Fakulta zemědělská
a technologická
Faculty of Agriculture
and Technology

Jihočeská univerzita
v Českých Budějovicích
University of South Bohemia
in České Budějovice

SCIENCE AND RESEARCH

WE DEVELOP TECHNOLOGIES, WE SHAPE THE NATURE


BIO-RAD

SCIENCE AND RESEARCH

WE DEVELOP TECHNOLOGIES, WE SHAPE THE NATURE

A WORD BY WAY OF INTRODUCTION

Scientific research, together with educational activities, is one of the fundamental pillars on which top universities of the 21st century stand. Therefore, the Faculty of Agriculture and Technology of the University of South Bohemia pays special attention to the development of scientific research activities of academic staff and students. We fully adhere to the position that without quality science there can be no quality university education.

Thanks to this attitude, the Faculty has achieved a number of significant successes in recent years. For example, academic staff have succeeded in prestigious grant competitions of the Technology Agency of the Czech Republic in competition with top research institutes, and they have repeatedly received funding for their research in the Technology Leaders Call. Furthermore, the number of research projects carried out in cooperation with foreign institutions has significantly increased, and our aim is that applied research and experimental development with foreign partners should constitute the major part of our Faculty's research activities.

In 2024, the University of South Bohemia in České Budějovice became a member of the ***Research Universities Association****, which brings together seven leading universities in the Czech Republic, thanks to its high-quality research activities. We perceive this membership as our commitment for the years to come – we want to develop our scientific research activities in an international context at a top level.*

The outputs of research projects often remain hidden from the public. Only a few outputs that are attractive to the media are continuously presented. However, there are many interesting projects and other outputs of scientific research activities being developed at the Faculty. In this publication, we would like to present some of those that have been implemented at our Faculty in recent years or are currently being implemented. In this publication, we aimed at being as concise and engaging as possible – that is why we have followed the principle that one photo is worth a thousand words. On the following pages you will find mainly photographs by the photographer Jiří Tvaroh, which were taken in our laboratories and cooperating companies during the implementation of the research.

Dear readers, we will be glad if your interest is caught by any of the presented activities and if you decide to contact us with the possibility of further cooperation. We will also be pleased if any of the research areas are chosen by applicants for study – whether from the Czech Republic or abroad. We look forward to working together on the next research project to take human knowledge and our society a step further.

doc. RNDr. Petr Bartoš, Ph.D.
Dean of the Faculty of Agriculture and Technology USB


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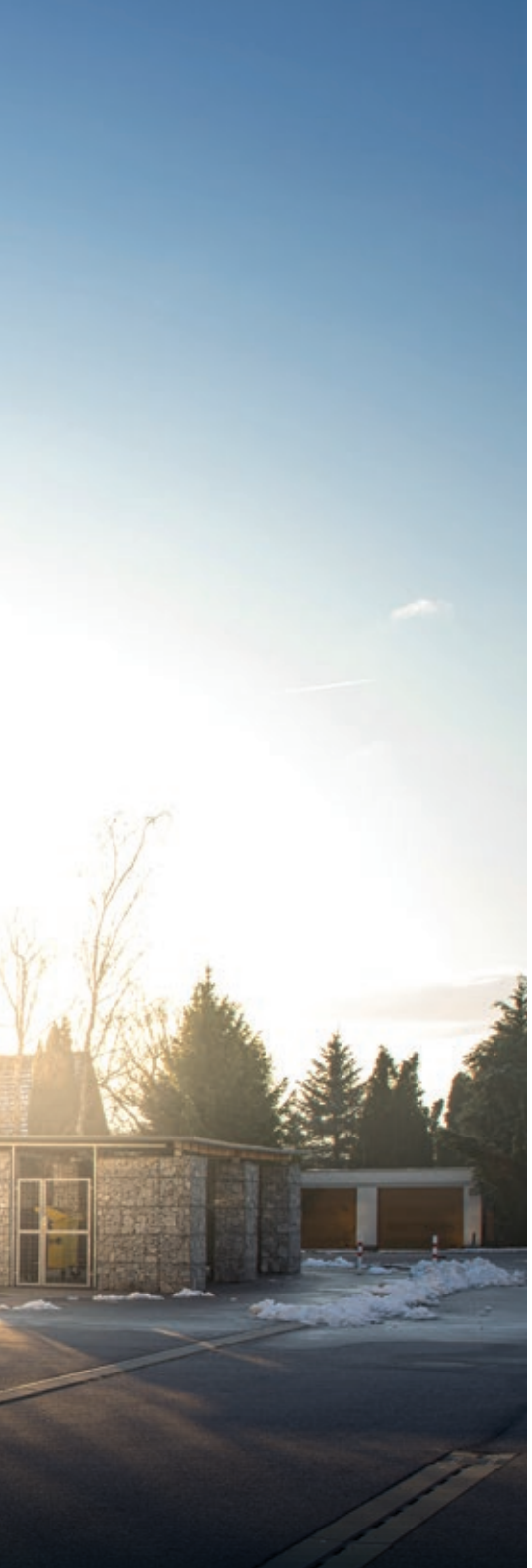
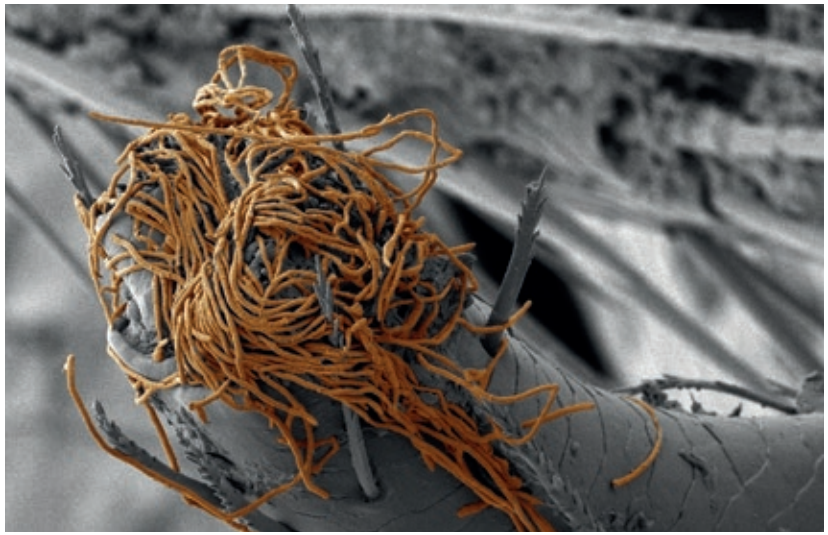
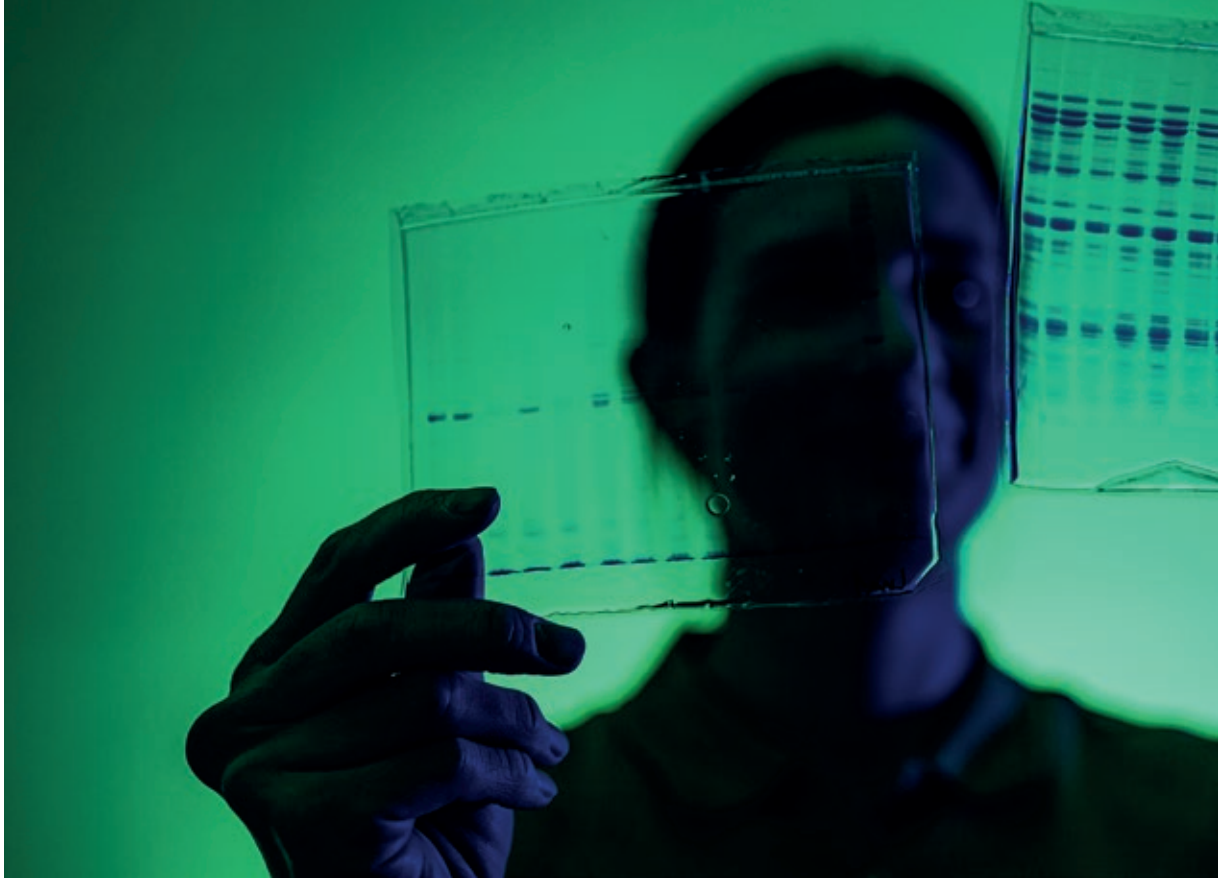


SCIENCE AND RESEARCH

Faculty of Agriculture and Technology

The Faculty of Agriculture and Technology (FAT) of the University of South Bohemia in České Budějovice is a modern faculty with a long tradition dating back to 1960. In 1991, it was one of the founding faculties which participated in the establishment of the University of South Bohemia. The faculty premises are located in the pleasant surroundings of the university campus on the western edge of the city. The faculty disposes of experimental fields and surfaces and a farm.





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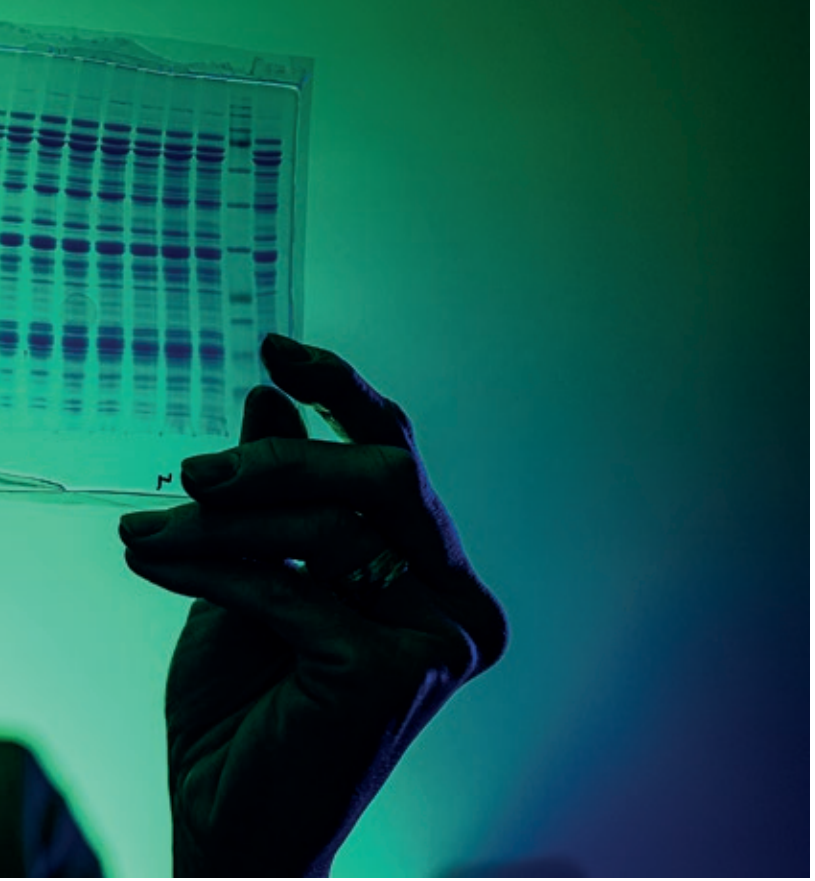

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Trace element analysis and its application in determining risk elements in fruiting bodies of mushrooms

Over the past decade, a number of studies have been conducted on trace elements in edible mushrooms.

The research has mainly focused on finding species that accumulate high concentrations of certain elements.

High levels of As, Cd, Cu, Hg, Pb or Se were found in various wild growing mushrooms, far exceeding the levels of these elements in other types of food. Concentrations of elements in fruiting bodies are strongly dependent on the species of the mushroom and its ecological strategy. Another important factor is also the substrate the mushrooms grow in, the pH value and the amount of organic matter contained in the soil. For example, elevated concentrations of Al, Pb and Rb were found in the fruiting bodies of *Boletus edulis* in an area rich in metal ore. Although a large amount of data on the content of dangerous trace elements in edible mushrooms has been collected so far, information on mushroom species with medicinal effects (medicinal species) is incomplete and often lacking. For centuries, some mushroom species have been collected for their benefits to human health. Their use is well known from traditional Eastern medicine. In this aspect the knowledge and use of European mushroom species is very limited and only few scientific publications are available.

Our research focuses on studying the contents of selected elements (Al, As, Be, Cd, Ca, Cs, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Ni, Rb, Se, Ag, Sr, Tl, Zn) in the fruiting bodies of wild growing mushrooms with medicinal effects. Samples are collected in selected locations in South Bohemia. Selected representatives of medicinal mushrooms are, for example, the *Flammulina velutipes*, *Amanita muscaria*, and the ear of *Auricularia auricula-judae*, *Tylopilus felleus*, *Pleurotus ostreatus*, *Armillaria ostoyae* and common *Coprinus comatus*.

Individual analytes are determined by atomic absorption spectrometry with flame and electrothermal atomization.

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Biogenic amines in food

Biogenic amines are mainly formed in protein-rich foods, such as meat and meat products, and similarly in dairy products, especially cheese.

And they are also found in wine or beer, sauerkraut and other foods.

Elevated levels of biogenic amines appear in fermented foods, as the microbial processes involved in fermentation are largely responsible for the increased amine content. The degradation of proteins first produces peptides, which further degrade by the action of bacterial enzymes to biogenic amines, in particular putrescine, cadaverine, histamine, tyramine, tryptamine, spermidine and spermine.

