

# University of Debrecen HUNGARY



Faculty of Agricultural  
and Food Sciences  
and Environmental Management





## Greetings

Thank you for your interest in our university with a great past and in our agricultural higher education with approximately 150 year old traditions.

The University of Debrecen is one of the institutions offering a wide range of courses and research activities in Hungary. As one of the most significant think tanks in the country and the knowledge centre of the region, we seek to provide unprecedented opportunities for our students to gain state-of-the-art knowledge and to carry out scientific activities.

With excellent infrastructure and high level education, the Faculty of Agricultural and Food Sciences and Environmental Management ensures excellent facilities for its students. In addition to gaining in-depth modern experience, a wide range of opportunities are available to perform professional and scientific activities beyond the scope of academic studies. After obtaining their certificates in higher education vocational training and BSc diploma courses, our students acquire a thorough practical knowledge, they can continue their studies in MSc training and then the best ones in Ph.D. training.

We firmly believe that the variety of trainings and courses we offer are attractive to many students who choose the Faculty of Agricultural and Food Sciences and Environmental Management for academic education.

The booklet, which introduces our institution, strives to give a comprehensive picture of education and research in our Faculty and to provide information about the system of education including diploma courses.

We hope that this booklet will provide interested readers with all the useful information they look for.



1 September 2016 Debrecen

Prof. Dr. István Komlósi  
Dean





## The University of Debrecen (UD)

The University of Debrecen is historically rooted in the Reformed College of Debrecen founded in 1538 whose three academic sections later served as the basis for the establishment of the Hungarian Royal University of Sciences in 1912. With this heritage of more than 450 years, the University of Debrecen is one of the oldest institutions of higher education in Hungary. Today, the university is comprised of 15 faculties and three agricultural research centers, with close to 35,000 students, 3,000 of which come from countries around the world.

The University of Debrecen ranks among the top state higher education institutions in the country and among the best 600 in world rankings. It has been awarded the titles "Research University" and "University of National Excellence" by the Hungarian Government.



According to the Quacquarelli Symonds (QS) World University Rankings, the University of Debrecen is among the world's top 200 universities in the field of agricultural science.

The institutes are compared by scientific fields and 6 factors are taken into consideration at the compilation of the list. Weighing 40%, scientific judgement is dominant in the making of the ranking.

The ratio of foreign and domestic teachers, and ratio of foreign and domestic students add 5-5% to the ranking.

The judgement of graduates by employers contributes 10%. The 20% of the teacher-student ratio intends to measure how student-centered the education is. The smaller the student per teacher number is, the better the institute's judgement is, presuming student-supportive educational environment. Research performance contributes 20% based on citation per researcher/teacher from the Scopus database.

In the top 50, there are universities our faculty cooperates with, e.g. Wageningen University (3.), Swedish University of Agriculture (10.), University of Reading (19.), University of Hohenheim (34.), University of Ghent (48.).





## Faculty of Agricultural and Food Sciences and Environmental Management

The aim of the educational, research and development activities at the Faculty of Agricultural and Food Sciences and Environmental Management (FAFEM) is to satisfy the present and medium term requirements of Hungary, the agricultural sector and the society. Via creative work in these fields, the Faculty contributes to the enrichment of national and international results and values and by offering diverse educational programs, it trains graduates for the highest level organizational and administrative tasks of the agricultural sector.

With its scientific activity, FAFEM contributes to the sustainable utilization of regional values and resources. Based on their active professional public activities and their relations to agro-economy, they undertake a leading role in making production more efficient and improving the competitiveness of enterprises. With the diverse activities of the faculty, they support the development of the human resources and tangible conditions of the agriculture-focused eastern part of the country and they utilize their accumulated knowledge also in the international scene.

### Education

The Faculty trains experts at the BSc, MSc and PhD levels in numerous fields of agricultural sciences: classical fields (animal husbandry, crop production, horticulture), environmental management, food processing, game management, nature conservation and crop protection are included in the diverse educational programs.

The first four steps of the training structure developed at the Faculty are represented by the four-term-long specialized higher education programs: animal husbandry engineer (specializations: poultry breeding, fishery, horse breeding, hog raising), environmental management (specializations: waste management, environmental management), agricultural engineer and crop production engineering.

### The following accredited BSc courses are available:

- animal breeding engineering
- food engineering
- horticulture
- environmental management
- agricultural engineering
- crop production engineering
- nature conservation
- game management

In order to be present in the international education market, we provide the following BSc courses in English: food engineering environmental management, agricultural engineering. With consideration to the expectations of society and economic life, the accredited master courses (MSc) will enable students to obtain special skills in a specialized agricultural field:

- agricultural engineering
- animal husbandry engineering
- food security and quality engineering
- horticultural engineering
- agricultural environmental management engineering
- crop production engineering
- plant protection
- environmental protection engineering

Of the MSc courses, students can apply for training in English in agricultural engineering, animal husbandry engineering, food security and quality engineering, agricultural environmental management engineering and plant protection courses.

### Research Work

The research strategy of the Faculty is closely related to the strategic fields of education and extension. Among the classical special agricultural fields, traditional plant production sci-





ences and the complex evaluation of field crop, fruit and vegetable species, as well as varieties and hybrids adapted to specific ecological conditions are of special importance. In the field of animal husbandry and related sciences, in addition to traditional research (pig, poultry, cattle, sheep, fish), new interdisciplinary fields (biotechnology, organic animal keeping, precision foraging) are of increasing significance. In each research area, the fundamental aim is to enforce the principles of climate change, environmental, biological, technological and economic sustainability.

One field that is highlighted is the economic study of the environmental aspects of agricultural re-

search, the factors and parameters influencing product quality, and the basic and supplementary agricultural activities. Research is also focused on the quality of agricultural products and food products, the scientific foundation of healthy nutrition and quality control.

*The teachers and researchers of the Faculty are active in four groups of topics:*

#### **Climate change and actions**

- The causes, expected trends of and adaptation to climate change
- The bases of crop production and its interactive technology development in various agroecological systems
- Adaptation to climate and weather change in horticultural production
- Bioenergetics research, developments and applications
- Preservation of biological bases, as well as their development with traditional and biotechnological methods
- Development of products, technologies and services based on the examination of biological and technical interactions
- Environmentally friendly crop protection in sustainable crop production technologies
- Development of the technological bases of floriculture and green area management

#### **Healthy nutrition**

- Research projects serving the production of quality and functional vegetable products and foods
- Development of the analytical and microbiological methods of food industry products
- Development of processing technologies reducing food safety risks

#### **Sustainable agricultural environment**

- Protection of soil quality
- Reservoir-based integrated water stock management
- Complex practical protection of the functions of agroecosystems
- Material- and energy-saving environmental technology
- Sustainable biodiversity and habitat protection

#### **Animal husbandry, animal keeping, animal welfare**

- Research serving quality and functional animal product and food production (nutrigenomics, molecular genetics)
- Research of genetics, foraging and animal husbandry technology serving the efficiency of quality animal husbandry
- Research of healthy livestock products in relation to nutrition based on genetic parameters
- Raising and breeding sheep which conform to market needs and climate





## International Students' Opinion



### Iva Krepelova (Czech Republic)

When I was searching for an appropriate place for my Erasmus studies, one of my friends suggested to me the University of Debrecen saying that it has a wide range of international courses, the people are friendly and Debrecen is a wonderful city. Here I could find courses I can make good use of to complement my studies at home in the Czech Republic. Having been an Erasmus Student of the University of Debrecen, I know coming here was a perfect choice.



