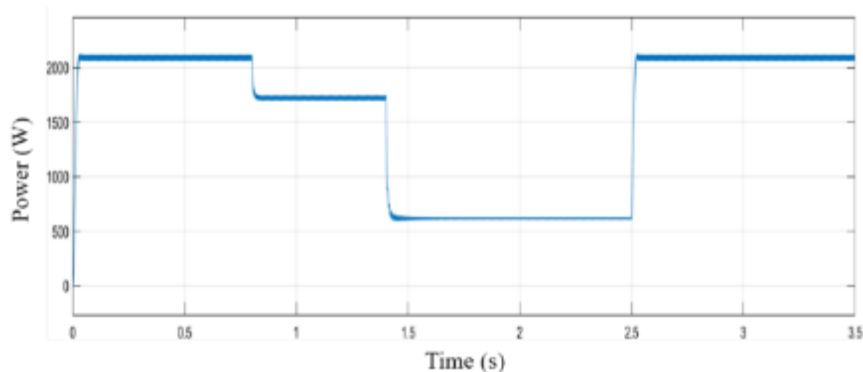


Fig. 2. PV power response using the modified PSO algorithm under dynamic irradiance conditions.

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ESP-NOW protocol for wireless sensors network in smart farming

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Keywords: sensing range, transmission range, energy consumption

ESP-NOW is a wireless communication protocol developed by Espressif Systems, which allows multiple devices to communicate with each other without the need for a router and is power efficient in operation. Wireless Sensor Networks (WSN) in smart farming are used to transmit data between sensor nodes in agricultural fields. The Wireless Sensor Network (WSN) required for smart agriculture can be assessed based on the transmission distance between nodes, data transmission speed, transmittable data capacity, and energy consumption. The transmission distance between nodes is limited by the sensing capability of the sensors. In a sensor network, each node has two types of range parameters, namely sensing range and transmission range, where the transmission range must be greater than or equal to the sensing range [2]. To obtain parameters that affect crop yield, the transmission distance between nodes is limited by the sensing capability of the sensor. The parameters of the growing media conditions that affect the harvest yield do not change quickly, so the measurement process does not need to be carried out every second. In the data transmission process, the data to be transmitted can be selected so that the capacity of data can be limited. In a sensor node, it only consists of one or several sensors, and the data to be transmitted can be determined so that the capacity of the transmitted data is not large. The energy consumption of sensor nodes in smart farming greatly affects the operating time, so low-power components are required.

An ESP-NOW protocol was used to monitor air conditions in the greenhouse. Four sensor nodes and one gateway were used with a tree topology

containing a DHT21 sensor [1] (Fig. 1). Maximum range test is conducted in a Line-of-Sight condition in an outdoor parking area and using the built-in antenna of WEMOS D1 mini (ESP8266 based microcontroller), the maximum range is 45 meters. In active condition, the power required is 78.67 mA and for 24 hours of operational time, a battery capacity of 1888.16 mAh is required. By activating the sleep mode feature available in the microcontroller, the operating time will be longer. Based on this study, the use of ESP-NOW as a WSN protocol in smart farming can be studied further for future research.

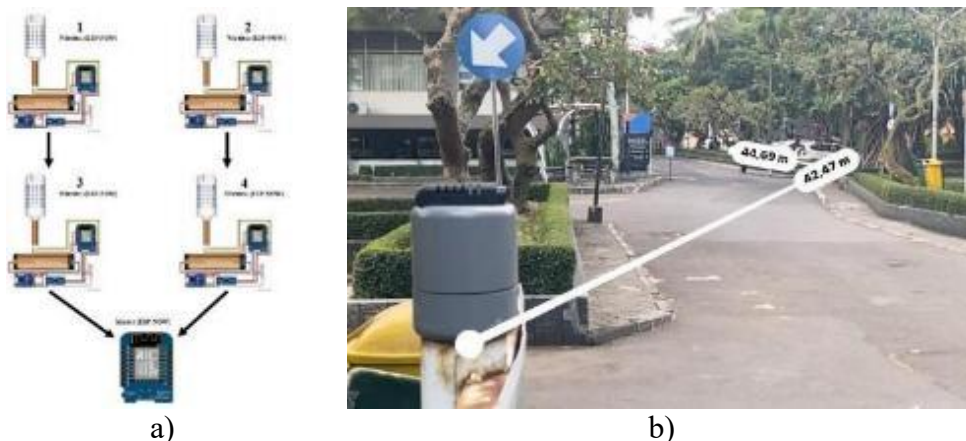


Fig. 1. a) Flow ESP-NOW protocol between sensor node; b) Range test in parking area (Hartawan et al., 2024)

Acknowledgments

This work was supported by the Stipendium Hungaricum Program and by the Doctoral School of Engineering Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

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Intelligent autonomous solar tracking using advanced PID

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Keywords: Solar tracking systems, Parabolic trough collectors, PID-based control, QRAWCP method, Energy efficiency

This study presents the design, modelling, and performance evaluation of an intelligent autonomous solar tracking system for cylindro-parabolic collectors (CPCs), incorporating an advanced Proportional Integral Derivative (PID) control strategy based on the Quadratic Regular Approach with Compensating Pole (QRAWCP), as illustrated in Fig. 1. In contrast to conventional solar tracking techniques that depend on predefined geographical parameters or computationally intensive optimisation algorithms, the proposed system operates in real time through sensor-based feedback, thereby ensuring enhanced responsiveness and adaptability under dynamically varying environmental conditions. Precise solar alignment is a critical factor in CPC systems, as it maximises the concentration of incident solar radiation on the absorber, leading to improved thermal efficiency (Touaref et al., 2025). Within this framework, the implementation of an intelligent PID controller facilitates continuous tracking error minimisation and ensures optimal dynamic performance. Furthermore, a comprehensive simulation framework was developed utilising climatic data from the MATE Solar Laboratory in Gödöllő, Hungary, in conjunction with a detailed three-dimensional model constructed in SolidWorks and analysed using ANSYS Fluent, to evaluate system performance under varying solar irradiance, ambient temperature, and wind conditions.

The QRAWCP-based PID controller demonstrates a significantly faster dynamic response compared to CSA, PSO, and FFA-based PID methods, as illustrated in Fig. 2. The proposed approach reaches steady-state almost instantaneously (≈ 0.05 s) with negligible overshoot, whereas the other

controllers exhibit slower rise times and gradual convergence, settling around 0.3-0.4 s. This confirms the superior transient performance and rapid convergence capability of the QRAWCP tuning strategy without the need for iterative optimisation:

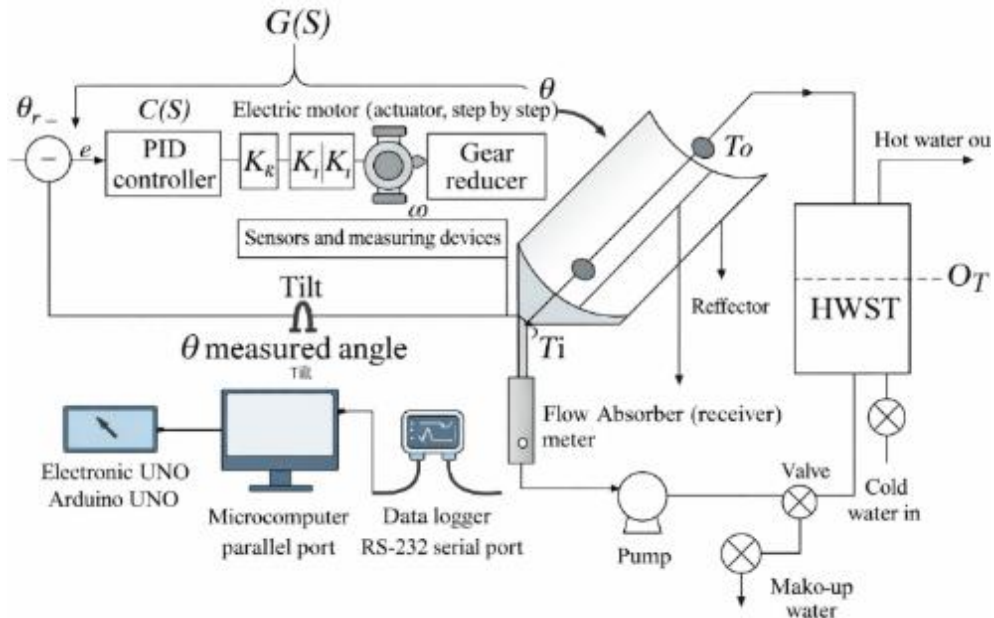


Fig. 1. Schematic diagram of the solar tracker control system

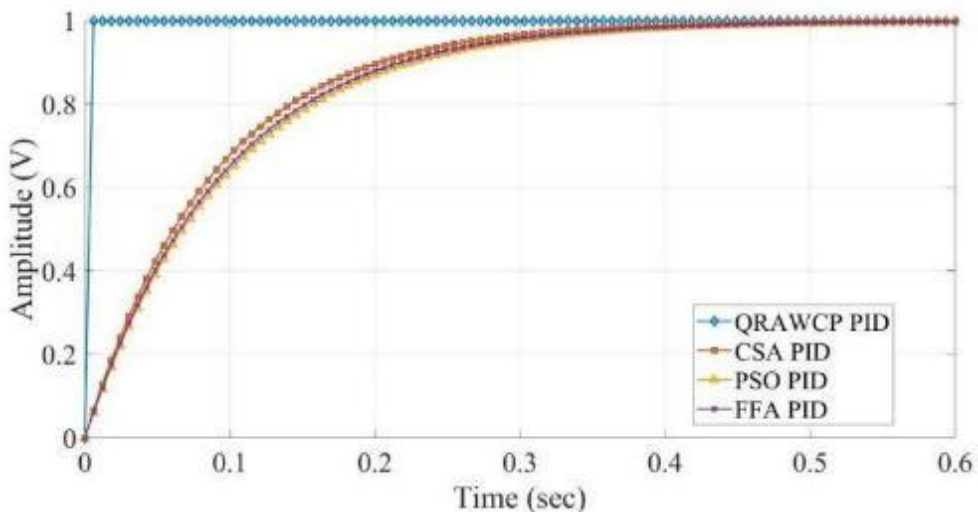


Fig. 2. Comparative step response of the system using QRAWCP-PID and metaheuristic-based PID controllers

The integration of real-time sensing and the QRAWCP-based PID controller enables up to 40% improvement in solar energy capture compared to fixed CPC systems. The proposed approach demonstrates superior dynamic performance, achieving settling times below 2 seconds, overshoot under 5%, and high tracking accuracy within $\pm 0.1^\circ$, significantly outperforming conventional optimisation-based methods. In addition, the system maintains strong robustness under disturbances and parametric uncertainties of up to 70%, ensuring stable and reliable operation under varying environmental conditions. The use of a direct analytical tuning method also reduces computational complexity by about 80%, eliminating the need for iterative optimisation. Overall, these results confirm that the proposed system is accurate, efficient, and practical, offering a scalable solution for advanced and intelligent solar tracking applications.