There are two reasons for monitoring biogenic amines in food. The first is the toxicity of these substances (especially in the case of histamine and tyramine). The second reason is the option of application of these substances to estimate the freshness or, conversely, the degree of decomposition or degradation of food. The acute toxicity of histamine and tyramine is manifested in seafood dishes (scombrotoxicosis) or in ripened cheese (cheese reaction), in particular. It is manifested by vomiting, migraine conditions, blood pressure fluctuations, palpitations and urticaria. Synergistically, intoxication is intensified by the simultaneous ingestion of alcoholic beverages. Biogenic amines may (especially in unfermented foods) also serve as indicators of the degree of decomposition. In particular, in meat and meat products, monitoring of the content of putrescine, cadaverine or tyramine can provide an estimate of the dynamics of the initial degradation before the onset of organoleptic changes.

Monitoring of biogenic amines in food for toxicity and the possibility of using these substances to estimate the freshness or decomposition rate of food.

SCIENCE AND RESEARCH

Plant polyphenols in food

Plant polyphenols have a unique molecular structure that allows them to function as potent antioxidants and important reducing agents.

They are able to protect sensitive food components such as vitamin C and polyunsaturated fatty acids, or vital nucleic acids, from oxidative damage.

By limiting the oxidation of blood lipids and preventing the development of atherosclerosis, plant polyphenols can suppress the development of conditions affecting the heart and blood vessels, the most serious civilisation diseases. Plant polyphenols are also important for their strong antiviral action (influenza, SARS-Covid). The beneficial effects of a diet rich in plant polyphenols have been confirmed in many epidemiological and clinical studies.

The easiest way to increase the intake of polyphenols is to focus on food having naturally a high content of them. Some plants (green tea, buckwheat, medicinal plants, fruits and vegetables) show a very high content of polyphenols and as such have been traditionally listed as scientifically proven functional food. Other materials have yet to find their use. We are therefore studying the distribution and content of phenols in non-traditional fruits and vegetables and in alternative crops. We are exploring the option of their food and gastronomic application. We use traditional and new sources of polyphenols for the enrichment of food products to broaden the spectrum of valuable food with high nutritional value (fruit components of dairy products). We develop recipes for non-traditional products based on exploiting the potential of natural sources of plant phenols (fruit and herbal drinks and concentrates).

We use traditional and new sources of polyphenols to enrich food products.

SCIENCE AND RESEARCH

Organosulfur compounds of agricultural products

Organosulfur compounds are important in terms of sensory and biological properties of many agricultural products, garlic and cruciferous vegetables.

The Laboratory of Organosulfur Metabolites is a part of the Department of Applied Chemistry of the FAT USB.

The research focuses on sulfur compounds occurring in many agricultural products, food or medicinal plants, where they significantly affect their sensory and biological properties. A detailed understanding of the structure of these compounds, their biogenesis, stability, content, as well as their fate during processing is therefore important for the production of quality agricultural products. At present, our research focuses mainly on the study of undesirable colour changes during technological processing of members of the alliaceous vegetables (greening of garlic, pinking of onions) as well as changes in their sensory properties (e.g. undesirable changes in taste).

This research can help garlic and onion producers not only to select suitable varieties, but also to optimise post-harvest storage to maximise the sensory, biological and technological quality of their production. The results can also be used by food producing companies to optimise their technological processes.

Sensory and biological properties of many agricultural products.

SCIENCE AND RESEARCH

Drones applied in haymaking

Cooperation between agricultural production and game management must be in long term harmony to maintain healthy ecosystems.

Wildlife is an integral part of the Czech nature and of the human environment.

Targeted management of game populations and their economic application contributes to a more efficient and better use of land as a basic production means in agriculture. To take heed of game management interests complies with both ethical and economic point of view. The principles of game preservation applied in game management and in some agricultural activities comply more with the interests of individuals than groups.

The optimisation of the hunting use of landscape ecosystems is directly dependent on the harmony between agricultural production and hunting. Evidently, the primary task of the agricultural sector is still to ensure that people are fed in the quantity and quality they need, which entails, among others, a constant effort to increase the yield of the soil, regardless of the feedback loop. It is therefore necessary not only to look for new efficient ways, but also to apply consistently the existing methods, to reconcile vital interests and preserve a healthy environment.

We have been developing the practical use of modern drone technology in hunting for several years. Drones with thermal cameras are used to search for small game and fawns during haymaking. Game is taken out of stands where it would have found death under the mowing gear of agricultural machinery. The automation and facilitation of game retrieval is an important factor to be applied in game keeping management.

According to statistics, 50 to 60 thousand fawns die annually during the haying season.

SCIENCE AND RESEARCH

UAV technologies

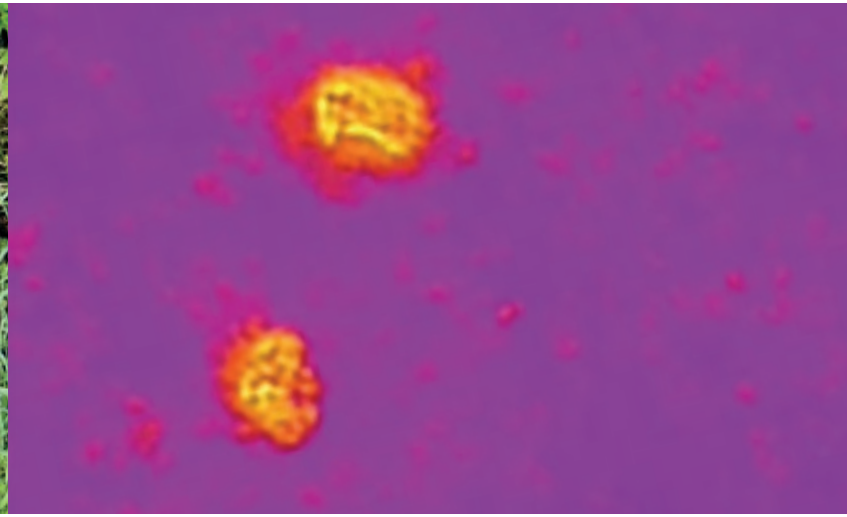
UAV – unmanned aerial vehicle – are remotely piloted machines or drones that have been one of the most evolving segments in the airspace over the last decade. Drones are used for recreational flying to take videos and photos from a bird‘s perspective. These hi-tech systems are frequently applied in agriculture, industry and emergency systems.

The Department of Landscape Management has been using drones since 2016.

The aim was not to develop unmanned technology but to exploit its potential for live data collection and subsequent evaluation, which brings significant pitfalls. At present, the autonomous drones are capable of monitoring a pre-defined area. The pilot only controls the surrounding airspace and changes the drone‘s batteries.

Our workplace focuses on the application options of drone technology. Land improvements related to landscape character and wildlife preservation are the main objectives of application of the technique. This comprises multispectral cameras to check plant nutrition, thermal images to detect drainage systems, RGB images combined into orthomaps for a detailed analysis of damage to agricultural crops. Drones are increasingly being used in agriculture and in the near future they will be part of every agricultural operation, either as monitoring or working devices operated from the instant when the crop is sown until harvest. The heavy machinery will not have to cultivate the crop, the drones will take over the work.

Use of UAV technology at FAT USB: checking the plant nutrition using a multispectral camera, thermal images to detect drainage systems, RGB images combined into an orthomap for detailed analysis of damage to agricultural crops.



SCIENCE AND RESEARCH

Changes of bioactive compounds during heat treatment of foods

Heat treatment of foods can affect a number of low molecular weight compounds that have a positive impact on human health, e.g. polyphenolic antioxidants.

Food production involves various technological steps that require high temperatures.

These include, for example, cooking, baking or frying. A temperature exceeding 200 ˚C, e.g. when baking bread, can affect a wide range of low molecular weight substances that have a positive effect on human health. Examples of these substances are polyphenolic antioxidants, a common component of plant materials used for food production. They occur naturally in fruits, vegetables, cereals and oilseeds.

In case the aforementioned vegetable raw materials are used in the production of foodstuffs which have undergone heat treatment, a significant change in the quality and quantity of the polyphenols occurs. Our research focuses on the observation of these changes and how they affect some of the properties of the polyphenolic substances, such as the antioxidant activity. In general, high temperatures decrease the content and the antioxidant activity of polyphenols. Significant changes also occur in the quality, i.e. in the abundance of individual substances, because, for example, deglycosylation, isomerisation, or the decomposition of dimeric and trimeric forms into simpler structures occurs.

The opposite example in which heat treatment has a positive effect on biologically active substances is the production of the so-called black garlic (also called aged garlic), which is also the subject of our research. Black garlic is a product originating from the East Asia.

It is produced by exposing the garlic cloves to a temperature of approximately 70 °C and high relative humidity (85–95 %) for up to several weeks. During this time, the garlic changes colour from white to black and its sensory properties and the content of biologically active substances change significantly. In this aged garlic, not only a higher antioxidant activity can be observed, but also an increased content of some Maillard reaction products (e.g. fructosyl arginine, melanoidins) or sulphur compounds, as exemplified by S-allyl-L-cysteine.

The cited examples prove that heat treatment of foodstuff can have both positive and negative effects on biologically active substances and can result in changes in their properties. It is therefore important to address this topic in the future research.

Our research is focused on the observation of changes in the quality and quantity of polyphenolic antioxidants and the influence on their properties, such as an antioxidant activity, caused by heat treatment.

SCIENCE AND RESEARCH

Agricultural and food processing

by-product materials: source of valuable nutrients and bioactive compounds

During the processing of agricultural raw materials and food products, waste or by-products can be generated in the form of peels, trimmings, oilseed cakes or low-quality food raw materials, such as healthy but undersized or deformed pieces of vegetables or fruit.

By-products usually ends up in biogas plants or as raw material for livestock feed.

Many nutritionally or health-relevant substances leave the food chain in this way. Even though they are contained in these wastes in larger quantities than in the consumed part.

An example of the use of agricultural waste for food purposes is onion peels. We have been working intensively on this issue in our research. The onion *(Allium cepa L.*) is the second most cultivated vegetable in the world after tomatoes in terms of quantity produced. During its post-harvest processing (picking, storage, bagging) a large amount of waste is produced in the form of the aforementioned peels. These contain large amounts of fibre and flavonoid antioxidants, the most dominant substance being quercetin and its derivatives (glucosides, dimers, trimer).

The onion peels can be used in various forms, such as aqueous extracts, ground into flour or the quercetin and its derivatives can be isolated from the peels and used as a concentrated source of antioxidants.

Antioxidants are important in several aspects. They have a positive health effect because they can eliminate oxidative stress in the organism, as stress is a factor inducing the development of many civilisation diseases. Flavonoids from onion peels also have a positive effect on the foodstuff itself. We have described in several publications the results of our research proving that these substances can very effectively prevent lipid oxidation in meat products. Lipid oxidation affects negatively the sensory properties of food and produces substances with a negative impact on human health. A practical consequence of the enrichment with onion flavonoids is the prolonged shelf-life of the meat product. Another food product enriched in our research was gluten-free bread. Onion peels were added in the form of finely ground flour. In addition to the increased antioxidant content, the bread samples also featured an increased fibre content, which is very important from a nutritional point of view.

Our research also focused on the use of by-products from the pressing of oil from milk thistle (*Silybum marianum L.).* The pressing process produces oilseed cakes as a by-product in which valuable proteins, residual fat, fibre and silymarin complex are preserved. The silymarin complex is a mixture of flavonolignans with beneficial effects on human liver and it has antioxidant properties. These oilseed cakes were re-used in flour form as a fortifying ingredient for bakery products increasing significantly the antioxidant, fibre and protein content.

The idea of waste recovery supports the so-called circular economy and the sustainable management of natural resources. And we consider this topic very important. In our further research, we intend to explore real impacts of the consumption of food enriched with waste of by-products on human health, but this is a very long and challenging journey.

The peels can be used in various forms, such as aqueous extracts, ground into flour, or quercetin and its derivatives can be isolated from the peels and used as a concentrated source of antioxidants.

SCIENCE AND RESEARCH

Qualitative characteristics
of meat from farmed game

Animals are slaughtered either by shooting on the pasture or by stunning and then exsanguinated on the farm. However, there is a reasonable assumption that the quality of the muscle meat obtained is different.

The current trend in livestock production is to move away from simply increasing production to considering the quality indicators.

Consumers are no longer satisfied with the supply of sufficient quantities of meat but they also monitor and evaluate its quality and the welfare of animals farmed for meat. As consumer concern for the environmental aspects of farming increases, so does the concern for free-range meat. One way of meeting these demands is game farming. This type of farming provides sufficient production of quality meat, while respecting the basic welfare requirements of the animals by keeping them in relatively natural conditions and at low operating costs.

Slaughtering farmed animals is a natural part of meat production. Animals are slaughtered either by shooting on pasture or by stunning and subsequently exsanguinated on the farm. Both methods are legally permitted, but there is a reasonable assumption that the quality of the muscle meat obtained is different. By evaluating the quality characteristics of the meat, external influences on both the composition and texture and the technological characteristics of the meat are determined. The research aims to verify which qualitative changes occur in meat depending on the method of slaughtering the game based on the physical characteristics of the muscle meat.

The results of observations, measurements and laboratory analyses will be applied to formulate basic breeding measures and recommendations. These recommendations and rules could serve as a basis for good animal husbandry practice and the establishment of uniform standards in the farming of fallow deer and other species.

Observations, measurements and laboratory analyses.

SCIENCE AND RESEARCH

Inhibitory substances in milk

Inhibitory substances occur in milk naturally or enter milk as a result of contamination.

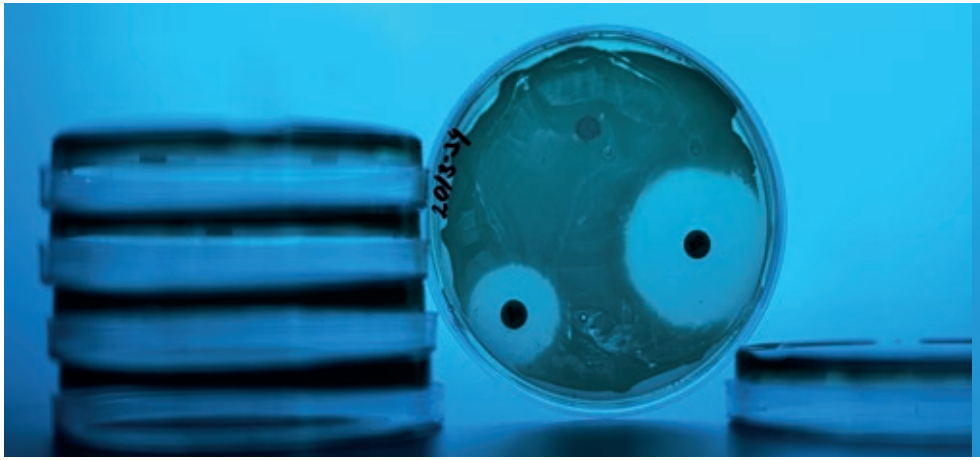
The importance of natural inhibitory substances, e.g. lactoferrin or immunoglobulins, consists in protecting newborns from sepsis caused by pathogenic microorganisms.