### Wariba Albert Mutambi (Cameroon)

It is a wonderful experience taking four semesters at the University of Debrecen Agricultural Faculty. Very motivated and inspiring Lecturers with international recognition and services boosting the learning resource base with latest scientific information. In one sentence, Debrecen University Students are competitive worldwide.

Different from learning, Debrecen is a cultural melting point with great historic structures and festival energizing youths and society.

I will never forget the fresh fruits of Debrecen, Tokai wine and how to say thank you in Magyar << köszönöm >>



### Takele Feyera (Ethiopia)

I spent five months in the University of Debrecen, Hungary in the Erasmus Mundus programme Faculty of Agricultural and Food Sciences and Environmental Management. What a nice place to stay in the beautiful city of Debrecen at the center of Europe. I will never forget the hospitality of the staff members in the Agricultural Faculty. My professors and the courses they taught are always my memory which makes me to scale up my thinking and knowledge in Animal Nutrition Science. I cannot forget the Hungarian students' cooking days, the time I felt I was at home in Ethiopia with the smoky

sky and nice spicy food we had full of paprika and garlic... I would have been happy to stay longer. I hope I will visit Debrecen again.

### Rodrigo Tozetto (Brazil)

„I spent an entire semester in Debrecen, studying Animal Nutrition at the Faculty of Agricultural and Food Sciences and Environmental Management. I definitely recommend the University and the courses I took part. It was very interesting for me to learn all the techniques used in Central-Europe, it has made me amplify my knowledge at each subject. The city is quite at winter time, but as soon as the weather starts to warm up, it becomes just as beautiful as it is in the pictures!”

### Bishnu Adhikari (Nepal)

It's my fortune to study in Debrecen as an EM-SANF student for one semester. Nice and hospitable staff with professionally sound teachers teaching in English made my studies really useful. Natural panorama of the city along with lots of international students and friendly Hungarian guys are another ornament of the University. Affordable living costs, lots of jovial international nights and parties made my life comfortable and blissful.



## AGRICULTURAL ENGINEERING (BSC)

### About the course:

The aim of the agricultural engineering qualification is to train agricultural engineers who have general knowledge in the field of natural-, technical-, agricultural sciences, economic knowledge of the area of agricultural production, general expertise in agricultural processing and farming furthermore have theoretical knowledge of adequate depth.

In our B.Sc. program, besides the theoretical knowledge emphasis is put on practical training and on the acquisition of different technological processes. In this specialisation students gain insight into the different fields of agricultural sciences: plant cultivation, animal husbandry, horticulture, fish farming, game management, and forestry.

### Areas of Study:

Knowledge of the field of crop production and animal breeding, unique agricultural engineering and another general engineering sciences: Zoology, Agricultural History, EU Policy, Mathematics, Agricultural Chemistry, Agricultural Botany, Informatics, Animal Physiology, Agricultural and Food Industrial Microbiology, Basic of Plant Physiology, Soil Science, Water Management, Agricultural Fundamentals, Environmental Management, Agricultural Machinery, Economic Sciences,



Crop Production, Agroecology, Feeding for Animals, Animal Husbandry, Horticulture, Plant Genetics and Plant Breeding, Statistics, Animals Health, Food Technologies, Quality Management System, Farm Business Management, Forest and Game Management, Grassland Management, Integrated Plant Protection, Agricultural Practice, Plant Pathology, Agricultural Entomology, Ethology, Forcing and Early Vegetable Production, Lake Economical Husbandry Technologies, Qualification of Animal Products, Soil Ecology, Irrigated Farming, Plant Nutrition Management, Medicinal Plants and Spice Crops Production, Operations Management

**Length of the study programme:** 7 semesters, including one semester long farm management practise period.

**Total credit: 180+30**

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation.

### Careers:

Postgraduates may progress to a MSc. courses or find employment in the agricultural sectors (for example in the field of crop production, horticulture, animal breeding, forest and game management, farm- and business management).

### Admission criteria, application

**requirements:** General Certificate of Education (G.C.E.), upper-intermediate English language certificate

**Tuition fee:** 5500 USD/academic year (150 USD application fee and 350 USD registration fee)

<http://englishstudies.sci.unideb.hu>







## FOOD ENGINEERING (BSC)

### About the course:

The BSc in Food Engineering is aimed to train professionals who are able to operate, supervise and develop food processing technologies. The studies contain the physical, chemical and biological basics of engineering with special emphasis on the food quality and safety related issues. Besides becoming acquainted with the operations and technological processes the students also learn economic, management and analytical subjects. Therefore, the main goal of the education is to train people who are able to fully provide the functions in relation with the everyday tasks of operation from the engineering, biological and chemical work to the management duties based on their comprehensive theoretical bases.

### Areas of study:

Principles of Food Technology, Unit Operations in Food Processing, Baking Technology, Wine Making Technology, Packaging Technology, General and Inorganic Chemistry, Organic and Biochemistry, Colloid Chemistry, Agricultural and Food Microbiology, Food Chemistry, Wine Microbiology and Chemistry, Analytical Chemistry, Instrumental Analytics, Raw Materials of Food Processing, Food Analytics, Quality Control of Plant Origin Food Products, Qualification of Animal Products, Measurement and Control, Introduction of Food Safety, Food Hygiene, Basics of Quality Assurance, Food Industry Technologies and Quality Assurance, Environmental Management, Environmental Technology, Food Industry Economics

### Length of the study programme:

7 semesters, including one semester long industrial practice period

**Total credit:** 180+30

Learning and assessment: Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation

### Careers:

Graduated students may find employment in the food industry, raw material and product qualification, food analysis, inspection, quality assurance or may work for the authorities. Graduates may progress to MSc in Food Engineering, MSc in Food Quality and Assurance or MSc in Nutrition.

### Admission criteria, application requirements:

General Certificate of Education (G. C. E.), upper-intermediate English language certificate.