Acknowledgments

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Environmental footprint of low-GWP working fluids in decentralised solar ORC systems

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Keywords: Solar-ORC, organic working fluids, greenhouse gases, life-cycle assessment (LCA), low-GWP alternatives

Global demand for sustainable energy makes Solar-ORC technology a key solution for converting low-grade solar thermal energy into electricity, especially where photovoltaics underperform [1]. Solar-ORC systems operate between 65 °C and 400 °C and emit zero greenhouse gases during operation. LCA is necessary for fluid selection, construction, operation, and decommissioning. Leaks of high-global-warming-potential (GWP) fluids like R245fa, R227ea, and R134a increase lifecycle emissions. The EU F-gas Regulation and the Kigali Amendment seek to phase out high-GWP fluids, encouraging low-GWP alternatives such as hydrofluoroolefins (HFOs) and natural refrigerants.

This paper presents thermodynamic and environmental analysis of four working fluids: R245fa (GWP = 1030), R134a (GWP = 1300), isobutane (GWP = 3), and R1234yf (GWP = 4) within a Solar-ORC setup (Fig. 1). The system is modelled as a closed loop consisting of a solar collector, evaporator, turbine, condenser, and circulation pump under steady state. Thermodynamic states are obtained using NIST REFPROP under two scenarios: constant turbine inlet temperature of 110 °C with pressures from 10–20 bar, and constant 10 bar with temperatures from 90–110 °C. R1234yf performance metrics are taken from the literature. The environmental analysis includes GWP, ozone depletion potential (ODP), atmospheric lifetime, ASHRAE safety class, and CO₂-equivalent footprint, supported by lifecycle studies of leakage, manufacturing, and decommissioning impacts.

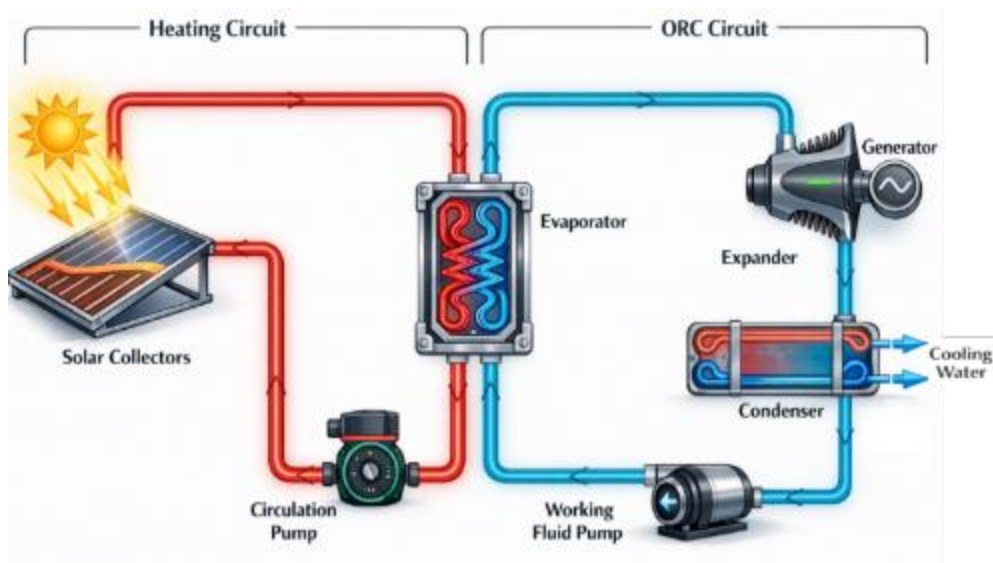


Fig. 1. Schematic layout of the solar-ORC system

The results show that isobutane achieves the highest power output (61.5 kW, 13.9%), while R245fa provides the highest efficiency (14.4%, 35.8 kW). R134a produces the lowest performance (9.6%, 23.7 kW) and R1234yf shows moderate performance (10.1%, 21 kW) with the lowest environmental footprint, a 99.7% reduction in emissions relative to R134a, and an upgraded 2AL safety classification. Isobutane is optimal for thermal performance, while R1234yf offers the best balance of performance and regulatory compliance.

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Assessment of the potential of various types of biomass for the synthesis of artificial humic acids

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Keywords: lignocellulosic biomass, artificial humic acids, artificial humic-like acids

Soil organic matter, particularly humic substances (HS), plays a fundamental role in soil fertility, structural stability, and sorption capacity, thereby influencing plant productivity and overall ecosystem functioning [1]. In recent years, increasing attention has been devoted to better understanding humification mechanisms and to developing methods for producing artificial humic acids (AHAs, called sometimes as artificial humic-like acids, HLAs) from waste biomass [2,3]. Despite considerable progress in this field, a systematic evaluation of different biomass types as substrates for AHAs remains limited. In particular, the relationships between biomass physicochemical properties, reactivity, and the ability to form stable humic-like structures require further investigation.

The aim of this study was to provide a comprehensive physicochemical and chemical characterization of selected agricultural and forestry waste biomasses to assess its potential to AHAs production. The study included the determination of density (helium pycnometry), moisture content (oven-drying method at 105 °C), pH (potentiometrically), ash content (muffle furnace combustion), metal concentrations (atomic absorption spectroscopy), carbon (C), hydrogen (H), nitrogen (N), sulphur (S) and oxygen (O) content (elemental analysis) as well as contents of lignin, cellulose, and hemicellulose (fiber analysis). In addition, Fourier-transform infrared spectroscopy (FTIR) was used to identify functional groups in the biomass.

The results revealed considerable variability among the investigated biomass types. FTIR and compositional analyses showed clear differences between woody and straw-based biomasses: woody samples contained more

lignin and showed greater aromaticity, whereas straw materials were richer in hemicellulose, indicating a more reactive carbohydrate fraction. Elemental analysis showed relatively similar C and H contents, while greater differences were observed for N and the H/C and O/C ratios. Sulfur content remained low in all samples. The characterization showed also clear differences between specific biomass samples. Oak was the most promising woody biomass, owing to the absence of detectable Cd and Pb, low ash content, favorable lignocellulosic composition, and relatively high H/C and O/C ratios. Among straw biomasses, rye straw showed the greatest potential due to its high hemicellulose content and accessible polysaccharide structures. Thus, oak and rye straw can be considered promising candidates for further studies on artificial humic-like acids production.

These findings provide a scientific basis for the selection of suitable biomass feedstocks and for the optimization of conversion processes aimed at producing AHAs. Overall, woody biomass appears to be promising due to its potential to serve as a structural backbone, source of oxygen, aromaticity and high stability of humic-like products. In turn, straw-based biomass may offer advantages related to higher reactivity during the initial stages of transformation and generation rich pools of precursors. This is particularly relevant for the development of sustainable biomass valorization technologies and soil remediation strategies.

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Influence of digestate-derived biochars enriched with *Trichoderma atroviride* G79/11 on soil wettability

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Keywords: biochar, contact angle, WDPT, *Trichoderma atroviride* G79/11, soil

Soil wettability is crucial for various physical and biochemical processes. When soil is not fully wetted by water, it is considered water-repellent, a condition caused by the adsorption of organic molecules onto mineral surfaces. These organic compounds can originate from sources such as organic amendments, fungal hyphae, humic substances, microbial biomass, or partially decomposed plant residues. Soil water repellency significantly influences key hydrological processes in the vadose zone, including infiltration, preferential flow, and the distribution and dynamics of soil moisture [1,2].

This study aimed to investigate the effects of biochar inoculated with *Trichoderma atroviride* G79/11, originated from the collection of the Laboratory of Molecular and Environmental Microbiology (IA PAS, Lublin, Poland), on the wettability of degraded soils.

The biochars used in the experiment were produced at 300°C, 450°C, and 600°C using digestate obtained from biogas plants. Next, biochars were inoculated with spores of *Trichoderma atroviride* G79/11 (5.04×10^8 CFU/g) and incorporated into Brunic Arenosol soil (BA) at application rates 0.5%, 1%, 3%, and 5%. The amended soils were then incubated at 23 °C during 14 days. Key parameters, such as the initial contact angle (CA) and water drop penetration time (WDPT), were measured goniometrically by observing a 5- μ L drop of distilled water placed on a flat surface of the sample.

The results showed that the type of biochar plays a key role in modifying soil wettability, and its effect can be partly linked to the content of soluble organic compounds, which may extensively coat mineral surfaces. Low-temperature biochar (produced at 300°C) increased both the contact angle and the water drop penetration time, indicating greater soil repellency. In

contrast, high-temperature biochars (produced at 450°C and 600°C) showed no effect or tended to decrease the contact angle, respectively. The application of low-temperature biochar may support improved soil water management in sandy soils, including enhanced water retention and controlled infiltration. More broadly, biochar may reduce surface runoff and, consequently, limit water erosion.

Acknowledgments

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Comparison of the effectiveness of herbicide and heavy metal immobilization in silty soil modified with waste-derived activated carbons

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Keywords: soil modification, pollution immobilization, activated carbon

Soil contamination by excess of herbicides and heavy metals poses an environmental challenge. One of the approaches to address this problem is the adsorption of these contaminants within modified soil, which may lead to their immobilization and limit their toxicity. Therefore, the aim of this study was to investigate the effectiveness of activated carbons (AC) derived from orange peels produced using different production methods as sustainable soil amendments for immobilizing both organic and inorganic pollutants. Additionally, polymers of different nature were used in the desorption studies. Among the herbicides, glyphosate was selected, while cadmium was chosen as the representative heavy metal. Two ACs were examined: (1) orange peels-derived AC, prepared at 800°C in a conventional furnace, under CO₂ atmosphere (OFC800) and (2) orange peels-derived AC, prepared at 800°C in a microwave furnace, under CO₂ atmosphere (OFM800). Both ACs described in this study were considered as suitable for environmental applications, according to *European BC Certificate* [1, 2]. Study was performed on silty soil (Haplic Luvisol, HL).

Previous studies performed in aqueous environment showed that OFC800 exhibits a higher affinity for herbicides than OFM800, whereas

OFM800 demonstrates greater adsorption capacity for heavy metals than OFC800 [1, 2], which has also been observed in soil systems. For example, HL amended with OFC800 adsorbed 53.4% of glyphosate, while OFM800-amended HL – 48.0%, compared to the 44.4% obtained for non-modified HL. Similar situation occurred for Cd(II) adsorption, where adsorption effectiveness reached 8.0, 17.5 and 23.2% for HL, OFC800-amended HL, and OFM800-amended HL, respectively. Desorption studies (Tab. 1) showed that investigated ACs can- effectively immobilize pollutants of different nature.

Tab. 1. Desorption degree (%) of glyphosate and cadmium(II) from HL and AC-amended HL with and without exopolysaccharide (EPS), cationic (CtPAM) or anionic (AnPAM) polyacrylamide

pollutant system	glyphosate		cadmium(II)	
	HL	HL + OFC800	HL	HL + OFM800
H ₂ O	55.0	23.1	32.6	10.5
100 mg/L EPS	15.8	19.9	44.8	10.8
100 mg/L CtPAM	19.2	7.2	48.1	26.6
100 mg/L AnPAM	43.9	27.2	36.7	10.9

This work was financed by the National Science Centre, Poland (OPUS21, 2021/41/B/NZ9/03059).