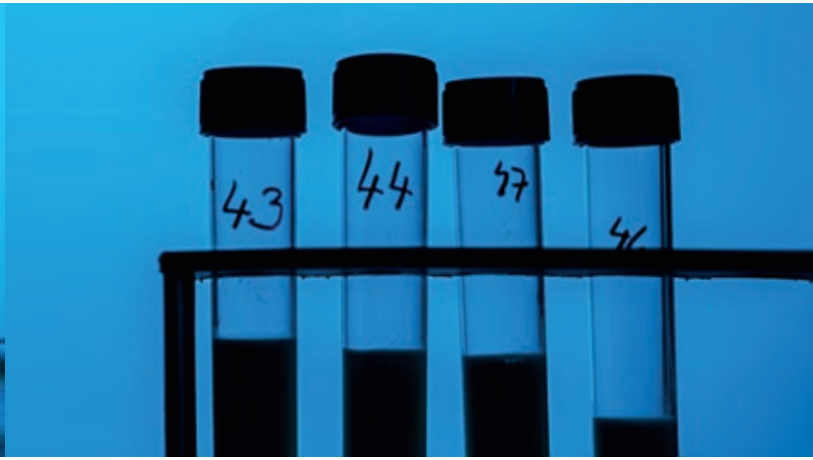
The antimicrobial as well as nutritional effects of these substances are utilized in infant formula products and various pharmaceutical preparations. From the group of contaminating inhibitory substances, the most attention is paid to residues of veterinary medicines, especially antibiotics. The presence of antibiotic residues in milk has negative technological implications for the processing of milk into dairy products but it also has an adverse effect on the human gut microbiota and, thus, can lead to the development of various diseases.

Estimation of the risk of antibiotic residues in milk, persistence of their excretion, study of related factors and rapid and reliable methods for the detection of these substances are important topics in terms of producing safe food and protecting the health of consumers. These topics are the main focus of the current project entitled "Options for influencing the occurrence of inhibitory substances in milk as an effective tool to promote animal health and improve food quality and safety" (QK21010326). The project studies in detail the relationship between the metabolic load of dairy cows during lactation, milk quality indicators and the duration of excretion of antibiotics by milk. Methods for the detection of both contaminating and natural inhibitory substances in milk are optimised. The relationship of inhibitory substances with technological indicators of milk and economic aspects is investigated. A number of sub-objectives is addressed in close cooperation with the Dairy Research Institute and the University of Veterinary Sciences in Brno.

Supported by the NAZV project QK21010326.

We optimize methods for the detection of both contaminating and naturally occurring inhibitory substances in milk.





SCIENCE AND RESEARCH

Fortification
of dairy products

Food fortification is carried out to increase the proportion of a nutritional component usually present in consumer‘s diet in insufficient quantities, e.g. vitamins, minerals, proteins.

Fortified food can not only contribute significantly to the proper functioning of the organism, but can also be more attractive to certain groups of consumers, for example, children.

In addition to the essential components, food can be enriched with other biologically active substances (e.g. polyphenols) having a preventive effect against various civilisation diseases. On the other hand, some components may adversely affect the sensory acceptability of enriched products. For these reasons, it is necessary to deal with fortified food in a comprehensive way, from its composition, technological processing and sensory properties to its effect on the health of consumers.

The topic of food fortification and the impact on selected food properties and consumer health is part of the consecutive GAJU projects, which builds on the collaboration of three research groups at the FAT, the research topics of which have long been interconnected and complementary. The team focuses on multidisciplinary approach addressing food quality and safety and animal and human health issues. The possibilities of fortification with various components of animal or plant origin are investigated for dairy products, including their acceptability by potential consumers. To make the fortified products available on the market, the FAT cooperates with food production operations. This cooperation resulted in, among others, an applied output entitled Enriched yoghurt with increased protein content and with plant antioxidants.

Food can be enriched with essential components and other biologically active substances (e.g., polyphenols) acting preventively against various civilisation diseases.

SCIENCE AND RESEARCH

Plant essential oils in beekeeping

The research focuses on obtaining practically applicable knowledge about the effectiveness of selected plant essential oils on the health status of honeybee colonies and their subsequent application in beekeeping practice.

The aim is to develop a product and its specific application for safe treatment of honey bee colonies, promoting their health and their subsequent higher population growth, resulting in increased efficiency of honey bee breeding as a "farm" animal.

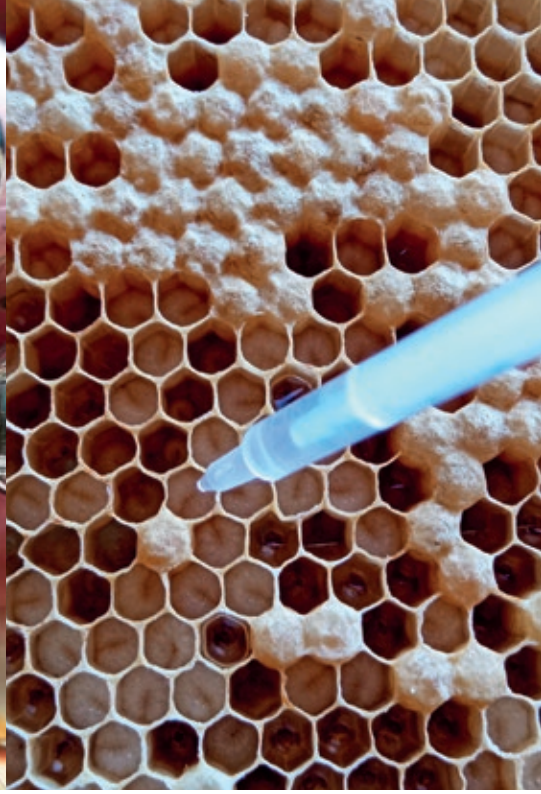
The high usage of existing products increases the risk of resistance of harmful agents to these substances. In addition, the natural origin and gentleness of the plant essential oils ensure significantly lower risk of contamination of bee products with unsafe foreign substances, compared to the synthetic products widely used today. The application of plant essential oils can help to increase the production of high-quality and nutritionally valuable honey and reduce the need to import honey, which is often of low-quality and originating from countries where the application of hive chemicals (including antibiotics) is not regulated.

Improved bee colony health will also result in a reduction in bee colony mortality rates, which will maintain the valuable pollination service.

As one of the most efficient pollinators, the honeybee ensures stable crop yields and maintains the diversity of wild species. Improving the health of honeybee colonies would support the ecological stability of the landscape in addition to increasing the quality and quantity of honey as a valuable food product.

Our research also focuses on the impact of plant essential oils on the fungal pathogens *Paenibacillus larvae* and *Ascosphaera apis*, as causal agents of the American foulbrood and chalkbrood disease. Microbiological tests are carried out under laboratory conditions, ranging from pre-routine screening to the determination of the minimum inhibitory concentration of the most effective plant essential oils, to tests of synergic effects and bee tolerance. The greatest emphasis is on parasitic diseases (Varroasis).

The research is very complex and includes testing methods of mite collection and preservation, preliminary screening of a large number of plant essential oils, cage experiments with bees and mites with several methods of application of plant essential oils, and finally in vivo experiments in synchronized pollinators and hives. As the final product must be bee-friendly, ecotoxicological tests on bees and their developmental stages are part of the experiments.



Toxicity testing on bee brood.

SCIENCE AND RESEARCH

Oilseed cakes

of oilseeds and its applications for sustainable food and feed production

Depending on the species, oilseed cakes (flax, hemp, milk thistle, pumpkin) contains 30–60 % of high-quality protein and is an important source of fibre and of valuable biologically active substances (especially antioxidants) with positive effects.

The oilseed cakes are a by-products of the pressing of oilseed oils and are an important source of nutritionally and technologically important substances such as protein, fibre and other biologically active substances.

With respect to the principles of circular economy, efforts are currently being made to valorise the oilseed cakes into various forms of products that are particularly useful for animal feed, direct human nutrition and food production. In the context of food applications, the production of oilseed cakes flours as alternatives to gluten-free flours for the full or partial substitution of wheat flour in food products (especially bakery and meat products) is a particular concern.

FAT USB deals with the use of oilseed cakes of minor oil crops (oilseed flax, hemp, milk thistle, oilseed pumpkin) for the production of protein flours or protein concentrates /isolates within the framework of the research project of the Ministry of Agriculture QK1910302 "Processing of by-products from oilseed pressing into new products with nutritional and health benefits" in cooperation with other research institutes, such as: University of Chemistry and Technology, Prague, Masaryk University, Agritec Plant Research Šumperk and HEMP PRODUCTION CZ, s. r. o.

The research is mainly focused on the application of the "dry way" techniques (using mechanical operations such as dehulling, milling and sieving) for the production of protein (protein content of 30–60 %) or fibre fractions of oilseed cake flours. Within the framework of the project, model food products were designed – bread variants substituting wheat-rye flour with oilseed cake flours, gluten-free bread with the addition of thistle flour, meatloaf variants containing oilseed cake flours (as a substitute for the usually used wheat flour), biscuits and other products.

Two utility models have been registered – "Mixture to increase the content of silymarin in bakery, pastry and meat products and bakery, pastry and meat products and bakery and/or pastry and meat products containing this mixture" and "Protein concentrate from hemp seeds". Next, a certified methodology has been developed and applied: "Optimized processes and methods for processing seeds of selected minor oilseeds into oil and refined oilseed cake products", which summarises most of the practically applicable knowledge gained during the project.

In addition to the actual process of increasing the protein content of the flours and their fractions by the aforementioned "dry way", the research concentrates on the evaluation of the quality of the products obtained. The following indicators are monitored: substance composition, evaluation of the quality and fractional composition of proteins, evaluation of technological and functional properties, antioxidant activity and, in the case of products derived from milk thistle seed cakes, detailed analysis of the silymarin complex.

Supported by the NAZV project QK1910302.

Flours made from oilseed cakes can partially replace wheat flour in a range of food products – meat products, bread, ordinary and durable bakery products – and thus enrich these products with protein, fibre and natural antioxidants.

SCIENCE AND RESEARCH

Potato tuber proteins

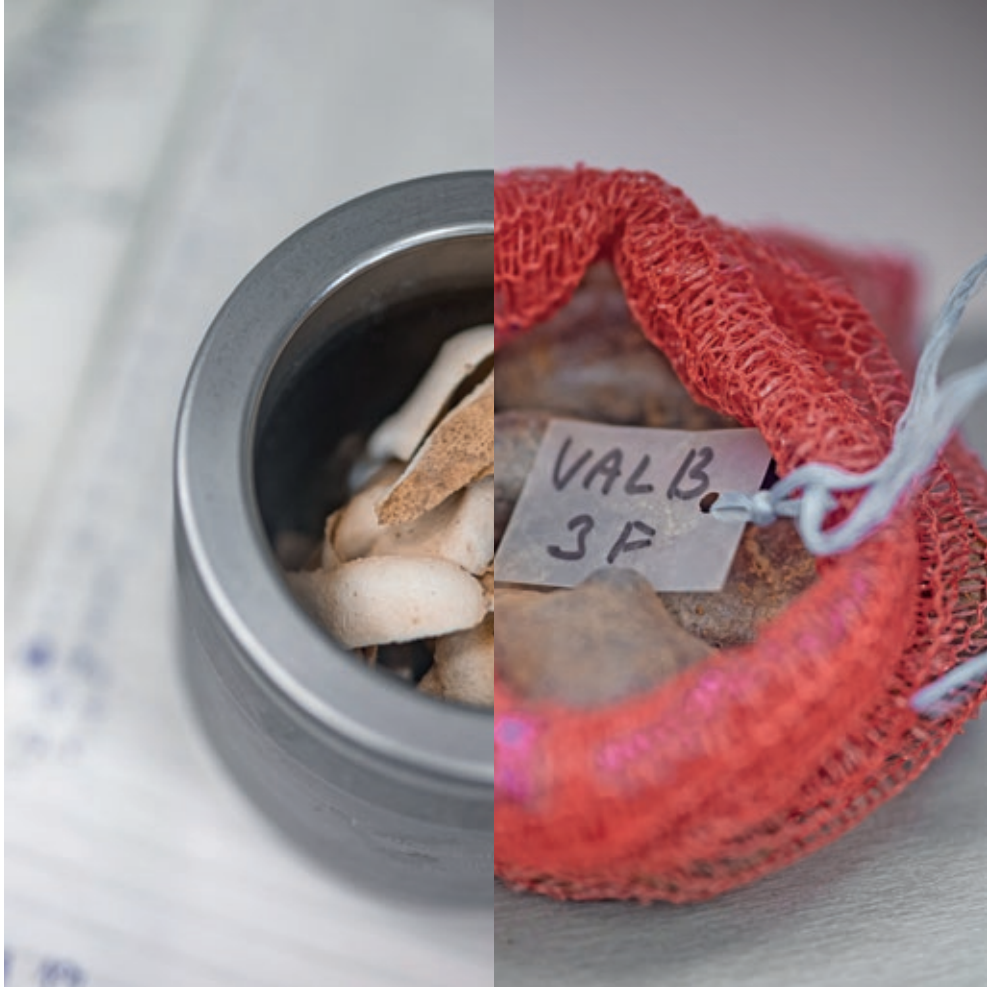
Potato tuber proteins belong to the most nutritionally valuable vegetable proteins. Their content in tubers represents, depending on the cultivar and the cultivation conditions only 1–2 % (i.e. about 40–60 % of the nitrogenous content), but due to the significant consumption of potatoes (65–70 kg/person/year in the Czech Republic), potato protein is of considerable importance in human nutrition.

Research in the field of potato proteins has a more than twenty-year-long tradition at the FAT USB.

The Department of Plant Production (KROV) has been working for many years on the evaluation of the influence of genotype (in the form of commercial varieties and wild genotypes) and other cultivation factors on the content, fractional composition and quality of tuber proteins. A suitably selected variety proves to be the most important cultivation factor influencing tuber protein content and protein yield per hectare.