### Tuition fee:

5500 USD/academic year (150 USD application fee and 350 USD registration fee)

<http://www.edu.unideb.hu>







## AGRICULTURAL ENGINEERING (MSc)

### About the course:

The MSc in Agricultural Engineering is designed to develop your undergraduate knowledge and improve it through application and research. The field of Agricultural Engineering is broad and the programme reflects this diversity, with emphasis on Applied Biochemistry, Applied Plant Physiology, Applied Genetics and Biotechnology, Applied Soil Science, Production Physiology, Nutrient Management are the key research areas of the Faculty.

Throughout your stay at Debrecen University, which is the second largest university in Hungary, with 30 000 students, as a postgraduate student of Agricultural Engineering, you will have a personal academic tutor to guide you through your studies and to meet your individual goals and interests.

We offer you a 4 week field practice in summer.

### Areas of Study:

Animal Nutrition, Integrated Crop Production, Animal Husbandry, Soil Cultivation and Land Development, Horticulture, Environment and Land Use, Marketing, Product Quality, Sectoral Economy, Research Methodology, Communication, Quality Assurance, Management, Medical and Spice Crops Production, Biometrics, Integrated Plant Protection, Organic Farming, Ethology, Project Management, EU Policy, Animal Breeding, Milk and Meat Processing, Extension in Crop Production

### Entry qualifications:

BSc degree or higher in Agricultural Science.

BSc degree or higher in a biologically-related degree.

Other approved accreditation or professional qualification.

Upper-intermediate English language certificate.

### Course length:

Two year full-time taught programme plus dissertation.  
Presently no part-time options are available.

### Credits: 120

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation.

### Careers:

Postgraduates may progress to a PhD or find employment in agricultural science research, crop science research, lecturing, consultancy or other science-based sectors of crop production, animal husbandry, and agriculture or food industry. Our Faculty has a good relationship with agricultural enterprises of the region.

### Tuition fee:

6500 EUR/academic year (150 USD application fee and 350 USD registration fee)

<http://www.edu.unideb.hu>





## AGRICULTURAL ENVIRONMENTAL MANAGEMENT ENGINEERING (MSC)

### About the course:

The MSc in Agricultural Environmental Management Engineering is designed to develop your undergraduate knowledge and improve it through application and research. The field of Agricultural Environmental Management Engineering is broad and the programme reflects this diversity, with emphasis on Natural Resource Management, Environmental Impact Assessment, Environmental Technologies, Environmental Informatics, which are the key research areas of the Department of Water and Environmental Management responsible for the course.

Throughout your stay at Debrecen University, which is the second largest university in Hungary, with 30 000 students, as a postgraduate student of Agricultural Environmental Management Engineering, you will have a personal academic tutor to guide you through your studies and to meet your individual goals and interests. We offer you a 4 week field practice in summer.

### Areas of Study:

Public Administration, Organization-Environmental Law, Natural Resource Management, Sustainable Agricultural Systems and Technologies, Land Use and Regional Planning, Environmental Impact Assessment, Environmental Laboratory Measurement Techniques, Ecotoxicology, Environmental Technologies, Nature Protection, Water Resource Management and Water Quality Protection, Landscape Management, Environmental and Quality Management, Environmental Informatics, Agri-

Environmental Politics, Environmental Economy, Agricultural Remote Sensing, Agrohydrology-Agricultural, Watershed Management, Precision Agriculture, Environmental Health, Agri-Environmental Protection.

### Entry qualifications:

BSc degree or higher in Agricultural Environmental Science.

BSc degree or higher in an environmental-related degree. Other approved accreditation or professional qualification.

Upper-intermediate English language certificate.

Course length:

Two year full-time taught programme plus dissertation.

Presently no part-time options available.

**Total Credit:** 120

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation.

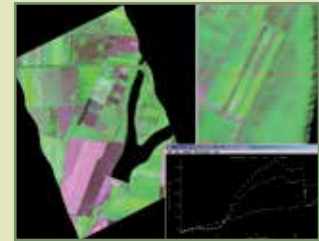
### Careers:

Postgraduates may progress to a PhD or find employment in Agricultural Environmental Management Engineering, lecturing, consultancy or other sectors where Agricultural Environmental Management Engineering is involved.

### Tuition fee:

6500 EUR/academic year (150 USD application fee and 350 USD registration fee.

<http://www.edu.unideb.hu>







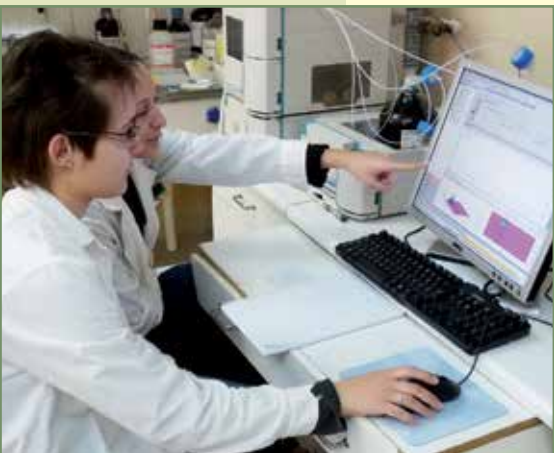
## FOOD SAFETY AND QUALITY (MSC)

### About the course:

The MSc in Food Safety and Quality is designed to develop your undergraduate knowledge and improve it through application and research. The field of Food Science is broad and the programme reflects this diversity, with emphasis on Raw Material Qualifying, Processing Technology, Quality Analysis and Quality Assurance.

Throughout your stay at Debrecen University, which is the second largest university in Hungary, with 30 000 students, as a postgraduate student of Food Safety and Quality, you will have a personal academic tutor to guide you through your studies and to meet your individual goals and interests.

We offer you a 4 week field practice in summer.



### Areas of Study:

Organic and Biochemistry, Food Safety and Quality, Food Processing Technology, Economics, Physical, Chemical and Microbiological Analysis, Laboratory Practices

### Entry qualifications:

BSc degree or higher in Food Engineering, Chemical Engineering, Biological Science, Agronomy.

BSc degree or higher in a chemically and biologically related degree.

Other approved accreditation or professional qualification.

Upper-intermediate English language certificate.

### Course length:

Two year full-time taught programme plus dissertation.

Presently no part-time options are available.

**Credits:** 120

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation.

### Careers:

Postgraduates may progress to a PhD or find employment in food and dietetics science research, lecturing, consultancy or other science-based sectors of the food science industry. Our Institute has a good relationship with food processing and qualifying enterprises and government organizations of the region.