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Exploring the biology and agricultural potential of entomopathogenic fungi from *Akanthomyces* genera

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Keywords: entomopathogenic fungi (EPFs), *Akanthomyces*, biocontrol

Entomopathogenic fungi (EPFs) are among the key biotic factors that play an important regulatory role in the environment, influencing the population sizes of individual arthropod species and their trophic relationships, often resulting in epizootics. Owing to their unique mechanism of infection and host specificity, EPFs are considered safe for the environment. Most of these fungi occur naturally in soils worldwide, and certain strains of selected species have been registered as biological control agents. Taxonomically, the majority belong to the order Hypocreales and the family Cordycipitaceae [1].

Akanthomyces is one of the earliest genera in the Cordycipitaceae family. It was founded by Lebert in 1858, based on the type species *A. aculeatus* Lebert, isolated from a lepidopteran moth. This genus currently comprises over 60 species. It includes entomopathogenic, endophytic, and saprotrophic forms. The wide variety and extensive distribution of these microorganisms make them promising candidates for use in biological plant protection [2]. Nevertheless, species belonging to the genus *Akanthomyces* remain less well understood and studied than other entomopathogenic fungi in the order Hypocreales.

In our research, we therefore decided to focus on deepening understanding of *Akanthomyces*, our aim is to identify the genetic and metabolic bases underlying their unique properties.

We conducted a meta-analysis of the available data on their environmental habitat preferences, and correlations with specific plants. Furthermore, we investigate the metabolic profile of these fungi as well as their

morphological characteristics, which are significant in the process of arthropod infection, biocontrol, and the promotion of plant growth, and their application in agriculture.

Acknowledgement

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Comparison of Surface Chemistry and Textural Parameters of Activated Carbons from *Hermetia illucens*

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Keywords: activated carbon, *Hermetia illucens*, surface chemistry, textural parameters

An increase in the quantity of post-production residues is associated with the growth of the insect industry on a large scale. For example, the global insect market was estimated to be worth US\$0.51 billion in 2021 and is projected to grow to US\$1.8 billion by 2028 [1]. Sustainable waste management is becoming more and more important. These wastes have special qualities and can be used for a variety of purposes, such as soil regeneration, pollutant removal, and carbon sequestration, when they are transformed into value-added carbon-rich products [2].

In this study, dead imagoes of *Hermetia illucens* were used to produce activated biocarbons. The materials were obtained by the indirect method (partial gasification of biochar) and the direct method (activation of raw biomass) [3]. In the first procedure, biochar was produced at 500 °C and further activated in a flow of water vapor for 30 min in a furnace preheated to 800 °C. Direct activation involves simultaneous pyrolysis and activation conducted in a furnace preheated to 750 °C for 30 min in a water vapor atmosphere. The resulting solids showed good surface, chemical, and textural parameters. Surface chemistry of both types of activated biocarbons demonstrated the presence of several functional groups with bands at: (1) 3600-3200 cm⁻¹, corresponding to –OH/–NH stretching vibrations from hydroxyl and amino groups, as well as adsorbed water, (2) 170-1390 cm⁻¹ corresponding to C=O stretching from amide, C=C stretching from aromatic ring, N-H/C-N stretching from amides, (3) 1271-995 cm⁻¹ corresponding to C-O and C-O-C stretch from symmetric and asymmetric saccharides, and finally (3) 657-430 cm⁻¹ corresponding to Si-O-Si and P-O stretches. All solids displayed

heterogeneous structures rich in channels, cracks, and cervices. The indirect activation of biochar with water vapour allowed the production of the materials of the most promising textural parameters with a specific surface area of 209 m²/g, microporosity of 175 m²/g, and total pore volume of 0.119 cm³/g. Such good parameters allow us to predict that this material will be an effective adsorbent for organic and inorganic pollutants. Thus, the waste from *Hermetia illucens* breeding can be effectively used to produce activated biocarbon with a well-developed surface.

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Biochar as a feed additive: potential applications in insect nutrition

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Keywords: biochar, feed additive, insect nutrition

Biochar, a carbon-rich substance obtained through the pyrolysis of biomass, is gaining attention as a potential feed additive in animal production systems. In ruminants, pigs, poultry, and fish, its inclusion at levels of approximately 0.1- 4% of daily feed intake has been linked to improved growth performance, better feed conversion, enhanced product quality such as meat, milk and eggs (Nair et al. 2023). Research shows that biochar has a wide-ranging impact on animals. It improves the welfare of farm animals by boosting their resistance to disease and maintaining a healthier gut microbiome. Adding biochar to the diet of laying hens has led to increased absorption of nutrients and minerals such as calcium and phosphorus (Kazemi 2025). Research on livestock supplemented with biochar (including cattle, goats, pigs, chickens, ducks, and fish) indicates increases in body weight along with a reduction in feed conversion ratio (FCR), suggesting improved biomass accumulation and more efficient feed use (Man et al. 2020). In the context of insects, studies have focused less on the nutritional role of biochar and more on its biological impacts. A study examining the impact of biochar on the survival of forest insect species found that, when these species were exposed to direct contact with biochar, a significant decrease in survival rates was observed only in three out of four species studied (Cook et al. 2018). When incorporated directly into artificial diets or pupation substrates, biochar has generally been shown to inhibit growth, survival, and successful

metamorphosis in lepidopteran species such as *Manduca sexta* and *Spodoptera frugiperda* (Wagle et al., 2025). When considering another species of insect - *Hermetia illucens* that adapts very well to environmental changes, the addition of biochar did not improve larval growth but did increase their calcium content. A lower number of potential pathogens, such as *Escherichia - Shigella*, was also observed in the larvae's intestines (Reyer et al., 2025). In contrary, when biochar has been added in the dose of 5% to the substrate of *Hermetia illucens* waste degradation efficiency was the highest (Beesigamukama et al., 2020). Therefore, it remains unclear whether biochar could be applied in the rearing of insects intended for feed and food in a way that supports their development. This presentation aims to summarize the current state of knowledge regarding the use of biochar in insect nutrition.

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Printability and rheological optimization of low-methoxyl pectin bio-inks crosslinked with calcium ions for 3D bioprinting applications

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Keywords: extrusion-based printing, shear-thinning behavior, calcium chloride crosslinking

Three-dimensional bioprinting has emerged as a versatile technique for fabricating biomimetic structures for biomedical and food-related applications [1]. In this study, low-methoxyl (LM) pectin crosslinked with calcium ions was investigated as a potential bio-ink for extrusion-based 3D printing [2].

Bio-ink formulations were developed by varying the concentrations of LM pectin and calcium chloride, followed by rheological characterization and printability evaluation using standard printed geometries. Structural fidelity and mechanical performance were assessed through image analysis and compression testing. Shape retention of printed structures was quantified using parameters such as uniformity factor, pore factor, and perimeter coefficient [3].

Comprehensive physicochemical characterization of the commercial pectin was conducted. Monosaccharide composition was analyzed via gas chromatography with flame ionization detection (GC-FID), while the degree of methylation was determined using high-performance liquid chromatography (HPLC). Molecular size distribution and hydrodynamic radius were assessed through size-exclusion chromatography coupled with multi-angle light scattering (SEC-MALS). Additionally, galacturonic acid content was quantified using a colorimetric continuous flow analysis, and nanoscale structural features were visualized by atomic force microscopy (AFM).

Both rheological characterization and image analysis based evaluations enabled a comprehensive assessment of printability and structural fidelity. The concentrations of LM pectin and CaCl₂ were found to significantly influence shape retention and mechanical performance of the printed constructs, allowing precise tuning of bio-ink properties. Formulations containing 4.4 g/100 mL LM pectin with 10 and 17 mM CaCl₂, as well as the formulation with 5 g/100 mL LM pectin and 17 mM CaCl₂, demonstrated superior printability and mechanical integrity. These formulations exhibited optimum minimum printing pressures (25-30 kPa) at a constant printing speed of 5 mm/s. These findings validate the rheological criteria used for selecting optimized bio-ink compositions.

Overall, the results confirm that LM pectin crosslinked with Ca²⁺ is an effective and tunable bio-ink for 3D printing, capable of producing structures with high shape fidelity and desirable mechanical properties.

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Organic soils as a source and sink of greenhouse gases

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Keywords: organic soils, peatlands, greenhouse gas emissions, carbon cycle

Organic soils are defined, according to IPCC guidelines, as soils with a substantial organic horizon (≥ 10 cm) and high (12–20%) organic carbon (C) content, depending on water saturation and clay content [1]. Although they account only for approx. 3-5% of Earth's land surface, they store up to one-third of world's soil organic C [2,3]. By functioning as long-term C sinks and sources, organic soils are fundamental to the global C cycle. However, despite their importance, the overall greenhouse gas (GHG) balance of organic soils remains highly uncertain due to their inherently dynamic nature, complex process interactions and a limited number of long-term field measurements.

Organic soils are key components of the GHG balance, as they exchange carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) with the atmosphere, which is modulated by water conditions. In their natural, waterlogged state, a high groundwater level results in anaerobic conditions that substantially decreases decomposition rate. This results in long-term C accumulation and net CO₂ uptake, while promoting CH₄ production through methanogenesis [2,3]. The climatic role of organic soils changes markedly under anthropogenic drainage, primarily conducted for agriculture and forestry, and further intensified by ongoing global warming. Lowering the groundwater level introduces oxygen into peat layers, stimulating microbial oxidation of organic matter. This results in substantial CO₂ emissions and enhanced N₂O production *via* nitrification and denitrification processes under nitrogen-rich conditions [3,4].

Apart from the hydrological conditions, GHG fluxes in organic soils are controlled by a range of other factors, including temperature, chemical properties, substrate availability, which affect biological activity. These factors regulate key soil microbial processes such as respiration, methanogenesis, and

denitrification, thereby influencing the balance between GHG production and consumption [2-4]. Interactions between vegetation and soil further modulate these dynamics, for example through effects on litter quality and plant-mediated gas transport. In addition, soil GHG fluxes are characterized by substantial spatial and temporal variability. This uncertainty arises from the presence of “hot spots” of elevated emissions and occasional “hot moments” triggered by environmental changes, which can affect annual budget [4].

Due to the complexity of interactions among these drivers, improved quantification of GHG fluxes through field measurements and long-term experiments are essential for reducing uncertainties in GHG balance estimates of organic soils. Integrating such data into GHG inventory modelling can support compliance with EU climate policy and regulations, while also contributing to the development of effective mitigation strategies.

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Influence of fruit ripening on the molecular and nanostructural properties of apple pectin (*Malus domestica* cv. Golden Delicious)

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Keywords: pectin, fruit ripening, monosaccharide composition, atomic force microscopy, persistence length

Pectin is a plant-derived polysaccharide abundant in the cell wall and middle lamella of plants. This study investigated the influence of fruit ripening on the molecular and nanostructural properties of water-, chelator-, and dilute alkali-soluble pectin fractions (WSP, CSP, and DASP, respectively) extracted from the pomace of Golden Delicious apples under three conditions: optimal harvest (O), twelve days of shelf life (S), and six months of cold storage at 4 °C (C).