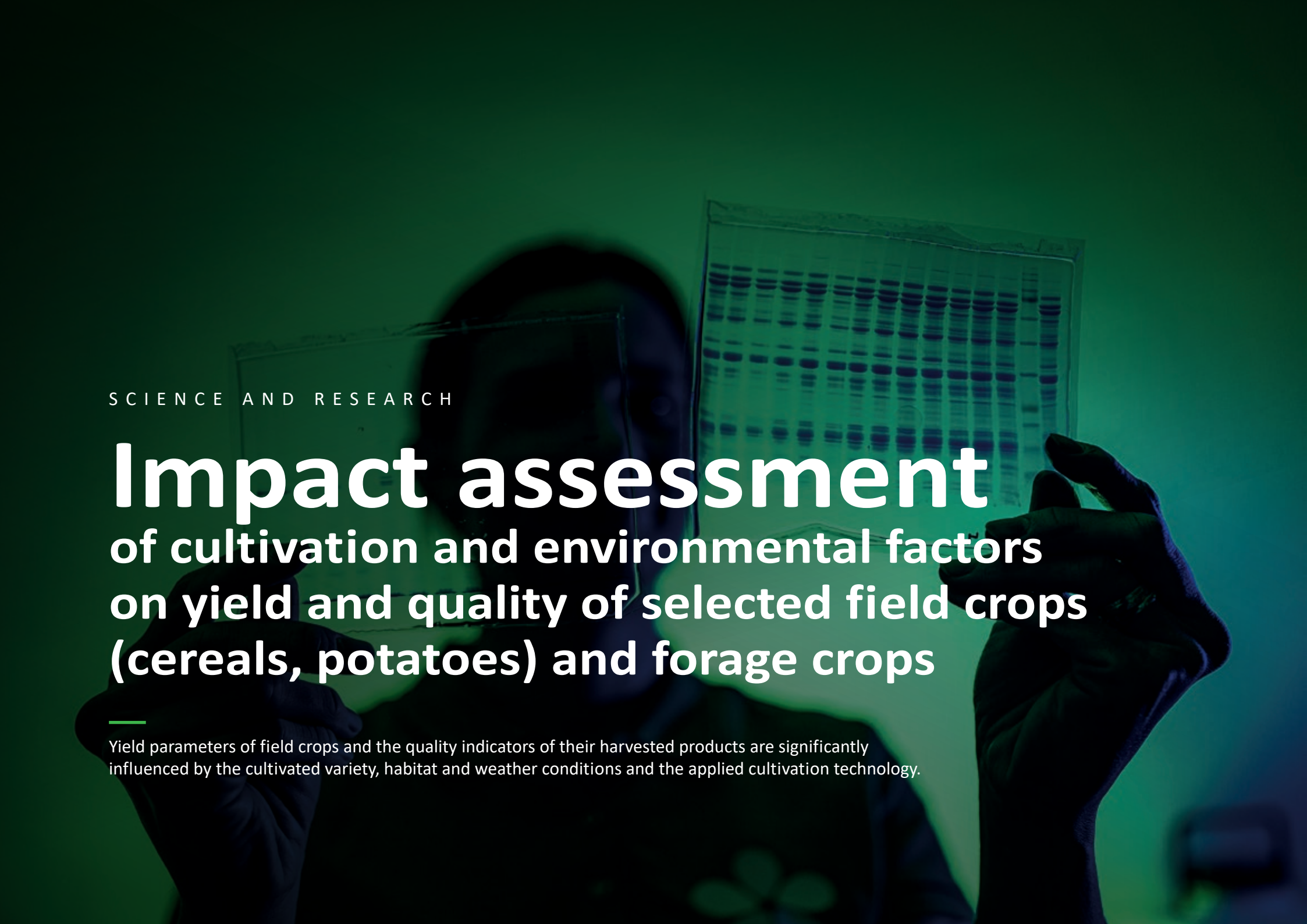
The methods of isolation of potato proteins from potato fruit juice, which is produced as a by-product of potato processing into starch, and the actual evaluation of the quality parameters of potato protein concentrates/isolates plays an important role in the research at the Faculty. In this respect, KROV FAT USB has been cooperating with the largest Czech processor of potatoes for starch production, Lyckeby Amylex a.s.

Potato proteins in the form of concentrates of denatured proteins or fractions including the main protein components (patatin, protease inhibitor group) in their native state can be used not only in animal nutrition, but also in human nutrition, in the production of food products and in other applications in which the biological and functional properties of these proteins are applied. The predominantly occurring storage albumin patatin possesses non-specific lipid acylhydrolase enzyme activity that can be used in a variety of technological processes. In general, potato proteins have excellent emulsifying properties, the ability to form foams and gels or to bind water and fat. Significant manifestations of some potato tuber proteins are antifungal activities against a number of filamentous fungi.



Potato tuber proteins possess a number of practical properties useful in food applications.

Supported by projects NAZV QF4030 and NAZV QI191A069.



SCIENCE AND RESEARCH

Impact assessment

of cultivation and environmental factors on yield and quality of selected field crops (cereals, potatoes) and forage crops

Yield parameters of field crops and the quality indicators of their harvested products are significantly influenced by the cultivated variety, habitat and weather conditions and the applied cultivation technology.

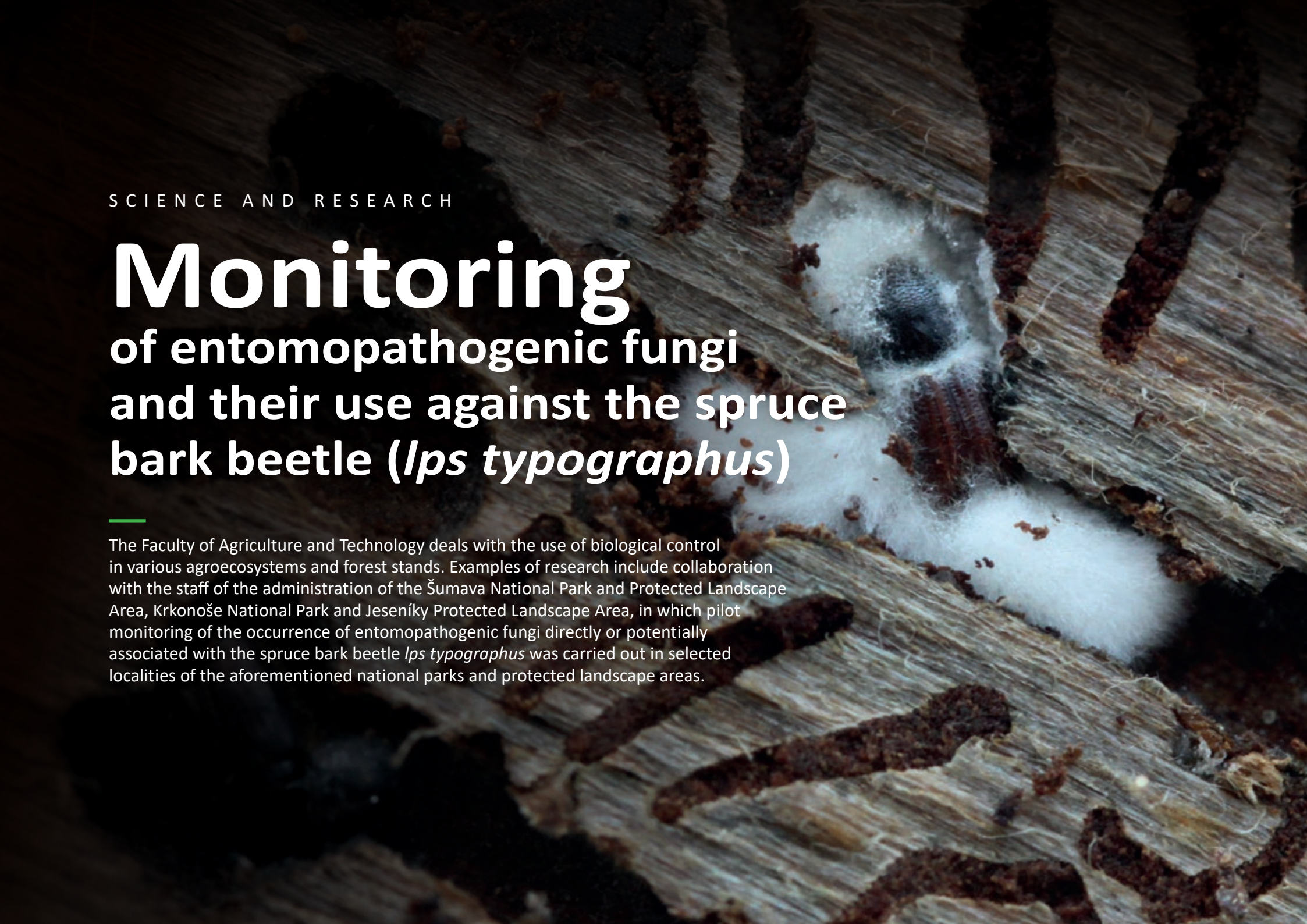
It is important to monitor the influence of these factors for both the profitability of cultivation and for achieving a suitable quality of plant products for subsequent processing.

Research on yield and quality parameters of field crops has a long tradition at the FAT USB. The Department of Plant Production (KROV) has been dealing with the influence of varieties in interaction with seasonal influences and different cultivation variations.
In the case of major cereal crops (wheat, barley), small--plot field trials are established every year which are used for the solution of final student thesis; in the case of minor cereal or pseudocereal species, the unstudied genotypes are tested in field experiments. Field trials with potatoes are very traditional. The following topics have been researched: the influence of conventional and organic cultivation on tuber yield and tuber quality, the influence of variety and cultivation technology on tuber protein content and its quality, and the possibility of biostimulant application to reduce drought stress in potato crops. Recently, the researchers at KROV have turned their attention to legumes and oilseeds, in particular in evaluating the possibility of growing soybeans in marginal conditions and the possibility of using micro-organisms to treat soybean and pea seeds.

Traditionally, the FAT USB pays attention to the research of species composition and phytocenological relationships of permanent grasslands, methods of grassland management, production of forage biomass and its quality. Our research is also focused on non-productive functions of grasslands and their impact on the agroecosystem. With regard to marginal area and the applicability of the findings in practice by local farmers, the research also focuses on grazing and the optimisation of grazing systems.

Supported by GAJU team projects and NAZV project QJ1610020.

Monitoring the influence of these factors is important both for the profitability of cultivation and for achieving a suitable quality of plant products for subsequent processing.



SCIENCE AND RESEARCH

Monitoring
of entomopathogenic fungi and their use against the spruce bark beetle (*Ips typographus*)

The Faculty of Agriculture and Technology deals with the use of biological control in various agroecosystems and forest stands. Examples of research include collaboration with the staff of the administration of the Šumava National Park and Protected Landscape Area, Krkonoše National Park and Jeseníky Protected Landscape Area, in which pilot monitoring of the occurrence of entomopathogenic fungi directly or potentially associated with the spruce bark beetle *Ips typographus* was carried out in selected localities of the aforementioned national parks and protected landscape areas.

Entomopathogenic fungi cause primary infections on a variety of pest species, including infections on the spruce bark beetle and on other species of bark beetles, *Scolytinae*, as well as on the pine beetle.

The general aim of monitoring the occurrence of entomopathogenic fungi in spruce forests is to observe species associated with bark beetles in a specific area. With regard to the potential importance of entomopathogenic fungi as natural regulators of the abundance of spruce bark beetle populations, their occurrence in direct association with the adults, or in natural niches of its occurrence, i.e. in the bark of infested trees or in the soil under bark beetle caused dry trees.

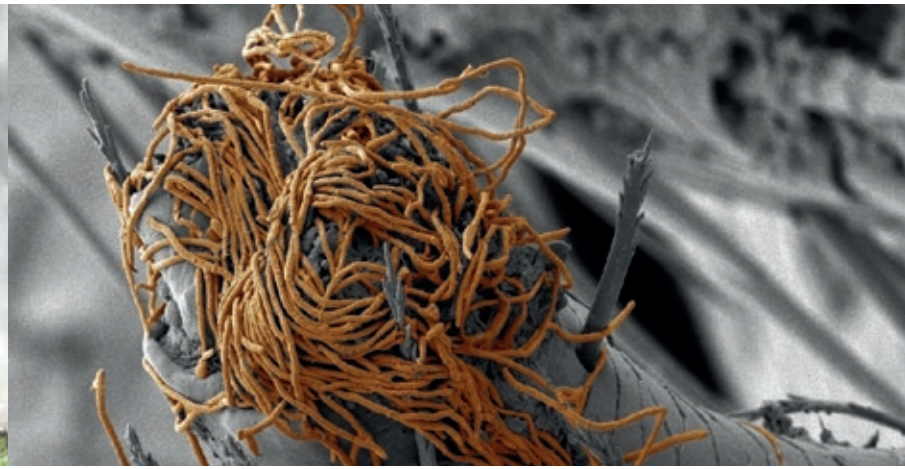
The results of the monitoring clearly confirmed the predefined assumptions, which stated that entomopathogenic fungi occur naturally in all monitored niches and at all sites included in the monitoring. The dominant species, most frequently recorded on adult spruce bark beetles, is the fungus *Beauveria bassiana*. In spruce bark beetle populations, there are also following species of fungi: *Beauveria caledonica*, *Isaria fumosorosea*, *Isaria farinosa*, *Akanthomyces atenuatus* (=*Lecanicillium atenuatum*), *Akanthomyces muscarius* (=*Lecanicillium muscarium*), in the soil under bark beetle caused dry trees also *Metarhizium brunneum*.

In connection with the targeted monitoring of entomopathogenic fungi in spruce forests, a special collection of isolated pure native strains was established at the FAT USB, which can be subsequently used in the integrated forest management. If necessary, the local strains of entomopathogenic fungi can be reintroduced to their area of origin as spore biomass.

The application aims at introducing conidia of entomopathogenic fungi into the sites of adult bark beetles. These can introduce the conidia into the bark niche where the bark beetle development occurs. The fungal conidia are applied to the environment in the form of powder or aqueous suspensions.

Conidia suspensions are applied by spraying or drenching onto the surface of the stems, and a powdered formulation of the spores is applied in the form of a cold dusting (image left).

Mycelial growth of B. bassiana from a spruce bark beetle's antennae (image right).



SCIENCE AND RESEARCH

Practical application

of biological control of fruiting vegetables and ornamental plants in greenhouses against pests and pathogens

Biological control is based on the introduction of macroorganism-based biopreparations (predators and parasitoids) and the application of microorganism-based biopreparations (e.g. entomopathogenic and mycoparasitic fungi).

Biological control is mainly used in greenhouses because it is a closed system where environmental conditions, especially temperature and relative humidity, can be regulated.

Currently, predators and parasitoids are mainly used to control greenhouse pest populations in commercial greenhouses. For successful control of fruiting vegetables and ornamental plants grown in greenhouses, emphasis is placed on regular monitoring of pests. Monitoring is important not only for assessing the abundance of pest populations but also for determining their developmental stages. Based on the monitoring, the appropriate predator or parasitoid species and the quantity thereof is selected to be introduced into the environment to inhibit the particular pest or its development stage. After the introduction, natural enemies must also be monitored to ensure the effectiveness of the measures. Different species of natural enemies can also be combined to eliminate one pest. The aim is not only to achieve an immediate protective effect but also a long-term control of greenhouse pest populations, over the entire crop growing cycle. The introduction of natural enemies is carried out repeatedly during the growing cycle. Biopreparations based on entomopathogenic fungi are applied in greenhouses to regulate pest occurrence.