### Tuition fee:

6500 USD/academic year (150 USD application fee and 350 USD registration fee)

<http://www.edu.unideb.hu>







## ANIMAL HUSBANDRY ENGINEERING (MSc)

### About the course:

The MSc in Animal Science is designed to develop your undergraduate knowledge and improve it through application and research. The field of Animal Science is broad and the programme reflects this diversity, with emphasis on Physiology, Nutrition and Genetics. Gene Conservation, Functional Food and Molecular Biology are the key research areas of the Institute.

Throughout your stay at Debrecen University, which is the second largest university in Hungary, with 30 000 students, as a postgraduate student of Animal Science, you will have a personal academic tutor to guide you through your studies and to meet your individual goals and interests.

We offer you a 4 week field practice in summer.

### Areas of Study:

Biochemistry, Quantitative and Molecular Genetics, Physiology, Reproductive Biology, Microbiology, Research Methods, Animal Production, Animal Nutrition, Natural Resource Management, Wild Animal Health, Aquaculture, Fisheries and Management, Food Safety and Quality, Economics and Planning.

### Entry qualifications:

BSc degree or higher in Biological or Animal Science.  
BSc degree or higher in a biologically-related degree.  
Other approved accreditation or professional qualification.  
Upper-intermediate English language certificate.



### Course length:

Two year full-time taught programme plus dissertation. Presently no part-time options are available.

**Credits:** 120

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessment is via oral and written examinations and a research dissertation.

### Careers:

Postgraduates may progress to a PhD or find employment in animal science research, lecturing, consultancy or other science-based sectors of the animal science industry. Our Institute has a good relationship with animal husbandry enterprises of the region.

**Tuition fee:** 6500 USD/academic year (150 USD application fee and 350 USD registration fee)

<http://www.edu.unideb.hu>







## PLANT PROTECTION (MSC)

### About the course:

Training specialists of plant sanitary, who are able to fulfil the directional, managing, organizing, consulting, regulating and marketing tasks related to plant protection, based on their wide theoretical knowledge. Such experts are able to detect the organisms, which are threatening plants (pathogens, pests, weeds) and they are acquainted with their biology and reproduction, and also with the effects and mechanism of chemicals used in plant protection concerning even the environment and humane hygiene. They can prevent the harms and damages caused by the above-mentioned organisms and they are applying the procedures of ecological and integrated plant protection in order to reduce the pesticide-load of the environment. In their work they are always attentive to the safety of food, processors, consumers and the environment. The further aim is to prepare the interested and inspired students for research work and PhD training in the field of plant protection.

### Areas of study:

Foundational subjects: Pesticide Chemistry, Molecular Biology, Toxicology, Soil Conservation, Plant Protection Ecology, Crop Cultivation, Horticulture, Applied Plant Biotechnology and Resistance Biology Plant protectional special subjects: General and Applied Plant Pathology, Entomology, Detailed Plant Protection Zoology, Weed Biology and Weed Management, Integrated Pest Management, Plant Protection in Ecological Farms, Protection of Stored Products, Mechanics in Plant Protection.

Economical subjects: Economy of Plant Protection, Rural Development and Business Management, Informatics in Plant Protection, Extension and Decision Making Support

Length of the study programme: 4 semesters

### Total credit: 120

Entry qualifications: BSc diploma, upper-intermediate English language certificate.

### Learning and assessment:

Learning is through lectures, tutorials, seminar groups, practical sessions, research projects and self-directed study. Assessments via oral and written examinations and working on a research project to survey the results in MSc Thesis.

### Careers:

Experts trained in this MSc course are capable of organizing integrated plant protection in farms, attaching to companies in the field of plant protection, plant doctor advisors.

### Admission criteria, application requirements:

Excellent command of English. Applicants intending to join to the Plant Protection Master Programme should hold undergraduate degree (BSc or equivalent) in relevant field of science or related area (agri culture, horticulture, forestry). Degree qualifications are assessed individually in accordance with the diploma and its attachments.

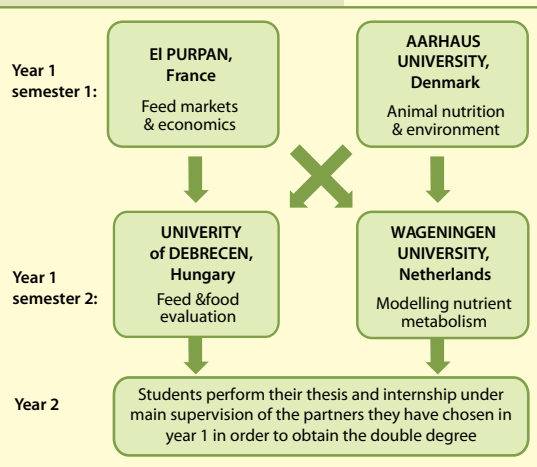
### Tuition fee:

6500 USD/academic year (+150 USD application fee and 350 USD registration fee)

<http://www.edu.unideb.hu/>



## European Master in Sustainable Animal Nutrition and Feeding Erasmus Mundus MSc course



### Partner universities:

- Wageningen University (Netherlands)
- Aarhus University (Denmark)
- École d'ingénieurs de Purpan (France)
- University of Debrecen (Hungary)

### The aim of the course

This unique joint MSc course aims to decrease the shortage of academics in this field by educating third world countries and European students in a state of the art, 2-year Master course in the feeding and nutrition of food producing animals.

It provides a multidisciplinary approach towards productivity,

welfare, environmental and economic impacts of animal production for all major animal species. EM-SANF is an international programme with links to international feed companies and capacity building in developing countries.

### Student Mobility – Experience different cultures

EM-SANF is one of a kind in its approach towards student mobility. By bringing together four universities with additional support from industrial and institutional partners worldwide, students from all over the world are able to get the latest insights from recently finished research.

The course is „thesis oriented“. Students work from the first week of the first year towards their thesis, the research for which is conducted in the second year. All subjects during both first year semesters are therefore in principle „thesis preparing“ subjects closely linked to the future thesis work. By following subjects at two universities in year 1 students experience different cultures and educational environments. Students learn in a true international environment which provides an extra dimension to their studies.

### Partner Universities – Combining strength

The aim of EM-SANF is closely related to achieving a second, double green revolution in the newly emerging and complex concept of sustainable animal production. The four universities work together to provide specialized subjects in their respective fields of expertise. The universities have high joint publication rates, experience from participation in joint EU projects, Erasmus Mundus Joint Doctorate, joint PhD courses and Erasmus exchange agreements.