The total pectin yield relative to dried pomace decreased under shelf life and cold storage conditions compared with optimal harvest. Enzymatic depolymerization and solubilization during shelf life and cold storage were evident from the increase in galacturonic acid (GalA) content and the decrease in arabinose (Ara) and galactose (Gal) contents in all three fractions [1,2]. A decline in both the degree of methylation (DM) and the degree of acetylation (DAc) with later fruit storage conditions, relative to optimal harvest, was observed by high-performance liquid chromatography (HPLC). Apple pectin exhibited fraction- and storage-dependent conformational behavior. DASP displayed compact conformations at optimal harvest and after 12 days of shelf life, but adopted a more extended structure following six months of cold storage, whereas CSP chains remained comparatively open under both shelf life and cold storage conditions.

Monosaccharide composition analysis and nanostructural imaging using atomic force microscopy (AFM) indicated that pectin chain cleavage occurred

during ripening, accompanied by a reduction in persistence length. This work will contribute to the optimization of pectin characteristics for practical applications in the food, pharmaceutical, and cosmetic industries.

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Engineered Corncob Biochar for Reduced Phytotoxicity and Efficient Antibiotic Removal: Advancing Circular Economy

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Keywords: Ecotoxicity, modified biochar, pollutant adsorption, agricultural waste

The use of biochar (BC) has gained popularity in recent years as an innovative, eco-friendly, and sustainable way to manage the large amounts of waste generated by intensive agriculture. Furthermore, BC serves as an excellent pollutant remover and soil conditioner. But sometimes, this material (BC) may contain harmful elements like PAHs, heavy metals, perfluorochemicals, free radicals, and dangerous volatile organic compounds [1, 2]. Additionally, it might have inadequate textural properties for its specific application [3]. So, this study aimed to modify BC from corncob (C) with ammonium hydroxide (NH₄OH), examine its toxicity toward sorghum (*S. bicolor*) and cress (*L. sativum*) seed germination and root growth, and assess its adsorption capacity towards tetracycline.

The production and modification of corncob biochar is described in previous study by [4] and [5], respectively. The biochars (0.1g) were mixed with 10mL of H₂O and stirred for 24 h, filtered, and 5 mL of the extract was used to incubate the seeds in a petri dish. After 72 h, germination, root growth, and germination index were measured. Adsorption of tetracycline was conducted in a batch experiment, with an initial concentration 10 mg/L for tetracycline at pH 6. The concentration of tetracycline was determined using HPLC.

The modification changes the surface of the biochar by introducing new groups as well as increasing the specific surface area and heterogeneity. Modified BC demonstrated 100 % seed germination for both cress and sorghum. It also contributed to the highest values of: root length of 37.4 mm and 9.1 mm, germination index of 150.2 % and 118.0 % for cress and sorghum, respectively. To add, the modified BC showed the highest adsorption capacity towards tetracycline – an increase in adsorption capacity was equal to 63.38 % when compared to pristine BC. This study demonstrates that modifying BC with NH₄OH not only reduces BC toxicity towards seed germination and growth, but also enhances the removal of tetracycline in aqueous solution.

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Intercropping enhances soil microbial biodiversity and reorganizes seasonal functioning in wheat-clover systems

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Keywords: soil microbial diversity, legume-cereal intercropping, soil microbial functioning, soil enzyme activity

Soil microbial community and biodiversity play a critical role in regulating nutrient cycling, soil fertility, and ecosystem resilience in agricultural systems [1]. Through carbon transformation, enzyme-mediated nutrient acquisition, and close interactions with plant roots, microorganisms regulate key biogeochemical processes that underpin soil functioning [2,3]. However, they are often assessed using single-time-point measurements, which overlook important seasonal changes driven by plant growth and the legacy of earlier soil conditions.

Presented study investigate the influence of wheat-clover intercropping on seasonal changes of soil microbial diversity, enzyme activity, and predicted functional patterns of bacterial community. The field experiment included the following agricultural management practices such as conventional monocropping (CM), integrated monocropping (IM), and integrated intercropping (II). To understand the composition and function of microbial communities, we combined community-level physiological profiling, enzyme assays, amplicon sequencing (16S rDNA), PICRUSt2-based functional prediction.

Intercropping increased soil microbial diversity and reshaped both bacterial and fungal communities over time. Microbial metabolic activity and substrate use followed a distinct seasonal pattern, with intercropping systems

displaying higher activity and a broader range of substrate utilization later in the season than monocropping. Enzyme activities varied depending on growth stage and function, with intercropping promoting higher late-season oxidative and phosphorus-acquiring activities. Phase-plane analysis further revealed time-lagged relationships between microbial metabolism and enzyme activity, indicating within-season legacy effects. Bacterial communities changed rapidly over time. Functional predictions suggested that diversified systems redistribute metabolic potential across the season rather than simply increasing it.

Overall, the results show that intercropping not only enhances soil microbial biodiversity but also reorganizes how microbial processes could be timed and coordinated, highlighting the importance of considering seasonal dynamics.

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Validation of filter paper matrix method for bacterial DNA isolation in soil splash studies

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Keywords: soil, splash phenomenon, microbial transport, DNA isolation, paper matrix

The soil splash phenomenon driven by raindrop impacts, is a mechanism for the physical transport of soil particles (Fig. 1) and associated microorganisms [1]. The role of soil splash in the transmission of microorganisms is poorly understood, thus standardized methods are needed for capturing the ejected material for the analysis of splash-mediated microbial transport. A methodological consideration is whether DNA can be effectively recovered from cellulose-based filter paper, as the presence of the paper may hinder mechanical disintegration of the sample and decrease the efficiency of commercial extraction kits. This is of crucial importance because splash events yield variable amounts of biomass, including low quantities resulting from single drop impacts. Verifying the analytical neutrality of the collection matrix (paper) is necessary to ensure that detected microbial quantity reflect environmental transport rather than extraction biases [2].

The aim of this study was to compare DNA extraction efficiency from cellulose-based filter paper in soil splash studies. An experiment was conducted using saturated soil samples reflecting the low mass of material transferred by a single drop impact. Soil samples were placed into Falcon tubes containing sterile Whatman filter paper (particle retention 11 μm , basis weight 87 g/m^2 ; Whatman, Cytiva, Maidstone, UK). Sterile paper and saturated soil aliquots without the paper matrix served as reference controls. Molecular analyses included genomic DNA extraction (DNeasy PowerMax Soil Kit, QIAGEN, Hilden, Germany) and quantification of the 16S rRNA gene copy number via Digital PCR (QIAcuity One thermocycler, QIAGEN, Hilden, Germany) using the 515F-BY and 926R primer set. Microbial community composition was characterized through Next-Generation Sequencing (NGS; MiSeq, Illumina, San Diego, CA, USA) using a primer set consistent with dPCR.

Comparison showed no difference in the number of 16S rRNA gene copies between samples extracted with and without the paper matrix. Furthermore, beta diversity analysis, visualized via Principal Coordinates Analysis (PCoA), revealed no significant differences in the composition of bacterial communities between control and tested samples (PERMANOVA, $p > 0.05$). These findings indicate that the filter paper does not affect DNA recovery or introduce taxonomic bias, thereby validate filter paper as an analytically neutral matrix for capturing microbial communities during splash events. The standardization of soil splash sampling procedure facilitates cross-study comparisons and supports the predictive modeling of splash-driven pathogen dispersal in agricultural settings [3].

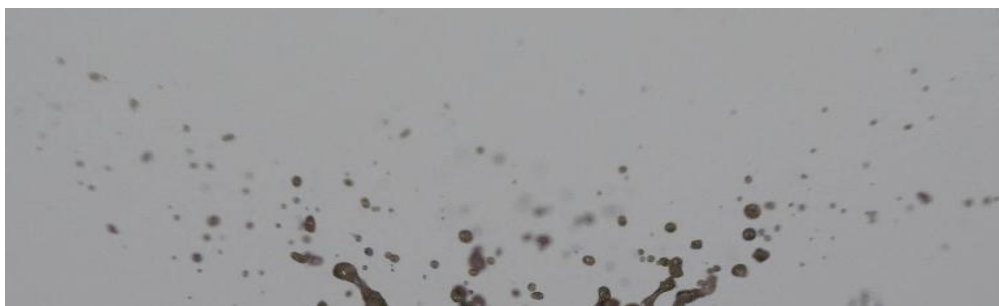


Fig. 1 The ejection of soil material during splash phenomenon including the splashed soil particles and water droplets.

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Selected methodological aspects of using deuterium-labelled water in splash research

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Keywords: deuterium labelling, splash of water drop,

Soil water erosion begins with soil splash, where the impact of droplets breaks down soil aggregates and displaces particles. On a microscale, this process is critical for the transport of pathogens and nutrients. The exact origin of the water within splashed droplets, whether it comes from the falling rain or the soil solution, has remained difficult to trace. Traditional labeling methods using dyes are often inaccurate as they alter the physical properties of water, such as surface tension and viscosity [1].

Deuterium-labelled water (D₂O) is utilized as an alternative tracer that remains physically and chemically indistinguishable from plain water, ensuring that the investigated splash dynamics are not altered. As a non-invasive and environmentally safe marker, it allows for the precise monitoring of phase mixing. However, in order to apply deuterium water labeling in practice, it is necessary to develop a method that identifies the sources of uncertainty/potential errors.

The presented research describes selected aspects of methodology in tests of splash resulting from the impact of drops on the water surface. Changes in isotopic ratios are expressed as $\delta^2\text{H}$. Isotope measurements were conducted on a Delta V Advantage Isotope Ratio Mass Spectrometer (IRMS) (Thermo Scientific, USA) coupled with vario PYRO cube Elemental Analyzer (Elementar, Germany). The $\delta^2\text{H}$ value of the water was expressed relative to VSMOW (Vienna Standard Mean Ocean Water). The following methodological parameters were investigated: the variation of $\delta^2\text{H}$ during static evaporation from a free surface, the impact of droplet fall height on $\delta^2\text{H}$ changes and the percentage of water mass loss in relation to the height from which the drop is released. These findings provide a baseline for eliminating

systematic errors and enabling the future use of the isotopic tracing technique as a precise tool for modeling water phase mixing and splash phenomenon in soil-water systems.

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Effect of bisphenol A on the growth processes of unicellular green algae

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Keywords: unicellular algae, growth processes, BPA

Bisphenol A (BPA) is a synthetic organic compound belonging to the phenol group. It is widely used in the production of polycarbonates and epoxy resins. Its use is increasing year on year due to the rapid growth of industry, which is causing increased environmental pollution, particularly in aquatic environments. The presence of BPA affects unicellular green algae, which are important in ecosystems as primary producers.