The Faculty of Agriculture and Technology deals with the practical application of entomopathogenic and mycoparasitic fungi in greenhouse cultures against greenhouse pests and plant pathogens. The research on biological control applying entomopathogenic and mycoparasitic fungi is carried out in commercial greenhouses and as well as, in cooperation with the Faculty of Fisheries and Water Protection of USB in an experimental aquaponic greenhouse. The effects of fungi in a tritrophic system: pathogen – pest/disease agent – host plant are tested. There are the following species/strains of entomopathogenic fungi tested to inhibit the selected pests in the greenhouses: *Aschersonia aleyrodis*, *Isaria fumosorosea*, *Akanthomyces atenuatus* (=*Lecanicillium atenuatum*) and *Beauveria bassiana* and against pathogens the mycoparasitic fungus *Trichoderma virens*. At the same time the mutual compatibility of the natural enemies is tested in the pattern: entomopathogenic fungus vs. entomopathogenic fungus interaction, entomopathogenic fungus vs. mycoparasitic fungus, entomopathogenic fungus vs. predator, or entomopathogenic fungus vs. parasitoid.

These studies are carried out at the FAT USB as part of the experiments:

1) *Comparison of the efficacy of entomopathogenic fungi on different developmental stages of insect pests, the greenhouse whitefly Trialeurodes vaporariorum and the silverleaf whitefly Bemisia tabaci and the green peach aphid Myzus persicae.*

2) *Comparison of the efficacy of entomopathogenic fungi on different developmental stages of two spotted spider mite Tetranychus urticae, where many entomopathogenic fungi also exhibit acariphagous status.*

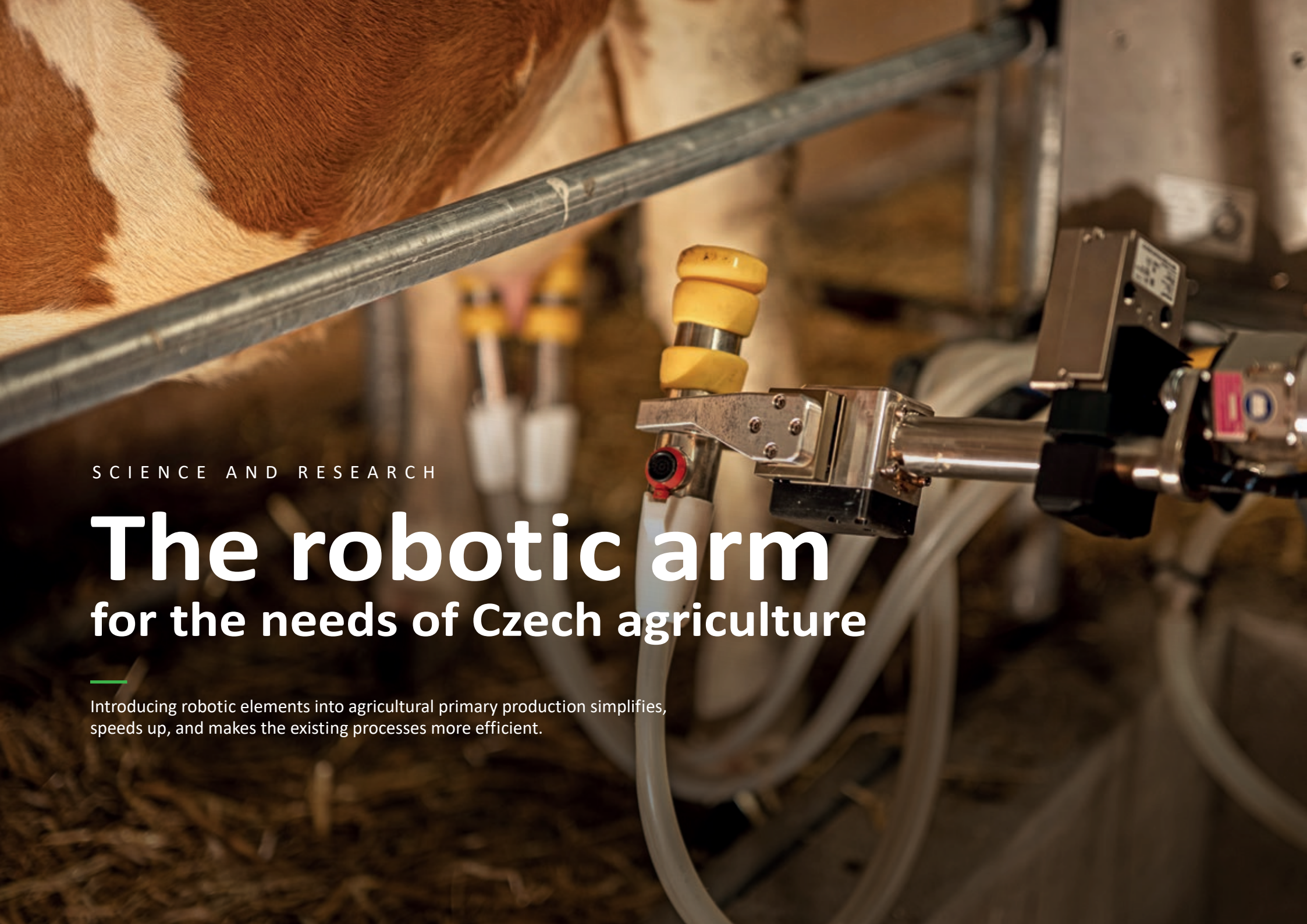
3) *Effect of optimal and suboptimal conditions on the efficacy of entomopathogenic fungi on selected hosts.*

4) *Evaluation of the efficacy of the entomopathogenic fungi Isaria fumosorosea and Akanthomyces atenuatus (=Lecanicillium atenuatum) and the mycoparasitic fungus Trichoderma virens on Erysiphales. Entomopathogenic fungi also show mycoparasitic status.*

5) *Preventive application of entomopathogenic fungi to plants in order to create an environment suppressive to the development of key pests or Erysiphales.*

6) *Evaluation of the strategy of preventive application of entomopathogenic fungi and monitoring of their occurrence in the environment after application (= long term suppressive effect in the programme).*

7) *Preventive application of mycoparasitic fungi to the substrate to ensure its suppressive effect against the development of plant pathogens causing damping-off, including monitoring the presence of fungi in the substrate after application.*



SCIENCE AND RESEARCH

The robotic arm
for the needs of Czech agriculture

Introducing robotic elements into agricultural primary production simplifies, speeds up, and makes the existing processes more efficient.

The use of a robotic arm in conventional milking parlours marks the next step in the automation of the milking process.

The robotic arm fully replaces the traditional milking operation carried out by the milker. It is designed to integrate with existing milking parlour setups, without the need for any construction modifications, replacement of milking machines, changes to milking routes, or the installation of new electrical wiring. Application of the robotic arm follows the same procedure for dairy cows as the traditional milking machine, eliminating any variation in the quality of the application by a milker or any emotional oscillations in the milker's approach. The robot operates irrespective of the set working hours, holidays, or sick leave. In the event of a malfunction, unlike most milking robots, the robotic arm can be put out of operations and the milking can be carried out manually.

The robotic arm was tested in the FAT USB laboratory using an artificial udder with varying teat sizes and geometries. The system was tested on herringbone, tandem, and side-by-side (SBS) milking parlour designs. The robotic milking system consists of three components: a six-axis handling robot by Fanuc company, a 3D camera tracking system, and a moving path. The robot can be placed on the floor in the milking pit or suspended above the parlour. After testing the milking parlour designs and different udder shapes, the robotic arm was implemented on the school farm of the FAT USB.

Artificial intelligence plays a vital role in the Agriculture 4.0 concepts offering great potential in both crop and livestock production. The robotic arm is another critical element in fully automating and robotizing the milking process. This system will feature the future growth of farms, improving productivity, management, and the quality of life on family farms.

Application of a robotic arm for milking and 3D visualisation of the udder area.

The robotic arm was designed as part of the TRIO project – Development of a complex system of robotic milking system with simultaneous evaluation of breeding parameters using artificial intelligence methods. This project received financial support from the state budget through the Ministry of Industry and Trade.

SCIENCE AND RESEARCH

Evaluation of welfare indicators in cattle breeding by machine vision methods

The use of computer vision plays an essential role in the detection of diseases in livestock.

Early diagnose of problems or discomfort in cattle can be an effective method to significantly reduce the negative economic impact.

Direct visual observation of livestock is the traditional method for detecting deviations in behavioural patterns to identify developing diseases. However, this method is time-consuming and labour-intensive. For these reasons, sensors such as multi-axial accelerometers, pedometers, or image-recording devices are used to continuously monitor livestock behaviour. The data collected can then be evaluated automatically using deep learning methods, such as convolutional neural networks.

New computer vision technologies can be used to identify individual behaviour in large enclosures, such as camera systems that enable object detection in images using advanced machine learning algorithms.

In our application, machine vision methods are employed to detect the position of cattle in the barn and their activity (standing vs. lying down), based on which a cow comfort index is calculated.

Supported by the MIT TRIO project FV40316.

Detection of individual cattle and determining their activity using neural networks.

Centre for the Best Available Technologies of USB

The task of the established BAT (Best Available Technologies) Centre of the USB is to create and operate a scientific centre where it will be possible to work at a high scientific level in laboratory, semi-operational and operational conditions using modern measurement technologies in accordance with Council Directive 96/61/EC of September 1996 on Integrated Pollution Prevention and Control (IPPC), elaborated in the BAT Reference Document (BREF BAT Reference Document), implemented into Czech legislation by the Act 76/2002 Coll., on Integrated Pollution Prevention and Control and on the Integrated Pollution Register and Act No. 201/2012 Coll., on Air Protection as amended.

New BAT technologies in the fields of air protection, wastewater processing, treatment of livestock excrements up to the ploughing thereof in soil are being tested in the centre.

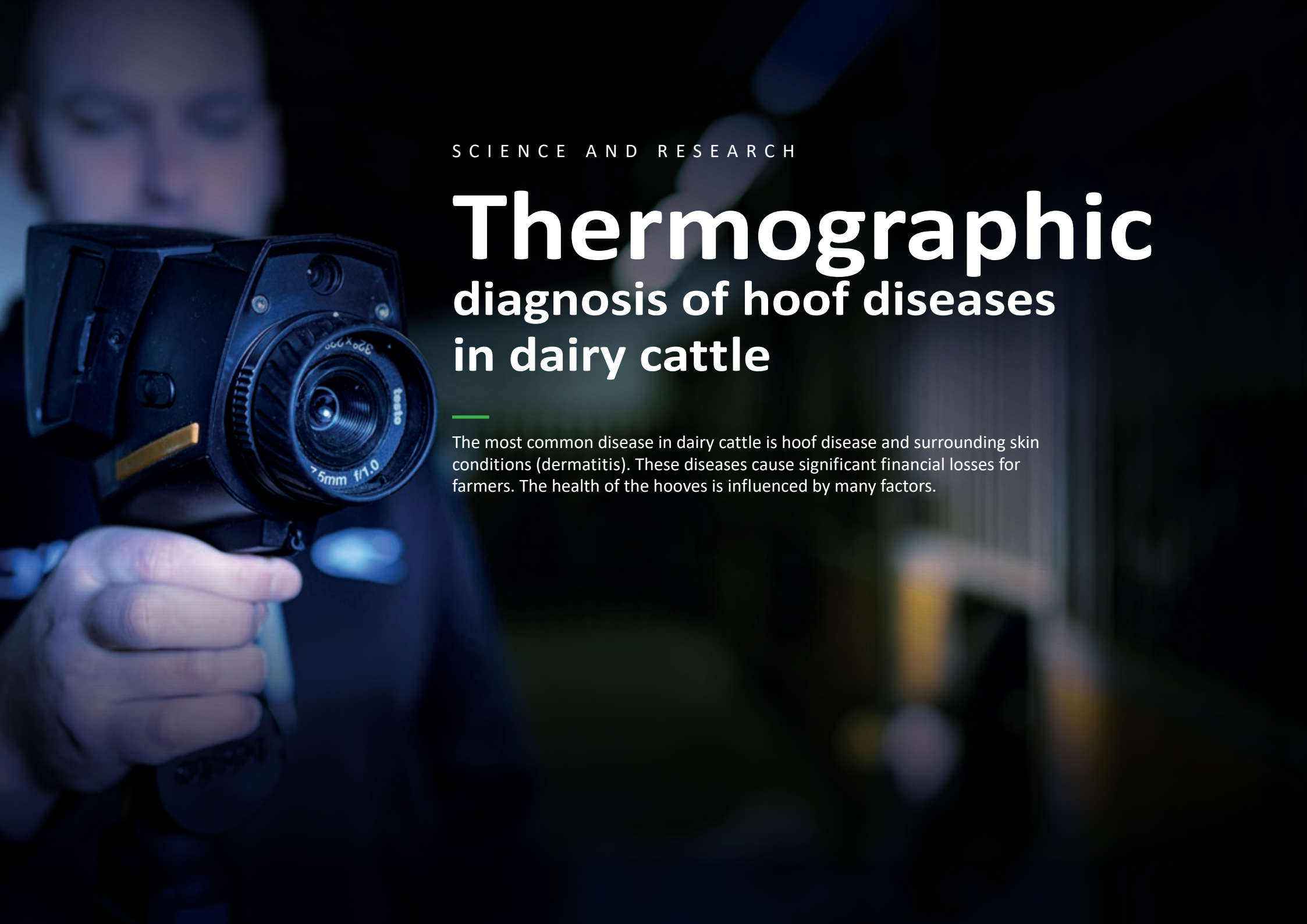
A laboratory for the determination of emissions and immissions of stress gases has been established (gas monitors Innova 1412, 1512 and Horiba, BUCK spectrophotometers, anemometers and thermohydrobarometers), as well as a noise measurement laboratory (BK sound meter), a laboratory for the measurement of dust particle concentration (DUSTRAK dust meters) and the biodegradable waste treatment laboratory (RAMKO adiabatic oxygen concentration meter).

The proposed technologies are tested in semi-operational and operational conditions directly in farms and their general application after successful test results will be achieved by succeeding projects. The topics are also dealt with in diploma, bachelor and doctoral theses, and by solving other grant projects as well as by cooperating with the Technical Working Group for Area 6.6. under Act No. 76/2002 Coll., on Integrated Pollution Prevention and Control, under the Ministry of Agriculture of the Czech Republic.

The tested results of the new BATs are being applied in co-operation with foreign experts in the revision of the BREF document.

Supported by contracts of the Ministry of Agriculture of the Czech Republic.

The proposed technologies are tested in semi-operational and operational conditions directly in farms.