### Entry qualifications

- BSc. In Animal Science, Biology or Veterinary Sciences
- Grade Point average of at least 70% of maximum
- proof of English proficiency

More information about the programme: [www.emsanf.eu](http://www.emsanf.eu)







## Services

### Accommodation

Agricultural Campus Computing services offers student accommodation for incoming students in the Arany Sándor Apartment House. In the flats shared by 2-4 students there are two rooms, a kitchen, a toilet and a bathroom. Free internet access is provided in all the rooms for the students using their own computers.

### Further information on accommodation:

<https://portal.agr.unideb.hu/kollegiumok/arany/galeria/index.html>

### Computing services and library

At the Agricultural Campus students can have access to computers in the Neptun Hall and at the library. Using their own computers, students are provided with free internet access in all rooms of the dormitory. Upon registering in the library of the Faculty, students gain access to all university library units of the National and University Library of Debrecen.

Sport facilities such as sport-court, tennis court, fitness rooms are at the students' disposal for spending their free time. The city's swimming pool is in walking distance from the Campuses.

### Entertainment

At the Campus „Kazánház” offers a wide range of opportunities for entertainment, hosts university parties, concerts and other events.

## Institute of Agricultural Chemistry and Soil Sciences

The Institute of Agricultural Chemistry and Soil Science was established in 2009 by merging the departments of “Agricultural Chemistry” and “Soil Science”.

### Our participation in Hungarian and international projects:

- Extracting solvents, determination of readily available boron in soils. Determination of the role of certain soil properties
- Optimization of plants' magnesium supply
- Application of soil survey methods which facilitate the rational plant nutrient management in sandy soils of Nyírség region
- C-, N- and S-content and ratio changes in soil organic matter fractions by effects of liming
- Changes in soil phosphorus stocks of flow-input conditions (Universität of Rostock)
- Optimization of German and Hungarian soil sampling raster density of soil nutrient availability, mapping and location-adjusted fertilization (FAL PB Braunschweig)
- The importance of nutrient balance in terms of sustainable agriculture
- Comparative evaluation of important properties of soils under different ecological conditions: soil fertility, biodiversity and carbon stock
- Functional diversity and effectiveness of substrate utilization of soil microbial population in different plant cultures and soil cultivation methods
- Changes of ecological characteristics of soils of Ukraine and Hungary in the conditions of anthropogenic, transformed ecosystems and optimization of biological processes for the mobilization of primary plant nutrients
- Advanced methods for the determination of soil acidity for more efficient soil amelioration
- Healthy plants from healthy soils: Resilience and stability of organic cropping systems (Humboldt- Universität zu Berlin, Universität Kassel, University of Aberdeen)

### Submitted applications:

- Comparative evaluation of the carbon and the nitrogen cycle in Japanese and Hungarian long term experiments on the soil-plant systems
- Plant nutrition-term experiments “ecological footprint” of six Central European countries of soil carbon and nitrogen cycle perspective

## Research results

- It has been confirmed that the conventional hot water method can be substituted by other extracting solvents for the determination of soil boron supply.
- We have found that determination of soil acidity with slow titration method reflects the actual situation more accurately than the methods which are used conventionally.
- It has been proved that the optimal Mg supply could be determined in acidic and magnesium poor soils by taking account of the multifactorial aspects.
- The plant uptake of  $\text{Cr}^{3+}$  and  $\text{Ni}^{2+}$  differs significantly and is highly affected by the characteristics of soils, such as pH value and texture. The similar  $\text{Cr}^{3+}$  and  $\text{Ni}^{2+}$  pollution rate of soils occurs significantly higher reducing of the dry matter production, which can be partly prevent by dosing calcium carbonate.
- It has been concluded from our experiments that the main soil chemical (pH) and microbiological properties has been changing in the long term field experiment as a result of different doses of NPK fertilizers. The lasting impact can be felt in the accumulation of certain nutrients, in their movement in the soil profile and the intensity of microbial processes.
- It is clear from soil microbiology and environmental protection aspects that small to medium dose macro element treatment (135kg/ha N; 90kg/ha  $\text{P}_2\text{O}_5$ ; 90kg  $\text{K}_2\text{O}$ ) with crop rotation and irrigation ensures optimal living conditions for soil microorganisms in calcareous chernozem soil.
- We have proved in small-pot and field experiment that the medium dose of bentonite and the small, medium dose of zeolite, alginate, perlite (5-10 t ha<sup>-1</sup>) stimulate the microbial parameters of soil.
- We have proved that different (such as food waste, agricultural biomass, sewage sludge) composts are good alternative plant nutrient sources.
- We have found in pot experiments that the commercially available bacterial fertilizers and the combined use of NPK fertilizer and microbial fertilizer may cause positive effects on soil physical, chemical and microbial properties.
- It has been found that soil microbial parameters are sensitive to environmental changes, climate changes and are important indicators of soil quality.
- It has been found that 200kg/ha  $\text{P}_2\text{O}_5$  fertilization over 40 years caused Zn deficiency in the field experiment, but the deficiency symptoms occur only at young maturity stage of maize. The P induced Zn deficiency was not affected the yield. The P doses affected Zn availability only at upper 0-20 cm layer.
- We proved that the DTPA-TEA- $\text{CaCl}_2$  extractant shows the available Zn quantity more sensitively than KCl-EDTA extractant.
- We proved that different cultivation methods (integrated, organic) affect the antioxidant and dry matter content of food materials.

## Education activity

The Institute of Agricultural Chemistry and Soil Science are involved in teaching all disciplines in each program (higher vocational education, BSc, MSc, PhD and postgraduate trainings), participates in teaching English language (Agricultural Engineer MSc, Food safety and Quality Engineering MSc, Agricultural Environmental Management Engineering, MSc). The subjects of Organic Chemistry, Biochemistry, Agricultural Chemistry, Crop Protection chemistry, Environmental Chemistry, Plant Nutrition and Soil Science are in the scope of our education and research activities dating back to several decades.

## The infrastructural background of related programs in the institute

In the Institute of Agricultural Chemistry and Soil Science nine graduated instructors and teachers are involved in education and scientific activities. Chemical and microbiological laboratories for soil and plant analysis, greenhouse for pot experiments provide the infrastructure for research activities. Field trials are also conducted in our research.

## References

Participation in Hungarian and in international projects, the publication activities of teachers and researchers.

## Prominent persons

### **Professor Dr. habil. János Kátai, CSc, PhD;**

soil microbiology and soil science researcher. Studies the soil-plant system C and N cycles in agro-ecosystems, as well as the impact of the bio-products on properties of the soil and plant biomass.



### **Associate Professor Balláné Dr. habil. Andrea Kovács, PhD;**

Director of the Institute  
N- and S-supply of plants, investigating of the effects of bacterial fertilizers, investigating the possibilities of alternative nutrient supply.