Studies conducted on the green alga *Chlorella sorokiniana* showed that it was capable of growing in the presence of BPA at concentrations in the range of 0-20 mg·L⁻¹ [1]. Green algae *Picocystis* sp., *Graesiella* sp. (amounts up to 30 mg·L⁻¹) and *Desmodesmus* sp. (at concentrations in the range of 1-13.5 mg·L⁻¹) also showed the ability to grow in the presence of BPA [2, 3].

The aim of the study was to investigate the influence of bisphenol A on the growth processes of unicellular green algae. Algal cultures were cultivated in BG11 liquid medium, illuminated under 16/8 h light/dark cycle, and aerated. To investigate the effect of BPA on the algae, both a culture supplemented with this compound and a control culture were used.

Spectrophotometric measurements of the optical density of the culture and gravimetric determination of dry biomass were used to monitor the growth of green algae. The analyses carried out allowed the specific growth rate, biomass doubling time and biomass productivity to be determined.

The results showed that the presence and concentration of BPA affect the growth of green algae.

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Searching for EPS-producing bacteria in soils exposed to diverse stress conditions

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Keywords: exopolymers, soil bacteria, environmental stress, soil health, agriculture

Exopolymers (EPS) are high-molecular-weight microbial metabolites composed mainly of polysaccharides, proteins, lipids, and extracellular DNA. They are produced by many different species of bacteria, such as *Pseudomonas*, *Bacillus*, *Azotobacter*, *Klebsiella*, *Paenibacillus*, *Rhizobium*, and *Sinorhizobium* [1]. EPS production is often stimulated by environmental stress, including drought, extreme pH, salinity, and temperature.

In microbial cells, EPS are associated with several beneficial properties that support adaptation to adverse conditions. They contribute to stress tolerance, improve protection against environmental fluctuations, and may help microorganisms persist in harsh habitats [2]. Representative examples of the obtained EPS after drying are shown (see fig. 1). Beyond their biological role in cells, EPS are also of practical interest because of their biodegradability, non-toxicity, and surface-active properties.

Although EPS have been widely studied in marine and wastewater-related systems, soil-derived EPS-producing bacteria remain relatively poorly explored. This is a significant gap, because soils exposed to stress conditions may represent a valuable source of novel EPS-producing strains with useful functional traits. The search for such bacteria is especially relevant in the context of soil degradation, climate change, and contamination, which increasingly threaten agricultural productivity and soil health.

From an agricultural perspective, EPS and EPS-producing bacteria may support soil aggregation, improve water retention, enhance nutrient sequestration, and contribute to bioremediation of contaminated soils [3]. Therefore, the identification and characterization of EPS-producing soil bacteria may provide new biological tools for improving soil quality and supporting sustainable agriculture under stress conditions.

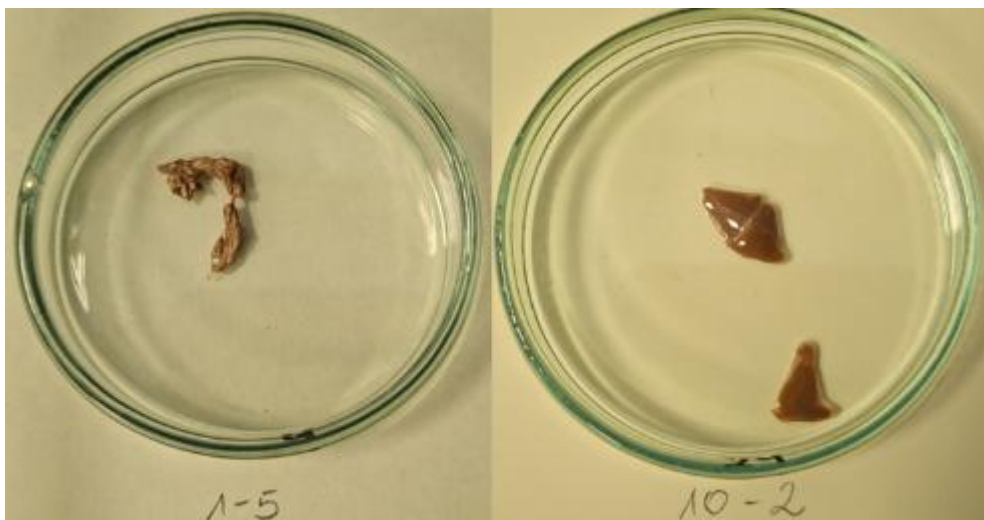


Fig. 1. Examples of EPS samples obtained during preliminary tests, after drying.

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The Fast Fourier Transform-Based Vibration Analysis of Mitsubishi Pajero Diesel Engine

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Keywords: Knocking, abnormal combustion, frequency spectrum

Diesel engines operate based on compression ignition, where combustion stability is influenced by parameters such as injection timing, pressure, and fuel quality. One abnormal combustion phenomenon is knocking, characterized by a rapid pressure rise that generates increased vibration in engine structures (Heywood, 1988; Suratman, 2019). Vibration analysis can therefore be used as a diagnostic approach to identify abnormal combustion behavior.

This study aims to understand the knocking phenomenon in a Mitsubishi Pajero Dakar diesel engine through vibration analysis. For study and evaluation, the secondary vibration data were obtained at variable engine speeds, i.e., 650 rpm, 1050 rpm, and 1500 rpm (Murthy, 2011). The resulting frequency spectrum at different engine speeds is presented in Fig. 1. Based on these infographics, it is found that the dominant vibration peak at 650 rpm occurs at approximately 21.67 Hz with an amplitude of 6.26 mm/s. Meanwhile at 1050 rpm, the dominant peak shifts to around 13.33 Hz with an amplitude of 3.43 mm/s, while at 1500 rpm the dominant vibration peak appears near 50.2 Hz with an amplitude of 3.22 mm/s. The increase in engine speed causes a shift in dominant vibration frequency, indicating changes in combustion excitation and dynamic engine response.



Fig. 1. Vibration frequency spectrum of diesel engine at different operating speeds (650 rpm, 1050 rpm, and 1500 rpm)

The highest vibration amplitude is observed at 650 RPM, suggesting that low engine speed conditions produce stronger vibration excitation. Meanwhile, at higher engine speeds, the vibration spectrum becomes more distributed across several frequency components, indicating more complex dynamic interactions between combustion pressure, reciprocating motion, and engine structural response. These findings indicate that vibration characteristics vary significantly with engine speed and that the Fast Fourier Transform (FFT)-based vibration analysis can effectively identify changes in combustion-related vibration behavior in diesel engines, including indications of abnormal combustion phenomena such as knocking.

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Vibration analysis for industrial diesel engine: Initial study

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Keywords: Internal combustion engine, Industrial diesel engine, accelerometer, predictive maintenance

A diesel engine is a type of internal combustion engine. It uses diesel fuel to ignite a mixture of fuel and air inside the engine's cylinders, causing an explosion that drives the pistons to produce mechanical energy. Since its invention in the 1890s, the diesel engine has become a valuable asset for industrial and manufacturing applications. Its fuel efficiency, high power output, and durability make it particularly well-suited for industrial environments, where it is used to power a wide range of heavy machinery. The sample of schematic diagram of diesel engine can be seen in Fig. 1.

Vibration in industrial diesel engines refers to the reciprocating motion of engine components occurring at specific time intervals. By measuring vibration parameters such as displacement and frequency spectrum using the CSI Emerson 2130 Machinery Health Analyzer, the engine condition can be evaluated based on the ISO 10816-6 standard (Emerson, 2012). The parameters examined include displacement in micrometers (μm), vibration velocity in millimeters per second (mm/s), and acceleration in meters per second squared (m/s^2).

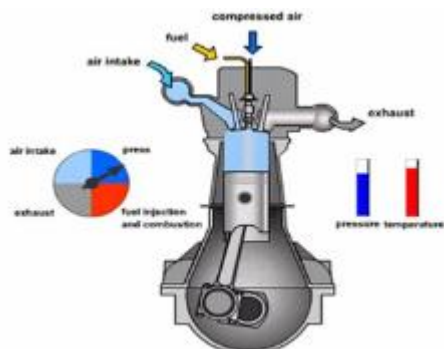


Fig. 1. The combustion Process in diesel engine

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Reliability centered maintenance: Application on electric motor

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Keywords: Electric Motor, Reliability Centered Maintenance (RCM), Risk Priority Number (RPN)

An electric motor is a system that functions to convert electrical energy into mechanical energy to drive various types of machinery. This conversion process relies on the interaction between magnetic fields and electric current to produce rotational motion. This tool is crucial for powering equipment in various industrial and commercial applications. Electric motors have complex component sub-systems so that if one of them fails, it will potentially cause failure of the motor itself. One of the causes of failure is the lack of maintenance on the electric motor components. This condition will cause downtime and financial losses. To overcome this problem and improve reliability, the implementation of reliability centered maintenance (RCM) on electric motors is an effective solution. RCM aims to reduce the risk of damage through failure and function analysis, and selection of appropriate maintenance strategies (Taufik, 2024).

This research implements failure modes, effects and criticality analysis (FMECA) by calculating the Risk Priority Number (RPN) value, prioritizing components with the highest RPN value and choosing the right maintenance strategy. Table 1 shows the decision logic diagram. The table systematically explains the sequence of actions that must be taken according to the evaluated RPN value calculations.

Table 1. The sequence of action on electric motor components

No	Component	Does it affect Safety/Health?	Does it affect Production or Quality?	Does it cause significant economic loss?	Selected Maintenance Strategy
1	Bearing	NO	YES (causes vibration & noise)	YES	Condition Monitoring Task (Routine condition monitoring)
2	Stator & Rotor Windings	YES (risk of short circuit/fire)	YES	YES	Scheduled PM Task (Preventive maintenance on schedule)
3	Wiring Box & Terminal	YES (risk of short circuit/electric shock)	YES	YES	Scheduled PM Task (Checking bolt tightness & insulation)
4	Cooling Fan	NO	NO	NO	Run-to-Failure (Repaired only when damaged)
5	Motor Casing / Housing	NO	NO	NO	Run-to-Failure (Repaired only when damaged)
6	Fan Cover	NO	NO	NO	Run-to-Failure (Repaired only when damaged)

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Development of an off-grid photovoltaic system for community-based waste processing facility

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Keywords: Independent electricity generation, load identification, system efficiency, renewable energy utilization, peak sun hour.

Solar energy, as an abundant renewable resource in tropical regions, offers a promising solution for independent electricity generation. Indonesia has an average solar irradiation of approximately 4–5 kWh/m²/day, making photovoltaic (PV) systems suitable for off-grid applications (Duffie & Beckman, 2013). This study aims to develop an off-grid PV system to supply electrical energy for a community-based waste processing facility in Pasir Jati, Ujung Berung, Bandung - Indonesia.

The daily electrical energy demand is determined based on the load power and operating duration using the following equation:

$$E = P \times t$$

where E is energy (Wh), P is power (W), and t is operating time (h), resulting in a total demand of 1160 Wh/day.