SCIENCE AND RESEARCH

Thermographic diagnosis of hoof diseases in dairy cattle

The most common disease in dairy cattle is hoof disease and surrounding skin conditions (dermatitis). These diseases cause significant financial losses for farmers. The health of the hooves is influenced by many factors.

It mainly concerns the hygiene of the barn space, the type of flooring, and regular hoof care to meet the required quality.

The health of the hooves can also be affected by the quantity and composition of the feed ration.

If hoof disease develops, the welfare of dairy cows is compromised. Typical symptoms of the disease include impaired mobility due to pain when walking and reduced feed intake, which eventually leads to weight loss and a decrease in milk yield. Ultimately, this can result in higher treatment costs or the culling of the affected dairy cow.

Using infrared thermography, temperature differences in the extremities can be detected, indicating the possible presence of the disease. Early detection of hoof lesions allows for immediate treatment, resulting in reduced financial costs for long-term recovery, minimized performance losses, and a lower risk of cow culling. However, reliable detection depends on frequent thermographic imaging and evaluation, which places high demands on the operator. Modern technologies enable the use of artificial intelligence methods to process and evaluate the thermographic data. If hoof disease is detected, an authorized person is immediately notified in real-time, who isolates the affected cow and takes the necessary steps to confirm the diagnosis.

Supported by the TACR Delta 2 project TM02000027.

By using infrared thermography, diseases can be detected in their early stages.

SCIENCE AND RESEARCH

Thermographic diagnosis of udder diseases in dairy cattle

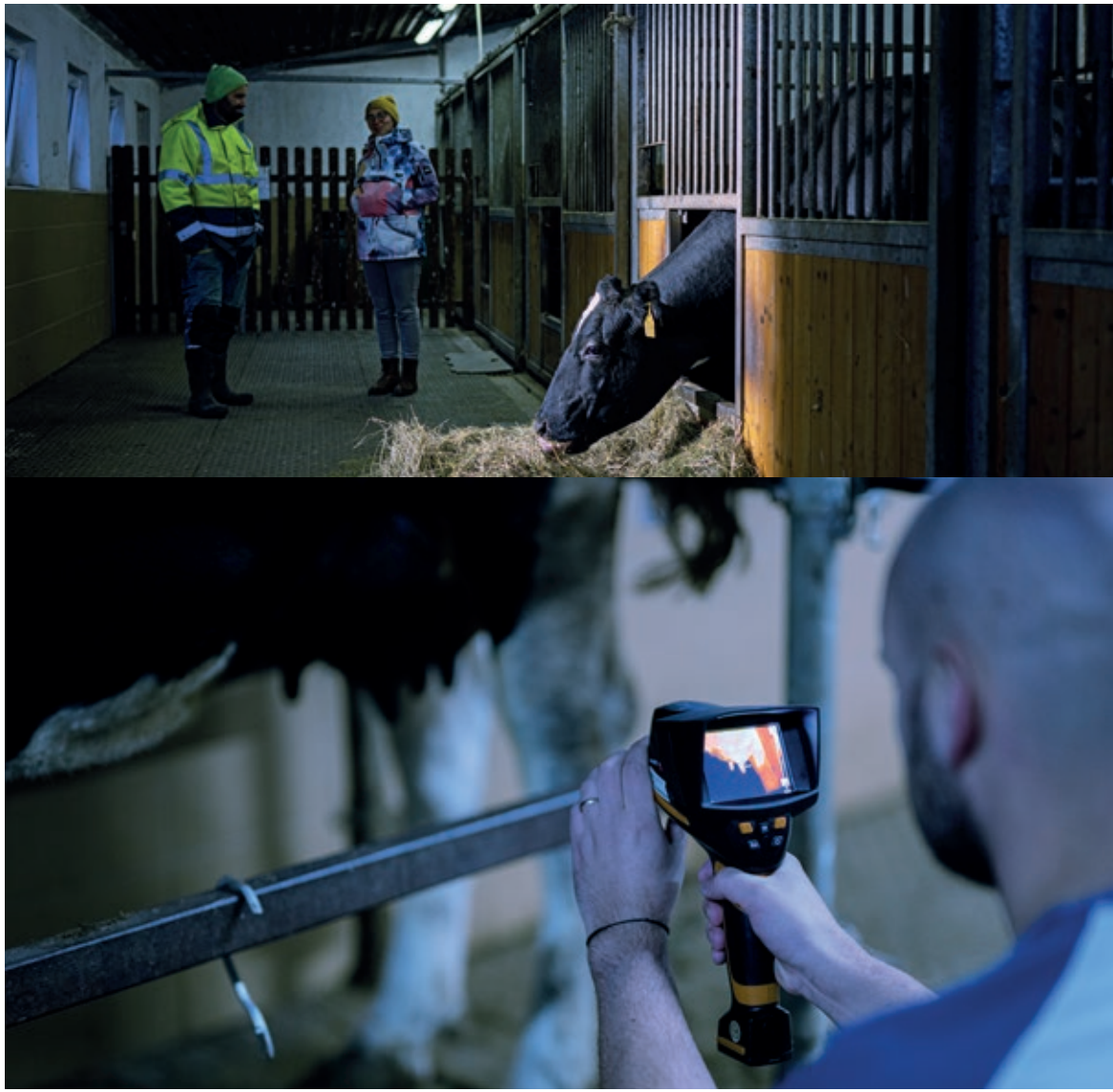
Infections cause serious health problems for dairy cows, which impact milk production and lead to economic losses for dairy farms.

The primary activity on dairy farms is milking. Different milking procedures and the use of milking machines can impact the health of dairy cows.

During milking, sensitive areas of the udder (mammary gland) come into contact with the milking machine, with the teats being the most stressed. The teats may change during the process, swelling, rupturing, hardening, or inflammation (mastitis) may occur. Inflammation causes serious health problems for dairy cows, which are reflected in reduced milk production and economic losses for dairy farms. Therefore, early detection of this condition is crucial. Inflammation is characterized by an elevated temperature before it becomes significantly advanced. For this reason, infrared thermography is an ideal tool for detecting and locating areas of elevated temperature on the udder.

Evaluating infrared thermography images across an entire herd on a dairy farm would be time-consuming, if not nearly impossible, for a worker. Therefore, application of artificial intelligence methods, such as image processing and computer vision, presents a viable solution. Neural networks can process thermographic images in real-time and identify areas of potential inflammation on the udder. This information can then be relayed to the responsible worker, who can isolate the affected animal from the herd, allowing a detailed examination by a veterinarian. Together, they can address the problem promptly, preventing unnecessary health complications and reducing the need for costly treatments.

Supported by the TACR Delta 2 project TM02000027.

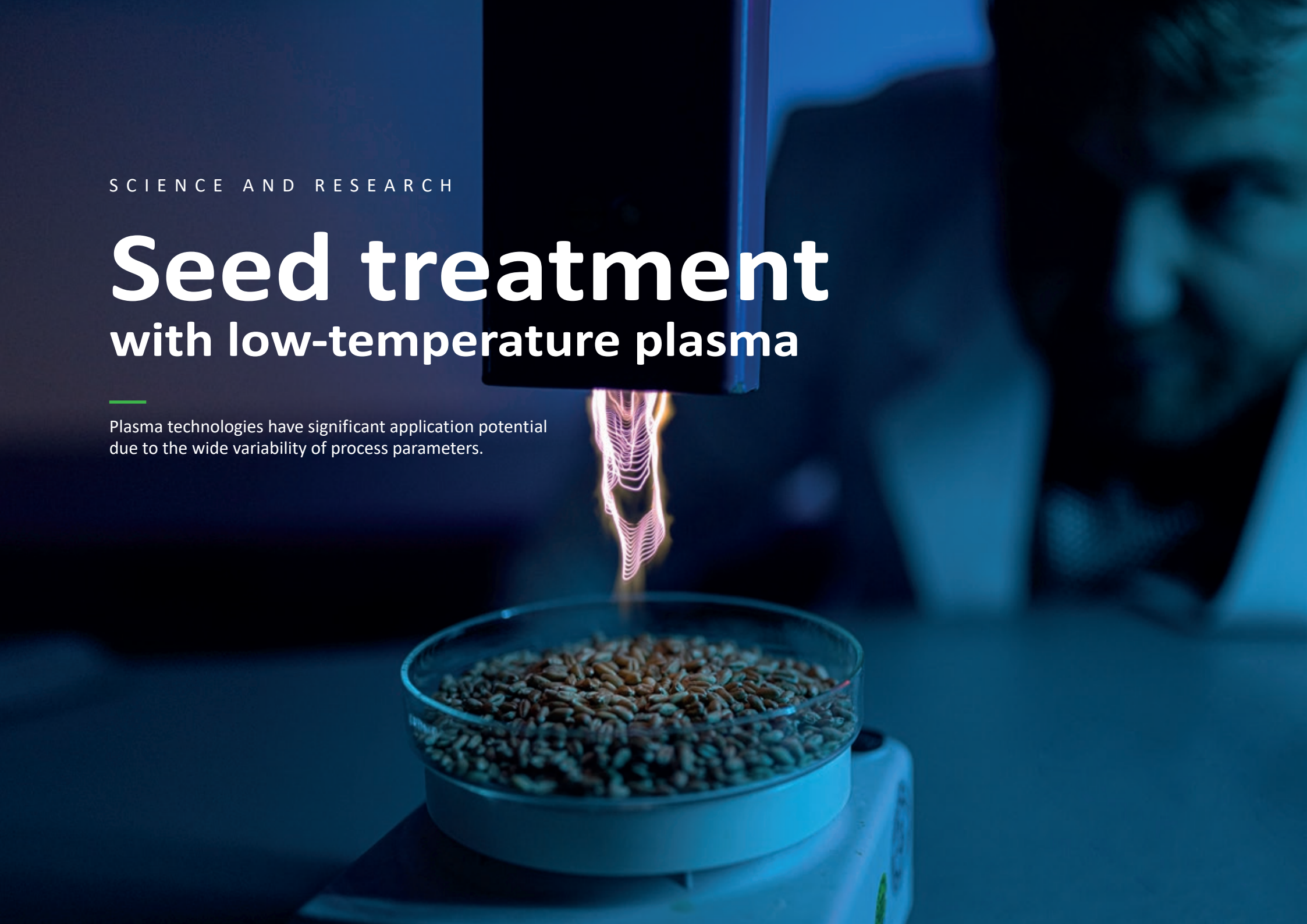


Use of infrared thermography for early detection of inflammation of the mammary glands.

SCIENCE AND RESEARCH

Seed treatment
with low-temperature plasma

Plasma technologies have significant application potential due to the wide variability of process parameters.



Plasma is routinely and successfully used to modify the surface properties of inorganic materials.

Applications can be found in biomedicine, the food industry, and the packaging industry. A new phenomenon currently receiving significant attention is the use of plasma to treat seeds of economic crops.

Plasma is one of the four states of matter, primarily composed of electrically charged particles, neutral particles, excited-state particles, and free radicals. Interaction with the surface of solids occurs when reactive particles reach the surface through UV radiation, heat, or ion bombardment. The intensity of these factors depends on numerous variables. The synergy of these properties can play a crucial role in the efficiency and effectiveness of processes aimed at decontaminating bacteria, fungi and other undesirable microorganisms from the surface of foodstuffs and feed. However, the treatment may not impair the quality factors of food and feed like colour, taste, and nutritional parameters.

Our experiments used low-temperature plasma generated under reduced pressure and atmospheric pressure. The plasma was used to decontaminate the surface of seeds of economic crops (e.g. spring barley, winter wheat, winter rape, etc.) with the subsequent possibility of pickling with biological agents. Plasma has also been used to modify the surface properties of powdered or solid materials and to modify the properties of liquids and solutions.

Supported by projects TACR TA040212E2,
TACR TE02000177.

Plasma treatment appears to be suitable for decontamination of the seed surface.

SCIENCE AND RESEARCH

Development of robotic system with applications in vegetable farming

Robotics is currently undergoing rapid development. The development, research and introduction of robotics affect also agriculture.

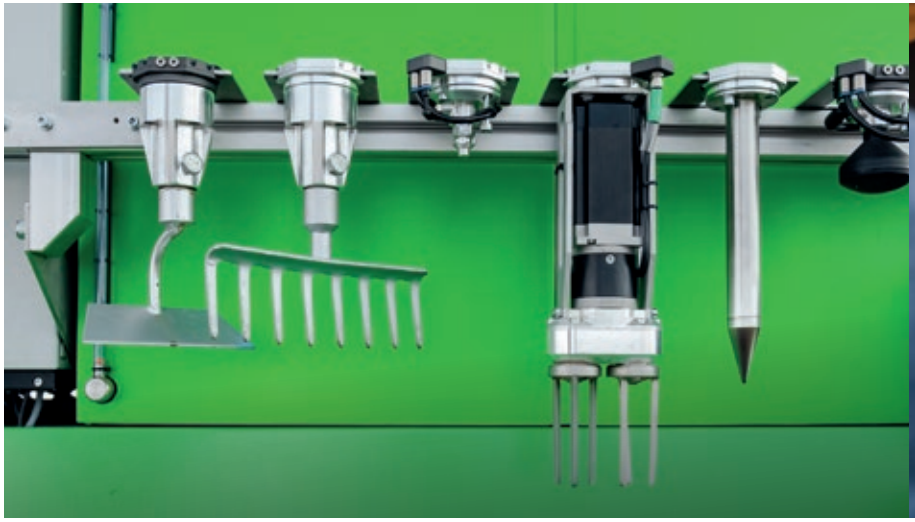
With growing population, it is necessary to increase the efficiency of the agricultural production process with regard to sustainable land management.

Some robotic solutions can already operate autonomously and, using geolocation and artificial intelligence methods, can carry out various agricultural activities efficiently.

The Faculty of Agriculture and Technology of South Bohemia develops in cooperation with Terms a.s. a robotic system for applications in agriculture. The system, called ROBOTON by the company, is an autonomous agricultural robot that plans the ideal procedure in the field and garden. It performs various agricultural activities and can target each crop individually.