### **Associate Professor Dr. habil. Imre Vágó, CSc, PhD;**

The boron content of soils and plants, the impact of heavy metal loads, the field of alternative plant nutrient sources; internationally significant research findings.





## Information on the Institute of Animal Sciences, Biotechnology and Nature Protection



Due to the size of the Department, it is engaged in several scientific areas from food development to the preservation of genetic resources. Especially imperative is to keep up classical animal husbandry, but at the same time to achieve results in new fields, as today the most significant issues are not addressed in the stables and animal farms but rather in various laboratories.

One of the research goals of our Department is to develop breeding programs, comprising the economic assessment of breeding objectives, the organization of performance tests, the evaluation of genetic parameters and breeding value evaluations, selection, mating plans and the evaluation of selection. These activities are performed in cooperation with the Hungarian Simmental Breeders Association, the Hungarian Charolais Breeding Association and the Hungarian Sheep and Goat Breeding Association.

Breeding programs include various performance tests, the development of breeding value evaluation models and selection progress calculations facilitating the judgement of Hungarian sport horses, the evaluation of domestic show jumping results and the evaluation of the genetic structure of domestic Mangalica stock.

The preservation of genetic resources has always been pivotal for the Department. Recently our research workers have participated in several projects, thus advancing the preservation of several indigenous species.

The following list is not exhaustive: Mangalica, Hungarian Grey Cattle, Racka (long-wooled sheep) Bronze and Copper turkey, Hucul (Carpathian) and Frizzled Hungarian goose. At present, the Carpathian brown cattle are the animals in the center of attention for our researchers.

The highly interesting, focal research question is the significance of wool as a product. By various types of crossings, our Department attempts to develop a new species, the Hungarian shaggy sheep featuring aseasonal reproduction, favourable twin lambing ratio, good hoof and leg position, perfect shedding, stomach and intestinal hookworm resistance.

Aquaculture, a quickly improving area, is also in the forefront of our research. An experimental unit of several recirculatory systems is available to carry out experiments simultaneously with several fish species independent of type (fresh or salt water fish, warm or cold water demand). Priority research areas are larvae and juvenile rearing and also various fish feeding experi-

ments due to the fact that the Department has its own experimental fish feed producing facility. The latest research areas of the aquaculture laboratory are Aquaponics and IMTA. The two systems facilitate the abatement of the negative effects of intensive fish production and simultaneously the production of high quantity plant products by using nutrient-rich water from fish ponds.

The Laboratory of Animal Genetics, with ongoing molecular genetic and proteomic examinations in the past 5 years, is also a part of the Department. The most crucial goal is the identification of molecular genetic markers which boost the efficiency of the identification and selection of organisms with genes of favourable effects on value properties. Molecular genetic examinations basically focus on DNDS and RNS tests, whereas mRNS level examinations on gene expression in terms of various environmental factors and tissue types. Initially, our DNS examinations were restricted to polymorphism, when we determined the genotypes of genes with an impact of meat, milk, disease resistance and proliferation, and sought to reveal their relations with production characteristics.

After this we carried out examinations on genetic diversity in relation to an increasing amount of species/types by micro satellite and mtDNS markers. The fast development of biotechnology, molecular genetic methods and techniques allows the easy selection of organisms with favourable genes.

Most products of animal husbandry are used as food and therefore they might influence the quality of human life. For years, our researchers have participated in several projects aiming at the improvement of food quality and its functionality. We believe that functional food, although not yet widespread these days, will be a significant element in the food supply of the future. Knowing this, our researchers have carried out research activities for the production of specially developed food available for a wide range of customers by now.



## University of Debrecen

### Department of Nature Conservation, Zoology and Game Management

Within the structural framework of the integrated University of Debrecen, the Centre of Agricultural Sciences was established on 1st January 2000.

The Department of Nature Conservation, Zoology and Game Management is under the guidance of the Faculty of Agricultural and Food Sciences and Environmental Management (DE MÉK).

Our Department has a long history that originates from the predecessor in title, the College of Agricultural Sciences, later the University of Agricultural Sciences of Debrecen, the founder of it. The name of the Department has changed several times due to expansion of courses. For several decades from the beginning, it has been called the Department of Animal Sciences.

Our main courses are Animal Science, Ecology, Nature Protection (educated since 1990) and Conservation, Wildlife and Hunting.

In 2000 we initiated the Nature Protection Engineer graduate degree program, supported by the Ministry of Education and by the Hungarian Accreditation Committee, approved in 2001.

We are proud to say that during the semester of 2002/2003 we were the first to offer this kind



of graduate program among Hungarian Universities at the Faculty of Agricultural and Food Sciences and Environmental Management.

Since 1998 the Wild Management program had been launched as a correspondence course. From the semester of 2006/2007 it had been offered as a BSc course. In 2005 we initiated the Nature Protection Engineering MSc program that started in 2008.

Each year a huge number of theses are defended and the best ones are presented at the Scientific Student's Association's Sessions.



#### Prominent persons:

Prof. Dr. András Jávora is the head of the Institute of Animal Science, Biotechnology and Nature Conservation; and vicerector of the University of Debrecen. He graduated in Debrecen and Gödöllő. His study field is the genetics and sheep breeding. He established Molecular Genetic Laboratory, what has cooperation with several laboratory from different countries on the field of genomics and proteomics, genepreservation. He is the leader of innovative research-development studies for functional and special quality food. He is the head of Cluster for Pharmapolis Innovative Food, which is operating work of 77 companies. He has also outstanding task in developing of the agricultural consultancy.



Prof. Dr. István Komlósi is the Head of the Department of Animal Husbandry. He pursued his studies in Debrecen, Kensington, Armidale and Bangor in the fields animal breeding, quantitative genetics, biometry and image analysis. His research area is the planning of animal breeding programs.



Prof. Dr. László Babinszky is head of Department of Feed and Food Biotechnology. His research fields are pig and poultry nutrition, digestion physiology. He is author of more than 210 papers, and more book chapters and books on animal nutrition. He is invited lecturer at numerous international conferences, seminars, and workshops. He has worked at the Agricultural University of Vienna (BOKU) and in the Oscar Kellner Research Institute in Rostock in Germany. He worked in the Department of Animal Nutrition of the Agricultural University in Wageningen and in the Department of Biochemistry and Animal Physiology of the Institute for Livestock Feeding and Nutrition (IVVO) in Lelystad in the Netherlands He earned a PhD degree at the Agricultural University in Wageningen in 1992. The title of his thesis: „Energy metabolism and lactation performance of primiparous sows as affected by dietary fat and Vitamin E”. His department is focusing on animal nutrition and on relationship between animal nutrition and animal origin food quality.