Considering system losses in PV modules, batteries, inverter, and wiring, the required system energy is determined by:

$$E_{system} = E_{load} \times F_{loss}$$

with a loss factor (F_{loss}) of 1.3, yielding a total requirement of 1508 Wh/day (Messenger & Ventre, 2010). The overall efficiency system is expressed as:

$$\eta_{total} = \eta_{pv} \times \eta_{scc} \times \eta_{bat} \times \eta_{inv} \times \eta_{cable}$$

and based on calculation, it is found that the total efficiency is 63.4%, which indicates energy losses during conversion, storage, and distribution.

The required PV capacity is determined using the Peak Sun Hour (PSH) method:

$$P_{pv} = \frac{E_{system}}{PSH}$$

Assuming a PSH of 4.5 h/day, the required PV capacity ranges from 400–435 Wp. The energy storage system is designed with a capacity of 300 Ah (lead-acid) or 150 Ah (LiFePO₄), while a 50 A solar charge controller and an inverter capacity above 1000 W are selected to accommodate starting loads.

The results show that the designed off-grid PV system can reliably meet the required energy demand of 1508 Wh/day. This system also demonstrates the application of biophysical principles in solar energy conversion and supports sustainable environmental management through renewable energy utilization.

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Health status monitoring and remaining useful life prediction of centrifugal pump: Preliminary study

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Keywords: Centrifugal Pump, RAM Analysis, Remaining Useful Life (RUL), Vibration Analysis, Health Status.

The centrifugal pump is a mechanical device designed to move fluid by transferring rotational energy from one or more driven rotors, known as impellers. In industrial applications such as oil and gas, centrifugal pumps play a critical role in maintaining continuous production. Unexpected failures of these pumps can lead to significant operational losses and system downtime. Therefore, monitoring the health status and predicting the remaining life of the equipment are essential for ensuring reliability and operational efficiency (Ahmad & Kamaruddin, 2012).

Reliability, Availability, and Maintainability (RAM) analysis is widely used to evaluate the performance and dependability of mechanical systems. Vibration analysis is one of the most effective techniques for assessing the health condition of rotating machinery. Based on ISO 10816 standards, vibration levels are classified into categories such as “Good”, “Satisfactory”, and “Unacceptable,” which indicate the severity of machine condition.

Fig. 1 illustrates the vibration monitoring system as applied to a centrifugal pump. In this setup, the acquired vibration data is processed to detect abnormal conditions such as misalignment, unbalance, and bearing defects—the primary failure modes in centrifugal pumps (Karassik, 2008).

This real-time diagnostic capability is further enhanced by degradation trend analysis, which observes shifts in vibration signatures over time to identify the critical transition from a normal operating state to a potential failure.



Fig. 3. Vibration monitoring system applied to a centrifugal pump.

The core objective of this research is to evaluate the comprehensive health status of a centrifugal pump and estimate its RUL by synthesizing Reliability, Availability, and Maintainability (RAM) analysis with vibration trend data. By collecting operational data and failure history, the study calculates the specific reliability parameters of pump components.

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Vibration Analysis of Pajero Dakar SUV: An introduction

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Keywords: Engine Vibration, Diesel Engine, Sport Utility Vehicle, predictive maintenance

The Mitsubishi Pajero Dakar is a Sport Utility Vehicle (SUV) equipped with a modern diesel engine featuring high-pressure fuel injection technology. It uses a 4N15 diesel engine with an inline four-cylinder configuration. This engine comes with Common Rail Direct Injection (CRDI) technology, which allows for a more efficient combustion process. A diesel engine is one type of internal combustion engine that operates on the principle of self-ignition, or compression ignition. In this engine, air is compressed until it reaches high pressure and temperature inside the combustion chamber. The schematic diagram of diesel engine can be seen in Fig.1.

Vibration analysis is one of the most widely used methods in mechanical engineering to monitor operating conditions and detect potential machine faults. It stands as one of the most effective techniques in condition-based maintenance (CBM), given its ability to identify machine defects at an early stage before they escalate into more serious damage. (Jardine et al., 2006), Vibration measured on engine structures uses three key parameters: displacement (μm), velocity (mm/s), and acceleration (m/s^2), all expressed as RMS (Root Mean Square) values. Measurements are typically taken at the

bearing housings or structural points of the engine to determine the vibration levels occurring during machine operation (Mobius, 2010).

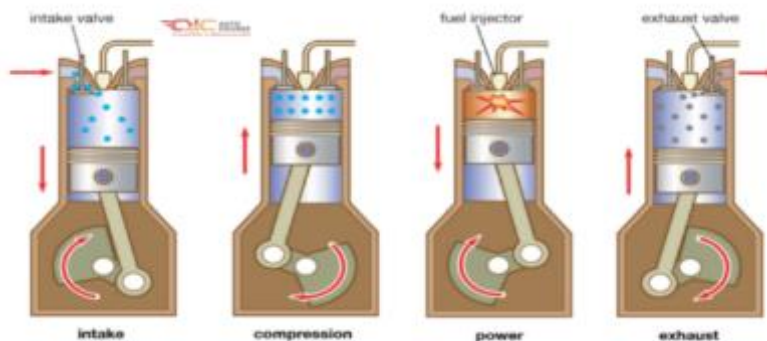


Fig. 1. The Working Principle of a Diesel Engine (OJC, 2024)

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Reliability Centered Maintenance (RCM) Steam Turbine Power Generation: Valves case

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Keywords: Failure mode analysis, maintenance optimization, turbine control system, reliability assessment

Steam turbine system is a critical component in power generation processes, where failures may result in significant operational disruptions, reduced system availability, and increased maintenance costs. This study aims to evaluate the reliability of steam turbine components and determine optimal maintenance strategies using the Reliability Centered Maintenance (RCM) approach integrated with Failure Mode and Effects Analysis (FMEA). However, the scope of this study is focussed on the various of valves only, as sub-system of the steam turbine. RCM is a systematic approach to determining maintenance activities that must be carried out on a system or equipment to maintain its reliability and availability (Vendi et al., 2024).

The research methodology involves system identification and functional analysis of key turbine components, including control valve, governor valve, and stop valve. Failure modes, failure mechanisms, causes, and effects were analyzed using FMEA. Each failure mode was evaluated based on severity (S), occurrence (O), and detectability (D) to calculate the Risk Priority Number (RPN). The RPN values were then used to identify critical components and prioritize maintenance actions. The summary of evaluation results on the type of valves in the stea turbine can be seen in Table 1.

Table. 1. Summary of Critical Failure Modes Based on RPN Analysis.

Equipment	Critical Failure Mode	S	O	D	RPN	Priority
Control Valve	Valve sticking	6	6	6	216	Medium
Governor Valve	Sensor error	10	4	8	320	High
Main Stop Valve	Trip mechanism fail	10	2	10	200	Low

Based on Table 1, it can be found that the governor valve has the highest RPN value (320), indicating it as the most critical component with a high risk of failure affecting turbine control performance. Control valve failures such as valve sticking also show significant risk with an RPN value of 216, while stop valve failure in the trip mechanism presents a critical safety concern with an RPN value of 200.

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Design and Manufacturing of a Pyrolysis Reactor for Buton Asphalt

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Keywords: Thermal stability, heating performance, liquid yield

Buton asphalt, as a heavy hydrocarbon material, has the potential to be converted into liquid products for fuel applications through pyrolysis (Han et al., 2019). Pyrolysis is a thermochemical decomposition process of hydrocarbon materials at high temperatures in the absence of oxygen, producing liquid, gas, and solid products, and is effective for converting hydrocarbons into alternative liquid fuels (Ridhuan, K et al., 2019).

This study aims to design and manufacture a pyrolysis reactor for processing Buton asphalt, including reactor specifications, heating system, insulation, and temperature measurement and control. Performance testing was conducted to verify the reactor's ability to reach the target temperature of 450°C.

The developed reactor has a capacity of 10 L, made of AISI 1020 steel ($\varnothing \pm 25$ cm; thickness 5 mm), equipped with a 3200 W electric heater (wire length 1,95 m; diameter 2 mm), SK-34 refractory brick insulation, and additional rockwool insulation.

Based on testing results, the reactor successfully reached a pyrolysis temperature of 450°C within 66 minutes with a stable heating profile. Design and realization of the pyrolysis reactor is shown in Fig. 1.

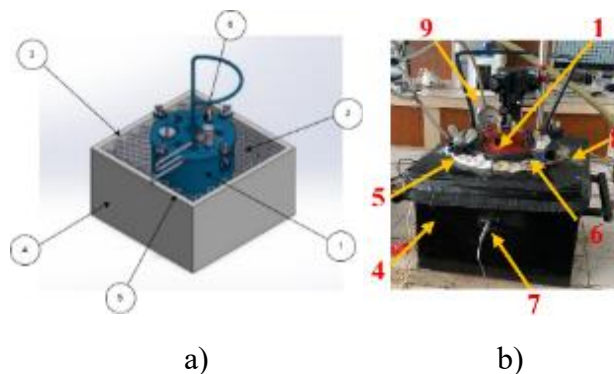


Fig. 1. a) Pyrolysis Reactor Design b) Pyrolysis Reactor Realization

Description:

1. Tank AISI 1020 (5 mm), 2. Heater Nickel alloy 4800 W, 3. Refractory SK-34 ≤ 1400 °C, 4. Structure ASTM A36 (4 mm), 5. Insulation Rockwool (≤ 1200 °C), 6. Thermocouple Type K (≤ 1200 °C), 7. Controller Tuya ZFX-TW0, 8. Cover Plate ASTM A36 (2 mm). 9. Pressure Gauge.

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Development of real-time monitoring of 1 kWp solar power system at ITENAS Bandung

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Keywords: Solar power system, ESP32, internet of things (IoT), renewable energy

The increasing demand for electrical energy and the depletion of fossil fuel resources encourage the development of renewable energy technologies, especially solar energy systems. Indonesia has high solar radiation potential due to its geographical location on the equator, making solar power systems suitable for implementation in educational institutions such as Institut Teknologi Nasional (ITENAS) Bandung. Solar photovoltaic systems are environmentally friendly and capable of converting solar radiation directly into electrical energy through photovoltaic modules (Gupta, 2020).

This study aims to develop a real-time monitoring system for a 1 kWp Solar Power System (SPS) at ITENAS Bandung using Internet of Things (IoT) technology based on the ESP32 microcontroller. The monitoring system is designed to measure and monitor electrical parameters including voltage, current, power, electrical energy, temperature, and solar radiation intensity continuously, and in a real time.

The research method includes literature study, SPS system identification, monitoring system design, sensor installation, sensor calibration, system integration with ESP32, system testing, and data collection.

The SPS consists of four monocrystalline photovoltaic panels with a total capacity of 1000 Watt-peak, where each panel has a capacity of 250 Watt-peak. Several sensors such as voltage sensors, current sensors, temperature sensors, and solar radiation sensors are integrated with the ESP32 microcontroller and connected through WiFi communication for real-time data transmission to the monitoring dashboard. IoT integration enables remote monitoring and improves maintenance efficiency while supporting faster troubleshooting and operational analysis (Sharma, 2022).