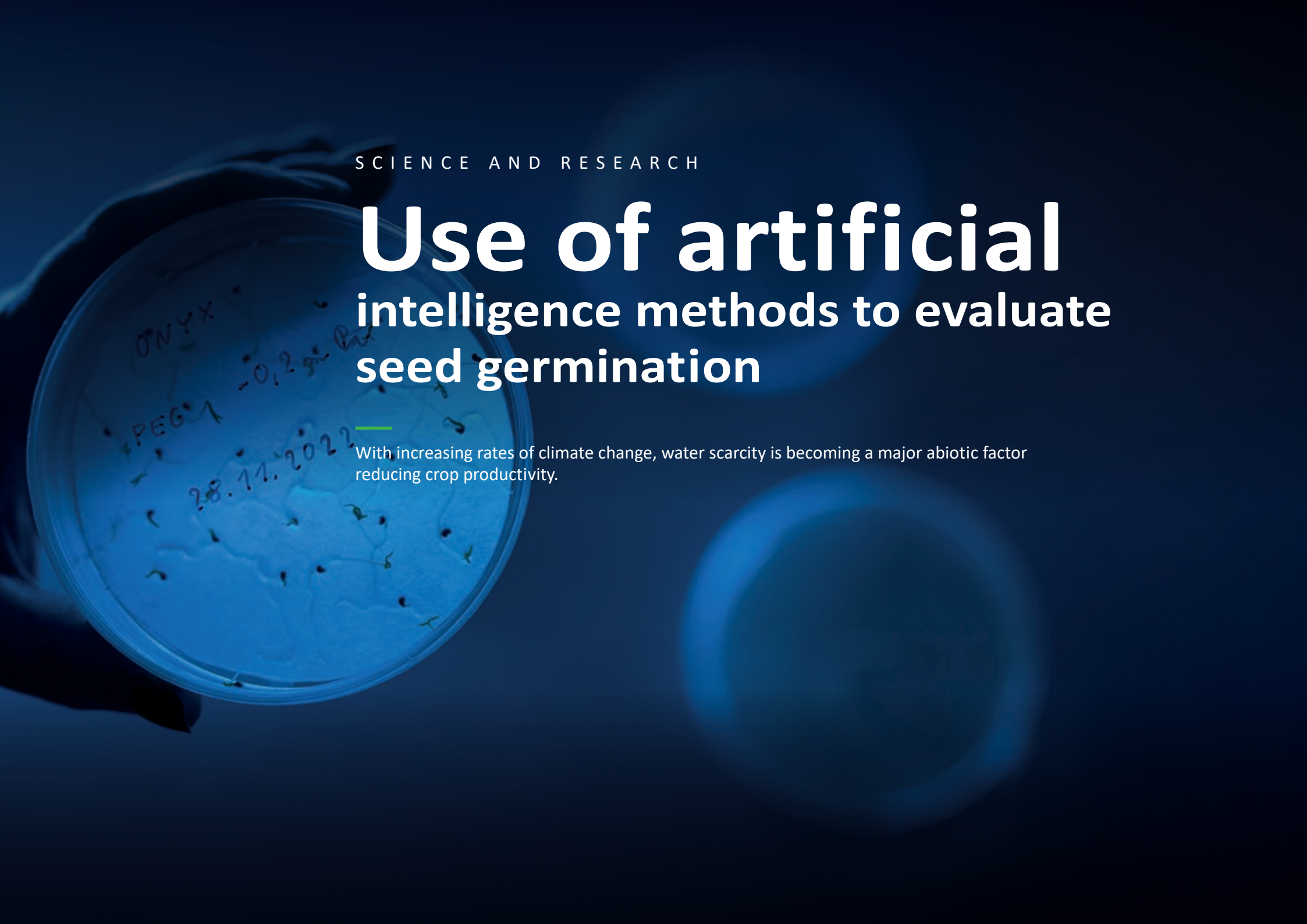
For the robot to be able to target individual crops and work with actual data artificial intelligence methods are used – image data processing. ROBOTON implements computer vision technology with its basis in convolutional neural networks for image analysis applied to detection and subsequent classification of crops, diagnosis of crop health, assessment of crop vegetative condition, recognition of fruit maturity, identification of tool type and assessment of its condition and exploration of the wider environment while respecting strict safety standards.

ROBOTON can assess the need for different agricultural operations autonomously and is equipped with interchangeable tools.



SCIENCE AND RESEARCH

Use of artificial intelligence methods to evaluate seed germination



With increasing rates of climate change, water scarcity is becoming a major abiotic factor reducing crop productivity.

Even though breeders have been focusing on producing drought-resistant varieties for several decades, we still do not have water-tolerant varieties for most crops.

This situation is mainly due to a very complex plant response to this abiotic stress involving many physiological and biochemical processes.

In the context of drought stress, we focus, for example, on the poppy *Papaver somniferum*, one of the important crops of Czech agriculture. Poppies are mainly grown for the food industry. Poppy seeds are a valuable source of high-quality oil rich in unsaturated fatty acids.

To assess the stress of different poppy breeding materials, we use a stress experiment in which sterile poppy seeds are germinated in Petri dishes containing chemicals that partially inhibit water uptake and thus seed germination. By changing the concentration of these chemicals we can simulate the varying intensity of drought stress. To evaluate these experiments, artificial intelligence methods (image processing and computer vision) are used to enable rapid monitoring of germinating plants, such as detecting the number and location of seeds and accurately identifying the stage of germination.

Supported by the NAZV project QK1810391.

We use a stress experiment in which sterile poppy seeds are germinated in Petri dishes containing chemicals that partially inhibit water uptake and thus seed germination.

SCIENCE AND RESEARCH

Recognition
of economic crops and weeds applying artificial intelligence methods

The very fast development in computing power and the therewith associated increasing application of modern information technologies caused innovative processing methods and evaluation of data to gain more attention.

One of the most important representatives of these new technologies is image processing and computer vision. Both have already been used in engineering, medicine, transport, geography and agriculture.

Computer vision is primarily used to classify the image, detect objects that occur in it and segment the image. In image classification, computer vision identifies the elements in an image and then, according to the highest assigned probability, assigns the entire image to a specific class, for example: pepper, pepper fruit and weed. When detecting, the individual objects in the image are localised and their exact position is marked by a rectangle whose sides pass through the extreme points of the object, the so-called bounding box. Segmentation consists of determining precise boundaries of each category of objects or their instances.

Artificial intelligence methods are applied to evaluate image information to distinguish individual plants from the background (soil) and determine whether these are a planned crop or a weed. The outputs can also be used in autonomous agricultural robotic systems.

The research is conducted in cooperation with TERMS a.s.

Using artificial intelligence methods, we can distinguish individual plants from the background (soil) and determine whether it is a planned plant or a weed.

SCIENCE AND RESEARCH

Solar energy
in landscape, vegetation and water

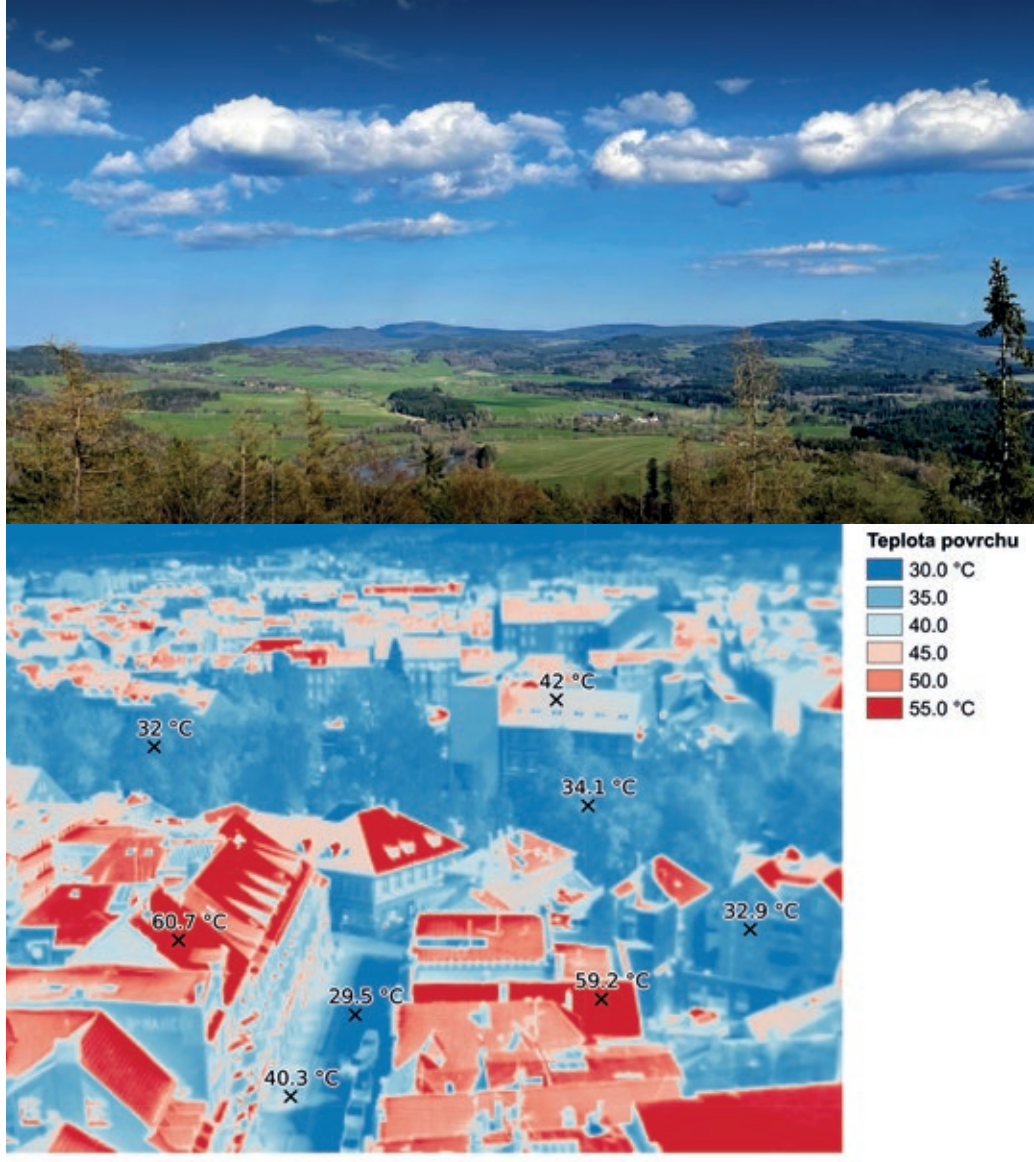
The transformation of solar energy is one of the most important dynamic processes that occur in ecosystems.

The sunlight that reaches the Earth‘s surface is the most important source of all natural processes.

The quantity of solar energy coming to the surface is considerable. The way this energy is transformed is responsible for shaping the climate, the water cycle and other processes. The transformation of the sun‘s energy is influenced by the physical characteristics of the surface (colour, shape) determined by the landscape cover and the presence of water in plants and soil. All these represent a complex feedback system.

Man‘s management primarily affects the spatial distribution and condition of land cover, vegetation and water. In doing so, man significantly contributes to the distribution of solar energy in space and time and thus influences the climate, the water cycle, but also the movement of substances in the landscape. Human influence on the landscape raises a number of issues. These include, for example, the issue of temperature fluctuations and stability, the distribution of precipitations, the hydro-chemical regime of the landscape, but also the issue of drought in all its forms and contexts or the creation of the so-called heat island of the city, which issue is important for health reasons, among others.

These questions and issues related to the transformation of solar energy, the water cycle, the flow of substances in the landscape and other contexts have been studied by the Department of Applied Ecology at the FAT USB. A particular attention has been paid to the impact of management on the functional aspects of the landscape. Meteorological approaches, landscape structure assessment, vegetation ecology approaches, hydrology, pedology, hydrochemistry, but also remote sensing methods and data have been applied.



Landscaping plays an important role in the transformation of solar energy. If there are areas in the landscape with sufficient functional vegetation and water, energy is consumed by water evaporation, which induces cooling and climate stabilisation. Dry areas (e.g. built-up areas) are significantly overheated, as shown in the thermal image.

SCIENCE AND RESEARCH

Artificial Intelligence

and remote sensing for water quality assessment

The monitoring and evaluation of water quality in reservoirs is important to ensure the technological quality for drinking water production, to assess eutrophication, hygienic safety of bathing and recreational waters, etc.

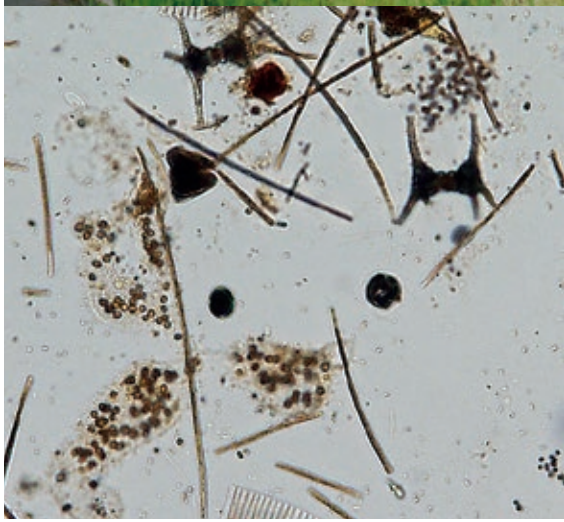
In addition to traditional laboratory approaches, one option for monitoring water quality is to use modern remote sensing technologies combined with advanced mathematical modelling and artificial intelligence.

With the help of Remote Sensing (RS), i.e. using images from a height (from an airplane, artificial satellites, drones), a number of water properties in the reservoirs can be monitored, such as the concentration of algae and cyanobacteria pigments, suspended solids content, water transparency, water temperature, etc.

Satellite data provide a very good insight into the condition and evolution of the reservoirs and their spatial characteristics. For example, up to several thousand reservoirs can be assessed simultaneously (e.g. from the European Sentinel 2 satellite).

A major advantage of satellite data is its availability. In many cases, the data are available free of charge, and the data archives allow the use of historical data. These include, for example, images from Sentinel 2 satellites, which have been available since 2015, and Landsat (Landsat 4 TM and later generations; NASA and USGS), which have been available even since 1982.

The Department of Applied Ecology of the FAT USB, has been involved in the research of water reservoirs and the application and implementation of remote sensing methods and advanced computational methods for the purpose of water quality assessment in reservoirs. Project activities include, for example, the development of a system for automated water quality assessment of reservoirs or the development of a prediction model for estimating harmful water blooms on large reservoirs (e.g. Reservoir Orlík). The automation of data processing and its provision via a web-based application will allow the use of satellite data for water quality assessment in reservoirs, even by non-experts, without the need to know how to work with satellite data. Thus, the data can be used by basin managers, nature conservation authorities, farmers or anyone interested in the information.



Knowledge of water quality in reservoirs is essential for environmental, technological, economic, hygienic and other reasons.