## Institute of Food Science, Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen

### Recent participation of national and international projects:

- „Grains safety”/„Researches regarding the influence of some technological elements over the wheat and corn grains quality stored in Bihor and Hajdu Bihar counties”.
- Population genetics and physiology of the plant pathogen fungus *Botrytis cinerea*.  
A *Botrytis cinerea* populációgenetikai és fiziológiai tanulmányozása.
- Sustainable control of grapevine trunk diseases.
- Grains safety
- Evaluation of protein, carbohydrate, element content and composition of winter wheat grains during ripening and storage; their effects on technological properties  
Construction of a multi-gene transformation system in *Botrytis cinerea* and examination of the alternative oxidase (aox) deletion mutant strain.



### Presentation of research results:

„Low-calorie flour replacement (premix) and low energy flour mix” is the name of our intellectual property which was registered by the intellectual property office (identification number of registration: 16/2008-DETTI-AMTC)

Impact assessment of the chemical forms of some trace elements in natural and man-made systems through the physical-chemical properties of elements with institute in India.

The expected result of the program determines the various chemical forms of trace elements using radiochemical procedures and related analytical methods.

These data help determine the toxic amount of some elements, in view of this we can issue the necessary warnings, or we can make suggestions for the right technological steps to prevent poisoning.

All of these help to understand and avoid the poisoning of agricultural crops and natural vegetation caused by trace elements.

The results of the „The analysis of heavy metal in bottom sediments of the Tisza river catchment area and floodplain soil” supported „Natural Attenuation of Metals along the Tisza River-Floodplain – Wetlands Continuum” research cooperation about the analysis of the heavy metal contamination in bottom sediments; the vertical and temporal changing of contamination.

The development of a definite food safety system of the „Farm to fork” project for the lower level of the food raw material-production (field plant production and feed-production).

The composition of a database of the techno-functional characteristics of materials for natural and synthetic baking flour improvement in the „substitution of chemicals with natural materials during the production of bread and dairy products with ABO-MILL Zrt.

### Infrastructure background of courses in the Institute of Food Science

Since its establishment, the range of courses has been growing continuously. Due to the fact that our institute is well-equipped instrumentally, education has been extended including courses in Chemical Engineering, Environmental Management of Agricultural Engineering and Specialized Engineering.

### Courses of our institute:

- Food Engineering BSc
- Food Safety and Quality Engineering MSc in Hungarian and English
- Nutrition Science MSc

The new facility, which was constructed in 2006, serves educational and research objectives with its floor area of 1.000 m<sup>2</sup> with 3 laboratories for students. There are many high value instruments in the laboratory of the institute, which are available for education and research, for analytical examination, for educational purposes, and for practical education.

#### References, major EU partners who are in active connections with the Institute:

Dr. Florence Fontaine (University of Reims Champagne-Ardenne, France)  
Dr. Marc Bardin (INRA, Avignon, France)  
Dr. Irina Druzhinina (TU Wien, Wien, Austria)  
Dr. Amnon Lichter, (ARO, The Volcani Center, Bet Dagan, Israel)  
Prof. Dr. Martin Wagner (Veterinärmedizinische Universität, Wien, Austria)  
Prof. Dr. Roland Möllby, Dr. Beatrix Semjen (Karolinska Institutet, Stockholm, Sweden)  
Prof. Dr. Susanta Lahiri (Saha Institute of Nuclear Physics, India, Calcutta)  
Dr. Bettina Eichler-Löbermann (Universität Rostock, Germany)

#### Prominent persons:



##### *Prof. Dr. Bela Kovacs:*

Professor Béla Kovács is the head of the Institute of Food Science at University of Debrecen. His research field is the elaboration of various analytical methods, mainly for inductively coupled plasma optical emission spectrometry and mass spectrometry in food, feed, plant, soil, water and sludge; moreover, in animal and human origin samples; examination of selenium, molybdenum and arsenic in the environment in food, agricultural and biological samples.



##### *Dr. Erzsebet Monika Karaffa:*

Dr. Erzsebet Monika Karaffa coordinates education and research in the field of microbiology in the Institute. Her main research areas are molecular phylogeny, population genetic and the physiology of filamentous fungi (*Botrytis cinerea* and pathogens connected to grapevine disease).

## Institute of Food Technology

#### Presentation of the Institute

The Institute of Food Technology has been established in 2014 to coordinate and lead the food technology related education, research and scientific activities. The food processing related research activities of the Faculty was done mostly on the field of cereal processing in the Institute of Food Science previously and the Faculty participated in the development of several new products, for example a flour mixture with low energy content and glycemic index and bakery products made from it and in the development of the first Hungarian commercial triticale bread (Hungaro), but the increasing demand on technological teaching and research required to establish this new institute.

The main aim of the Institute is the teaching food processing technologies with special emphasis on the food chain approach and the aspects of quality and safety of end products. In the research we are working in strong collaboration with the other Institutes of the Faculty and the University offering the opportunity of turning of the raw materials to food products for physical, chemical, microbiological and nutritional researches. Our issue is the product development in collaboration with industrial partners from the region.

A small food processing pilot plant provides the basic infrastructure for the education and research what was built on about 600 m<sup>2</sup> in 2015. In this small pilot plant there are six operational units: a mill, a bakery and confectionery, a past, a fruit and vegetable processing, a dairy and a meat processing factory. These small units can help the students to overview, understand and learn the basic processing technologies in the practice under real manufacturing conditions from the production of staple foodstuffs, such as bread, sausage and jam to the knowledge of emerging technologies like vacuum and freeze drying, sous vide and supercritical fluid extraction. This pilot plant will be authorized for legal food production and it will give opportunity to produce test samples for human sensory and nutritional evaluations.

The main activity of the Institute in education is the teaching of food technology for the Food engineer BSc, Agricultural engineer BSc, Plant production BSc, Animal husbandry MSc and Nutrition Science MSc students, but analytical and molecular biological subjects are also offered by the Institute.





## Prominent persons

### Dr. Péter Sipos



Dr. Péter Sipos is the head of the Institute and the main lecturer of food processing technology related programs. His main research interest is the processing of plant originated products with special emphasis on the development of cereal and fruit and vegetable products and the evaluation of the factors influencing their quality. In education he coordinates and give lectures in food technology (plant originated products), qualification of agricultural products for food use and rheology in the Food Engineering BSc, MSc in Food Safety and Quality, MSc in Nutrition Sciences and other BSc, MSc and PhD programs.