The developed monitoring system is expected to provide accurate and continuous monitoring data for evaluating the performance of the 1 kWp SPS at ITENAS Bandung. Furthermore, this research contributes to the development of renewable energy technology and supports the implementation of smart monitoring systems in academic environments.

Acknowledgments:

The synopsis of this scientific work is presented in a scientific exchanges joint event, as one of the partnership implementations between Institut Teknologi Nasional Bandung (Indonesia), Czech University of Life Sciences Prague (Czech Republic), Institute of Agrophysics of the Polish Academy of Sciences (Poland), Slovak University of Agriculture in Nitra (Slovakia), and Hungarian University of Agriculture and Life Sciences, Gödöllő (Hungary).

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The first phase of inverter reactivation in a 1 kWp photovoltaic system

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Keywords: Solar power plant, study and research purposes, voltage, current, power

The increasing demand for electrical energy has encouraged the development of renewable energy sources that are environmentally friendly, one of which is Solar Power Plants/SPP system (Photovoltaic System). A Photovoltaic (PV) system converts solar radiation into electrical energy using photovoltaic modules. In a PV system, the inverter is a crucial component that functions to convert direct current (DC) generated by the solar panels into alternating current (AC) that can be used by electrical loads.

A 1 kWp SPP system has installed at the campus ITENAS Bandung for study and research purposes. In the normal condition, the operational data of the SPP can be monitored by online from another place. but presently the sytem was problem. To find the probable cause of the problem, at the first the inverter was checked and evaluated (Pamungkas et al., 2025)

The successful operation of a SPP system is strongly influenced by the inverter operation process, which depends on the operating conditions of the system, particularly the voltage, current and power produced by the photovoltaic modules.

This study aims to investigate the inverter activation process in a 1 kWp photovoltaic system. The research method includes literature study, installation of the PV system, inverter activation testing, and measurement of system parameters such as voltage, current, and electrical power generated by the solar panels. The testing process is conducted to determine the operational conditions required for the inverter to activate and operate stably.

The results of this research are expected to provide an understanding of the operational conditions that influence the inverter activation process in a 1 kWp photovoltaic system. Furthermore, this study can serve as a reference for the operation and development of small-scale photovoltaic systems, particularly in the inverter activation stage.

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The synopsis of this scientific work is presented in the workshop as one of the partnership implementations between Institut Teknologi Nasional Bandung (Indonesia), Slovak University of Agriculture in Nitra (Slovakia), Institute of Agrophysics – Polish of Academy Sciences (Poland), Czech University of Life Sciences Prague (Czech Republic), and Hungarian University of Agriculture and Life Sciences, Gödöllő (Hungary).

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Differential Disease Response of Six Elite Oil Palm (*Elaeis guineensis*) Progenies to *Ganoderma ryvardeenii* Infection

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Keywords: *Ganoderma ryvardeenii*; Basal Stem Rot; oil palm breeding; progeny screening; Disease Severity Index; wood block inoculation

Basal Stem Rot (BSR) remains one of the emerging threats to sustainable oil palm production in West Africa. In Ghana, effective early diagnostic tools, screening methods and resistant planting materials are still limited. This study evaluated the disease response of six elite oil palm (*Elaeis guineensis*) progenies (131, 132, 133, 135, 136, and 61) following artificial inoculation described by Breton *et al.* (2006), with *Ganoderma ryvardeenii* recently identified as a highly aggressive pathogen from the Eastern Region of Ghana (Lekete-Lawson *et al.* 2025). To study the disease progression and response of the progeny, a dual-screening approach combining *in vitro* and *in vivo* nursery assays (Fig. 1) was adopted to assess disease development under controlled conditions.

In the laboratory experiment, germinated seeds were inoculated using colonised wood blocks in Beatson jars maintained at 28 ± 1 °C and 70% relative humidity. A parallel nursery experiment was conducted on three-month-old seedlings arranged in a randomised complete block design with four replications and a total sample size of $n = 144$. Disease progression was assessed using a Disease Severity Index (DSI) based on foliar symptoms, root discolouration, and internal tissue necrosis. Pathogen re-isolation was performed to confirm Koch’s postulates (Fig. 1). Data was analysed using analysis of variance (ANOVA) in R.

Significant differences ($P < 0.05$) were observed among the progenies in their response to infection (Fig 2). Symptoms developed as early as 14 days post-inoculation, with Progeny 61 (Cross 61) emerging as the most susceptible, recording 60% mortality (Fig. 2). Conversely, the remaining five progenies exhibited varying degrees of partial resistance (Fig. 3). The strong correlation between our *in vitro* and nursery data validates the use of early-stage screening as a reliable, high-throughput method for selecting tolerant planting materials. These findings provide a practical framework for integrating resistance screening into breeding programmes to safeguard oil palm resilience in *Ganoderma*-endemic regions.



Fig.1. Set-up for *in vitro* (A)/*in vivo* (B) screening of selected oil palm progenies.

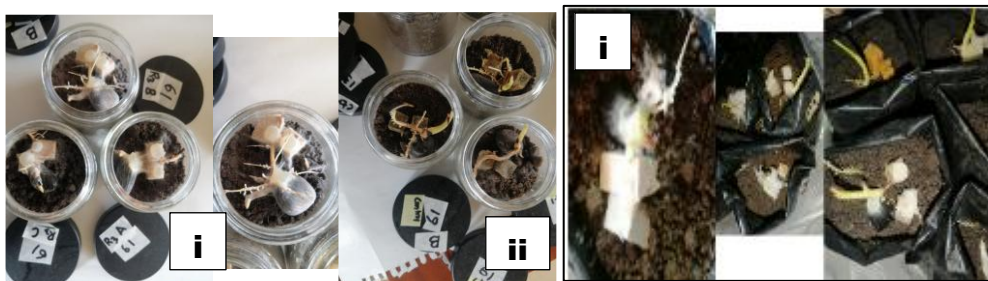


Fig. 2. (i). Infected germinated seeds after inoculation, and control (ii).

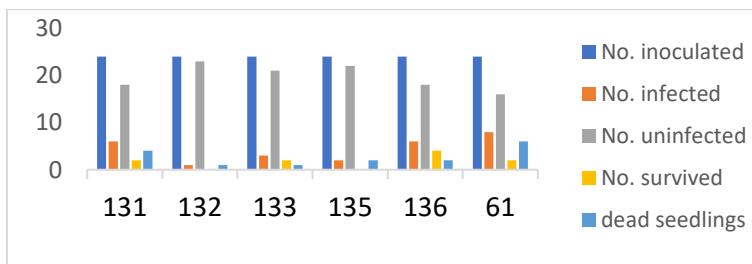


Fig. 3. **Index stability:** Analysis of progeny resistance/susceptibility

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Enhancing Remote Sensing Accuracy for Agriculture and Field Heat Mapping with Thermal UAVs

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Keywords: thermal UAV, crop water stress index, hop fields, precision agriculture, remote sensing, NDVI, surface temperature

Thermal UAV sensing provides a high-resolution alternative to satellite-only crop monitoring, particularly where field-scale temperature heterogeneity is important for irrigation and stress diagnostics. This contribution evaluates the use of a DJI Mavic 3T for thermal mapping of hop gardens near Stekník (Czech Republic) during field trials in 2024. Thermal and multispectral outputs were used to identify spatial patterns of canopy temperature, surface moisture-related contrasts and the crop water stress index (CWSI) across hop varieties.

The UAV imagery resolved intra-field variability that is not captured with comparable detail by coarser satellite data; Sentinel-1 imagery was therefore used mainly as a contextual layer for field delineation and wider-scale interpretation. The raw thermal orthomosaic revealed clear differences between rows and field sections, while the CWSI product highlighted variety-specific stress patterns for Sládek, Premiant and Agnus. The combined RGB, NDVI and thermal layers further showed that vegetation status and surface temperature provide complementary information for interpreting crop condition (Fig. 1).

Results indicate that thermal UAV data can support precision irrigation planning, early detection of biotic and abiotic stress and targeted field management in hop production. The main methodological benefit is the combination of flexible timing, low-altitude spatial detail and direct thermal contrast. Future work should focus on radiometric calibration, repeated flights under standardized weather conditions and automated classification of thermal

anomalies using machine learning to improve comparability between campaigns and move toward near-real-time decision support.

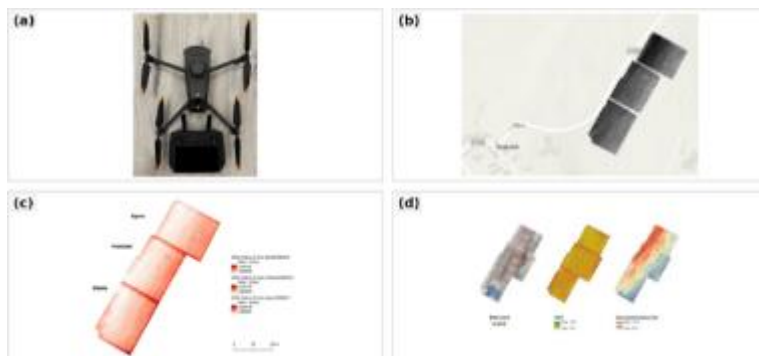


Fig. 1. Selected poster outputs: (a) DJI Mavic 3T platform, (b) raw thermal UAV image of the hop field, (c) crop water stress index by hop variety, and (d) combined RGB, NDVI and thermal products.

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Effect of sex on carcass characteristics and meat quality of pheasants

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Keywords: pheasant, sex, meat quality, pH, water holding capacity, colour

Pheasants represent an important alternative poultry species with increasing relevance for niche meat production due to their specific nutritional profile and technological properties. Among biological factors influencing meat quality, sex plays a significant role, affecting growth intensity, muscle composition, and physicochemical characteristics of meat (Kokoszyński et al., 2024). The aim of this study was to evaluate the effect of sex on carcass traits and selected meat quality parameters in pheasants.

The experiment included 80 pheasants divided into males and females. Birds were reared under standard fattening conditions with ad libitum access to feed and water until 16 weeks of age. After slaughter, carcass characteristics were evaluated and samples of the *pectoralis major* muscle were analyzed for physicochemical traits, including pH, colour (L^* , a^* , b^*), water holding capacity, drip loss, cooking loss, shear force, and basic chemical composition.

The results showed that males achieved significantly higher slaughter weight ($P < 0.01$) and carcass yield ($P < 0.05$) than females. Males also exhibited lower pH₂₄ ($P < 0.05$) and higher drip loss ($P < 0.01$), indicating reduced water holding capacity. Although cooking loss differed ($P < 0.05$), the absolute difference was small.

Meat from males was darker, with lower L^* and higher a^* values ($P < 0.05$), while b^* was not affected. Higher shear force in males ($P < 0.01$) indicated tougher meat. Females showed higher intramuscular fat content ($P < 0.05$), whereas protein content did not differ between sexes ($P > 0.05$).