SCIENCE AND RESEARCH

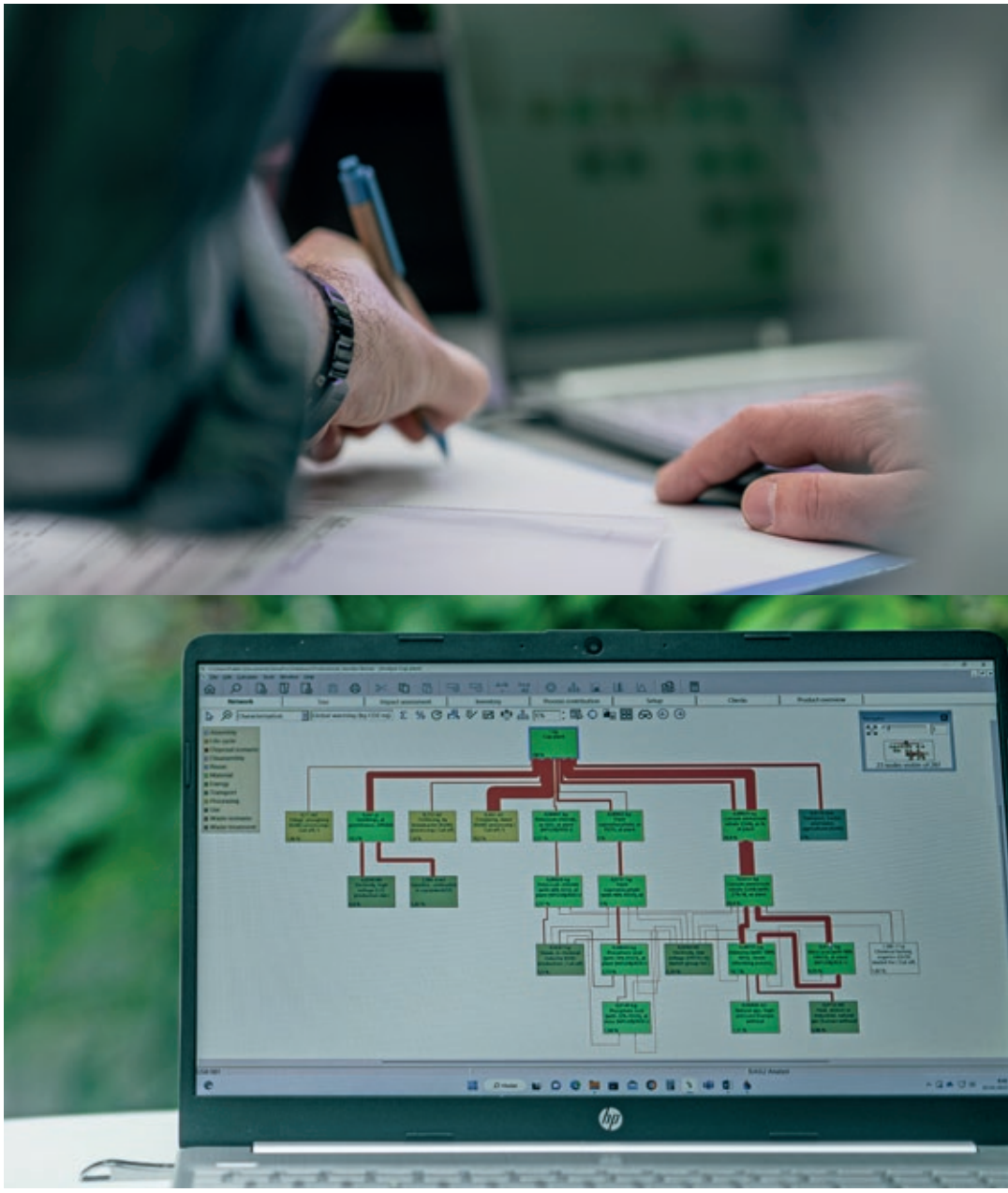
Life Cycle Assessment (LCA)

LCA studies can serve as a tool for reducing environmental impacts of companies, as motivational aspects in communication with customers, as motivational tools for environmentally-driven policies (e.g., in agriculture), for enhancing competitiveness, or for research and development.

The benefit of the LCA method is its ability to interpret data into a clear set of environmental indicators or ecological footprint.

LCA can be used to compare the environmental impacts of products regarding their function or to assess the environmental impacts regarding the whole life cycle of the product. In general, an LCA study identifies the transfer of environmental problems both in space and between different impact categories. Thus, the transfer of problems from place to place can be detected. The outputs of a particular LCA study are not valid in general, but always under given and clearly specified conditions. The benefit of the LCA method consists in the clear definition of the conditions under which the studies are valid, which situates the findings on the interactions of technological processes and the environment within a specific technological, environmental and socio-economic context.

The studies are based on detailed data collection directly at the site of implementation (so-called "site-specific data") and are complemented by unit or system data from professional databases and libraries. The studies are based on long-standing experience in the field of agriculture and modern approaches.



Detailed data collection on site.

SCIENCE AND RESEARCH

Soil
organic matter

The SOIL – an irreplaceable component of the environment, provider of a range of important ecosystem services, and an indispensable production factor in agricultural production.

In terms of human lifespan, the soil is a non-renewable natural resource.

It is therefore essential to manage agricultural soil in a way that ensures high yields while maintaining the good environmental health and well-being of local communities. Soil fertility depends on complex interactions between chemical and physical soil properties as well as biological factors. Soil organical matter plays a key role in soil fertility maintenance and in environmental protection.

Soil organic matter encompasses a whole spectrum of substances: from non-degraded plant and animal tissues, ephemeral decomposition products to relatively stable and complex products of their transformations. These substances perform a range of irreplaceable functions in the soil. They affect soil structure and water retention. They provide nutrients to plants through the mineralisation process. If the organic matter undergoes humification it assists in protection of plant nutrients from being washed out. In this respect, the nature of the substances in question plays a key role. A lack or poor quality of soil organic matter can negatively affect soil fertility and the landscape as a whole.

Since the soil environment is a dynamic, constantly evolving system, it undergoes continuous transformations of organic substances and changes in their quantity. How do different agricultural practices affect soil organic matter? Over what timescale? Can we identify, separate and quantify the factors that contribute to changes in soil organic matter? These and other questions are subjects of research at the Department of Agroecosystems of the Faculty of Agriculture and Technology of the University of South Bohemia in České Budějovice.

We analyse the effect of different agricultural practices on soil organic matters.

SCIENCE AND RESEARCH

Sustainable
methods of quality wheat grain production

A common problem of wheat cultivation in Low Input Farming Systems (e.g. organic farming) is the reduction of grain quality in terms of baking quality.

The grain not only features a lower protein content, but its characteristics are also negatively affected.

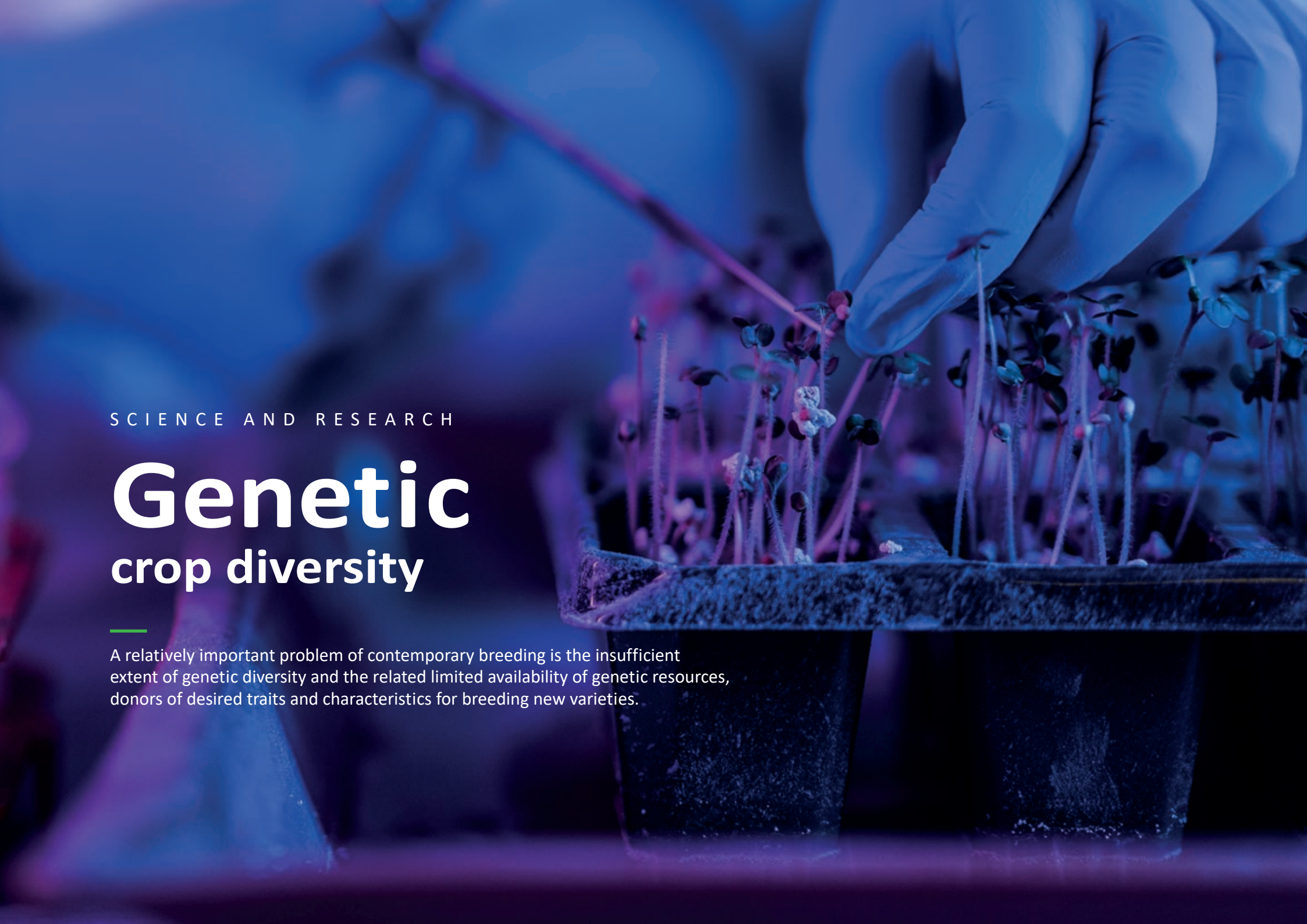
In practice, this fact is reflected in the lower quality of baked products compared to what consumers are accustomed to. At the same time, the lower protein content of the grain results in a lower farm-gate price for farmers. The issue of wheat grain quality is currently not only relevant to organic farming but also to conventional farming, due to the rising cost of nitrogen fertilizers. Therefore, it is necessary to search for cultivation practices that ensure the necessary grain quality even with reduced inputs (reduced nitrogen fertiliser doses).

Different approaches are tested in our experiments. The first option is to replace common wheat with other species that will provide adequate yields with high grain quality. Such an example is spelt. Another possible alternative is Einkorn wheat or Emmer wheat. The grain, however, must be processed in a different way because it is not suitable for the conventional products the customers are accustomed to.

The second option to increase grain quality while reducing inputs is to change established agronomic practices. Several practices show promise: the cultivation of varietal mixtures (for higher stability of yield and quality); the cultivation of mixtures of wheat and leguminous crops (which enhances nitrogen uptake by the plant and improves crop health); or the use of intensive hauling (possibly also weeding) of wheat crops during the growing season, which, in addition to its weeding effect, leads to an increase in nutrient mineralization and improved plant nitrogen uptake.

The grains from various experiments are analysed in the laboratory to determine the effect on the classical baking parameters of the grain. We also conduct complex rheological analyses using the Mixo-lab II device, which represents the current state-of-the-art in dough rheology, as it efficiently evaluates the interaction between protein and starch quality. The results obtained can then be evaluated in relation to different products. Additionally, it is possible to identify the weak points of the sample and design the ideal product with the required quality.

The grains from the experiments are analysed in the laboratory. The effect on the classical baking parameters of the grain is investigated.



SCIENCE AND RESEARCH

Genetic
crop diversity

A relatively important problem of contemporary breeding is the insufficient extent of genetic diversity and the related limited availability of genetic resources, donors of desired traits and characteristics for breeding new varieties.

The impoverishment and narrowing of genetic diversity have occurred alongside the development of modern breeding since the early 20th century, mainly due to intensive breeding focused on a limited range of traits (yield and quality), and due to the cultivation of high-performance but often relatively closely related crop varieties.

The continuous reduction in the number of cultivated species and varieties and their widespread expansion has led to genetic erosion, partial or complete loss of landraces and a reduction in genetic diversity. The consequences of the lack of genetic diversity are apparent in the loss of important genes, genetic vulnerability, and the limitation of genetic gain in quantitative traits, which is difficult to overcome. The vulnerability and negative impact of the very narrow genetic diversity can be documented in many examples where the mass use of one or a limited number of genotypes grown over a large area, has led to a significant reduction in yields due to the spread of aggressive strains of pathogens.

The narrowing of genetic diversity is thus a major problem and a limiting factor for plant breeding. Molecular biology methods are suitable for assessing the degree of genetic variability in plant genetic resource collections. Based on the analysis of molecular markers, it is possible to determine genetic diversity and the degree of divergence of genetic resources used for crossbreeding, detect duplications and misclassified origins, and identify rare genotypes. These methods also provide a suitable way to properly manage genetic resources.

Within the framework of this research focus, the Department of Genetics and Biotechnologies of FAT USB has long been cooperating with the Crop Research Institute in Prague Ruzyně, breeding companies in the Czech Republic and foreign universities in the USA and Great Britain.

Based on the analysis of molecular markers, it is possible to determine genetic diversity and the degree of divergence of genetic resources.

SCIENCE AND RESEARCH

Molecular and industrial biotechnology

The modern world is changing and technologies have a significant impact on that change. Many theories attempt to describe this evolution. One of them is a modification of Kondratieff‘s original theory.

This theory describes developments in long waves lasting decades, which are driven by technology and whose shape is influenced by the application or the use of modern technologies in innovation.

The next wave, according to the application of Kondratieff's theory, will most likely be the wave of biotechnology.

The Hungarian agricultural engineer Karl Ereky applied the term "biotechnology" for the first time in 1917. He referred to the processing of biological materials and industrial fermentation. At the end of the 1970s, a new scientific discipline emerged: molecular biotechnology. This triggered the molecular biotechnology revolution, the last great technological revolution of the 20th century. Modern biotechnologies comprise the application of microorganisms or cells in industrial production, biotransformation, genetic engineering and genome editing, bionanotechnologies, application of molecular biology and "omics" technologies. Biotechnologies are the fastest-growing scientific disciplines worldwide.

The Department of Genetics and Biotechnologies at FAT USB has long been cooperating with the biotechnology companies Retorta s.r.o. and OncoRa s.r.o. on various projects focused on the development of procedures for genotyping industrial strains of microorganisms, optimization of cultivation conditions, and the use of adaptive evolution methods for breeding production strains of microorganisms to enhance the production of target enzymes or metabolites. This collaboration has fostered many bachelor, master and doctoral theses. Students profit from the opportunity to work in microbiology and biotechnology laboratories.

Use of adaptive evolution methods to breed production strains of microorganisms for increased production of target enzymes or metabolites.

SCIENCE AND RESEARCH

WE DEVELOP TECHNOLOGIES, WE SHAPE THE NATURE

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