Table 1. The effect of sex on productive, carcass, and muscle characteristics and meat quality of 16-week-old pheasants

Parameter	Sex		SEM	P-value
	Female	Male		
Slaughter weight (g)	1025 ^b	1188 ^a	24.15	0.0012
Carcass yield (%)	71.42 ^b	72.96 ^a	0.31	0.0284
pH24	5.89	5.72	0.03	0.0147
Drip loss (%)	1.82 ^b	2.46 ^a	0.12	0.0063
Cooking loss (%)	21.4	21.1	0.68	0.0112
Shear force (N)	21.8	22.6	0.95	0.0045
L*	48.12 ^a	45.94 ^b	0.57	0.0321
a*	7.84 ^b	9.02 ^a	0.29	0.0135
b*	6.98	6.72	0.22	0.2987
Protein (%)	23.4	23.6	0.18	0.4123
Fat (%)	1.62 ^a	1.28 ^b	0.06	0.0189

Differences were considered statistically significant at a probability level of $P \leq 0.05$; SEM = standard error of the mean. Statistical analysis was performed in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

These results confirm that sex significantly influences both carcass performance and physicochemical properties of pheasant meat. Males showed higher slaughter weight and carcass yield, whereas females exhibited lower drip loss and higher intramuscular fat content, indicating more favorable water holding capacity.

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How sewage sludge and composted sewage affect soil properties and processes

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Keywords: sludge, compost, hydraulic properties, CO₂ emissions

Abstract

Sewage sludge from wastewater treatment plants is often applied to soil to enrich it with nutrients. This study therefore focuses on the effect of digested or composted sewage sludge on basic and hydraulic soil properties, as well as on CO₂ emissions from the soil. The experiment was conducted at the Častrov site, where Cambisol soil is present. In 2024, three plots measuring 12 × 12 m were established on a selected field (Fig. 1). Two of them were treated either with digested sewage sludge (C3) or composted sewage sludge (C2), while one plot was left as a control (C1). Maize was cultivated across the entire field during this year. Throughout the year, undisturbed soil samples with a volume of 100 cm³ were collected to determine the soil water retention curve, porosity, and bulk density. At the same time, disturbed soil samples were taken to determine basic soil properties (e.g., pH, salinity, and organic carbon content). In addition, unsaturated hydraulic conductivity was measured directly in the field using mini disk infiltrometers at a pressure head of -2 cm, and soil respiration was measured using the LCi-SD device.

After the application of soil amendments, changes in basic soil properties were observed. For example, plot C2 showed higher active pH values (pH H₂O) compared to plots C1 and C3 (Fig. 2). Salinity on plots C2 and C3 reached higher values than on plot C1, and the highest organic carbon content was found on plot C2 (Fig. 2). Results also indicate that soil amendments can influence hydraulic soil properties. For example, soil water retention capacity increased after their application. Unsaturated hydraulic conductivity on plots C2 and C3 was higher than on plot C1 (Fig. 2). The amendments also affected soil respiration, with both field and laboratory measurements showing higher values on plots C2 and C3 compared to the control plot C1 (Fig. 2) as also observed by Fér et al. (2025). The results obtained thus demonstrate a clear effect of soil amendments on all monitored parameters.



Fig. 1: Area of interest after the application of sewage sludge and composted sludge

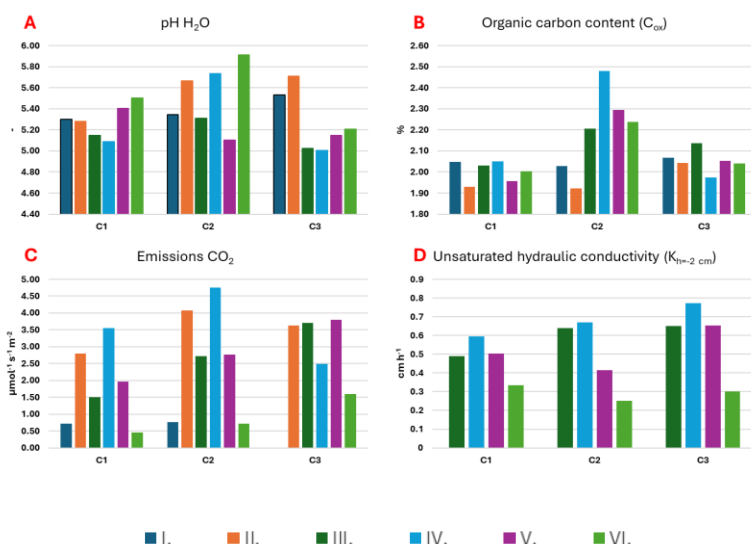


Fig. 2: A – Average active pH (pH H₂O), B – Average organic carbon content (C_{ox}), C – Average CO₂ emissions (NCER) values, D – Average unsaturated hydraulic conductivity (K_{h=-2 cm}); Soil sampling and measurements on 23. 4. 2024 (I., a day before application of both amendments), 6. 5. 2024 (II.), 30. 5. 2024 (III.), 29. 6. 2024 (IV.), 30. 7. 2024 (V.), and 13. 9. 2024 (VI).

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Effect of genotype on carcass characteristics and meat quality of geese

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Keywords: geese, free range, meat quality, yield, bedding

Geese hold a traditional position in poultry production, valued for high-quality meat (22 % of protein), feathers, and specific nutritional profiles. With rising consumer demand for premium and alternative protein sources, identifying optimal genetic lines is becoming key to economic efficiency [1]. The objective of this study was to evaluate the influence of genotype, specifically white broiler geese and Landes geese, on production parameters, carcass yield, and meat quality within a free-range system with water access.

The research involved 80 geese divided by genotype. The fattening period lasted 14 weeks under natural light conditions (16:8/L:D), with ad libitum feeding (17% crude protein, 11.5 MJ ME/kg). Post-slaughter analysis focused on the *pectoralis major* muscle, assessing carcass yield along with physical, chemical, and sensory properties.

Preliminary results showed that white broiler geese achieved significantly higher slaughter weight (6760 g, $P=0.0065$) and carcass yield (74.52%, $P=0.0438$) compared to Landes geese (6320 g, $P=0.0065$; 73.10%, $P=0.0438$, resp.). Regarding meat quality, broiler geese exhibited higher lightness (L^*) and lower yellowness (b^*) than Landes geese. Chemical analysis revealed lower ($P=0.0182$) intramuscular fat content in broiler geese (2.40%) compared to Landes geese (2.91%), observing the same phenomenon in [2]. Sensory evaluation identified broiler goose meat as significantly ($P=0.0001$) more tender, juicier, and with higher flavor.

Table 1. The effect of genotype on productive, carcass, and muscle characteristics, and meat quality of 14-week-old geese fattened in free-range system

Parametr	Genotype		SEM	P-value
	Landes	broiler		
Slaughter weight (g)	6320 ^b	6760 ^a	112.21	0.0065
Carcass yield (%)	73.10 ^b	74.52 ^a	0.202	0.0438
Fat (%)	2.40 ^a	2.91 ^b	0.002	0.0182
L*	45.42 ^b	46.48 ^a	0.684	0.0426
b*	8.61 ^a	6.42 ^b	0.365	0.0001
Tenderness	4.50 ^b	5.80 ^a	0.089	0.0001
Juiciness	4.81 ^b	5.70 ^a	0.096	0.0001
Flavor intensity	4.60 ^b	5.23 ^a	0.101	0.0001

Differences were considered statistically significant at a probability level of $P \leq 0.05$; SEM = standard error of the mean. Statistical analysis was performed in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

These findings confirmed that the genotype is a key determinant of growth performance and meat quality and sensory characteristics. The higher fat content in Landes geese reflects a genetic predisposition for lipogenesis, typical for breeds used in foie gras production. These results provide practical implications for optimizing breeding strategies to maximize yield and sensory quality in sustainable poultry systems.

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Effect of glycol coolant type on the cooling in the engine radiator of agricultural machines

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Keywords: engine radiator, glycol coolant, temperature, heating, cooling

Heat transfer between two or multiple fluids is provided by devices termed heat exchangers. The role of heat exchangers is to ensure the implementation of technological processes requiring cooling or heating of fluids [1]. For example, they perform a cooling function by cooling the fluid heated by the car's radiator, in order to prevent damage caused by overheating [2]. The increasing demand for more powerful engines in the limited space under the hood of a car creates a problem with the efficiency of heat transfer from the coolant to the surrounding air by means of the engine radiator [3].

Figure 1 shows the course of the temperature difference between the inlet and outlet of the heat exchanger (ΔT) for heating and cooling four coolants compared to purified water. The most effective coolant for agricultural machinery is G12 (a mixture of water and antifreeze). The other coolants are more suitable for engines with higher power parameters, different designs, and component materials. The G12 coolant achieved the fastest heating and cooling times compared to other coolants. Purified water also achieved similar heating and cooling times, however, it is not suitable for engine cooling because it evaporates at high temperatures, is unusable in winter, and does not protect the engine cooling system against corrosion and calcium deposits. G12 coolant may be mixed with blue-green G11 coolant or with red coolant with the same G12 designation; however, for long-term operation and durability, it is recommended to use a single concentrated type mixed with purified water. Coolant G11 achieved a similar heating curve as coolant G10, however, the cooling of coolant G10 in this type of radiator was more effective compared to coolant G11. Coolant G13 required the longest heating time, and its cooling also required significantly more time compared to coolant G12. Coolants contain additives that increase their boiling point and lower the freezing point. Rapid heating and cooling of the coolant is beneficial to the correct operation of the engine, emissions and improved fuel economy.

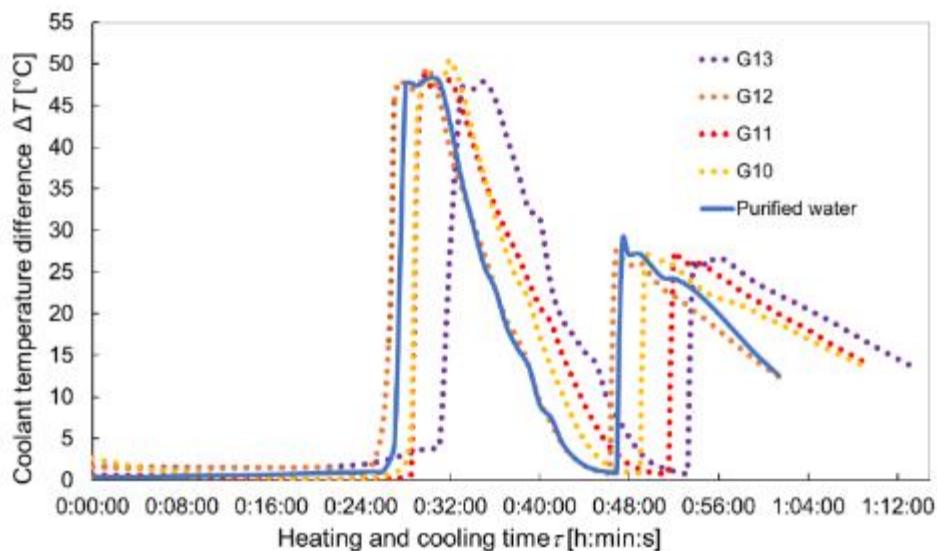


Fig. 1. Temperature differences at the inlet and outlet of the radiator for all examined coolants.

Acknowledgement

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