### Professor Dr. János Csapó



Professor Dr. János Csapó is the former head of the Institute. His research interests are food chemistry, food biochemistry, analytical chemistry, research of the foods of animal origin, milk and dairy products in human nutrition, development of functional foods, and food falsification. His current research subjects are: investigation of colostrum and milk of ruminants, investigation of the conjugated linoleic acid content of different foods, mainly milk and dairy products, determination of the D-amino acid content of foods and feeds, separation and determination of the tryptophan enantiomers from heat treated foods, development of new methods for the determination of the protein produced by the bacteria based on D-amino acid content, and new analytical methods on the field of amino acid analysis of foods. He is giving the following lectures in the Food Engineering BSc, Food Quality Management MSc and the Animal Science doctoral programs: Organic and biochemistry, food chemistry, food analytical chemistry, milk and dairy products in human nutrition, dairy technology, functional foods, food falsification and grape and wine chemistry.

### Dr. Endre Máthé



Dr. Endre Máthé research interests are related to genetic and nutritional control of cell cycle and cellular metabolism including the molecular mechanism of action of bioactive compounds with natural origins. He is giving lectures in the Food Engineering BSc and Food Quality Management MSc programs. In his teaching and research activity puts a great emphasis on promoting the molecular aspects and genetic control of vital phenomena, and their implications with regards to personalized preventive and/or therapeutic nutrition based food development. He is studying the bioactive compounds composition and their mechanism of action of several fruits, vegetables and medicinal plants in order to design and produce new innovative food staff.

## Institute for Land Utilization, Regional Development and Technology 2004-2015

### Hungarian projects

#### *Methodological support of sustainable and precision agricultural system (OTKA, TS 049875)*

A complete system of models was developed which consists of the following main modules: The plant growth model simulates the correlations between soil, climate, hydrology and the crop system. The stochastic model describes the risk factors arising from the variability of weather. The agrotechnical module characterises the production technology and the changes in the conditions of the production site (amelioration, degradation, etc.). The economic decision support system produces the optimal production structure, considering production site conditions, resources, as well as risk and economic conditions. The model providing sustainable development describes changes in the condition of the production site's dynamics in the long run and it regulates production with economic tools. These models can be used independently or connected into a model system which describes the whole process of crop production from the micro level to the regional level.



*Agro-environmental management geoinformation consultancy  
(GVOP-3.1.1.-2004-05-0184/3.0)*

The established system is suitable for the detailed, plot-scale examination of production site circumstances and yield, as well as the spatial-temporal analysis of agroecological production technological parameters. The system has a significant “added value” in terms of the method of access to information which makes the work of the players in the system more effective, while the utilisation of the accumulated data wealth and its use for public purposes increase.

*Developing a nutrient management and environmental protection control system based on fermented liquid manure produced at a biogas plant (GVOP-3.1.1.-2004-05-0220/3.0)*

The fermented liquid manure produced at the Nyírbátor regional biogas production plant was authorised as a yield increasing material and a nutrient management system based on fermented liquid manure, as well as the environmental protection control system of its utilisation were developed. These developments can provide the nutrient replenishment of the agricultural areas of Bátortrade Kft, as well as the environmental friendly use of the fermented secondary product.

*Development of the stone fruit production sector for economic and health preservation purposes (OM, 00063/2004)*

The technology of the plot-scale utilisation of space and aerial images was developed, the image query dates and the parameters of the requested images (e.g. level, wavelength, regional coverage and resolution) were determined. The classification methodology, as well as measurement and analysis methods were developed to keep track of condition changes. Furthermore, applications serving data logging and processing, as well as the detection of correlations were developed. Recommendations for the production plant adaptation of the system were worked out.

*Development of industrial scale production of biofuels and organising its utilisation for environmental protection purposes (OM, 00077/2004)*

Building up and launching the operation of a country-wide production and processing system which also covers the end product. Accordingly, the R&D activity covers basic and applied research in the production of feedstock and the establishment of the economic system of conditions.

*Increasing quality production and yield safety with modern water management and irrigation (NKTH, OM-00210/2008)*

The methodology of a new irrigation method was developed. The more effective and more accurate determination of the irrigation date and dose are supported by a separate information system. Within the scope of the project, a GIS consultancy information system was developed



in order to establish environmental friendly and effective agrotechnical interventions. This methodology is suitable for the detailed and plot-scale analysis of production site circumstances, the temporal-spatial analysis of agroecological and production technological parameters, while it also provides reliable support in forecast, making it possible to operate a modern agricultural monitoring system. This system contributes to reducing the used pesticides and irrigation water by 20% and the efficiency of production increases.

*Enterprise level analysis of irrigation and development of an irrigation system in the North Great Plain region (Baross Gábor, OMFB-00820/2009)*

Based on the research findings, reliable and effective irrigation procedures can be developed, while the irrigation date and dose can be determined more accurately. Agroeconomic consultancy adapted to production site is also provided, which also makes it possible to analyse the economic aspects of irrigation in addition to performing consultancy related to cultivation and nutrient management in reference to irrigation.

*Production of corn germ oil-based functional foods with feedstock and technological optimisation (Baross Gábor, OMFB-01005/2009)*

The production of cold-pressed corn germ oil and its wrapping technology were developed in addition to the selection of the maize hybrid most suitable for this purpose.



*Determining the impacts and interactions of plant stress factors  
(TÁMOP-4.2.1/B-09/1/KONV-2010-0007 2010–2012)*

Exploring the physiological background of the climate sensitivity of varieties of different genotype, as well as their adaptability to production site circumstances. Determining the correlations of changes occurring in the photosynthetic activity of plants, as well as water cycle processes.

**International projects**

*Initiatives for Sustainable Rural Development (Structural Funds, RO 4 RURAL BIZ, POSDRU/83/5.2/S/47717)*

Publishing promotional material and information which assist the project and can be utilised in the dissemination phase.

*New forms of employment to improve the welfare creation ability of rural communities  
(EU FP7-KBBE-2007-1 EU FP7, RuralJobs-211605)*

Identification of factors influencing employment opportunities in order to assist the rural development policies of the future. Encouraging dialogues and the exchange of experience between academics, students and practical users in the area of sustainable rural development.

*Improvement of the research potential of the Institute for Land Utilisation, Regional Development and Technology in the field of GIS, precision agriculture, land use and rural development (FP7-REGPOT-2010-1 UD\_AGR\_REPO)*

Mapping soil science, soil use and climatic conditions, as well as their arrangement into and integrated GIS monitoring system, based on which the region-specific land use structure and sowing structure adapted to the ecological conditions of each area can be determined. Acquisition of necessary instruments and the exchange of professionals needed for the establishment of these activities and implementation of the research potential development of the Institute.

*Pesticide Use and risk Reduction in European farming systems with Integrated Pest Management (FP7-KBBE-2010-4/265865)*

The aim of the project is to work out a new integrated crop protection system based on sustainable agricultural production covering the most significant agricultural region in Europe. Within the scope of the project, a novel environmental friendly crop protection system is planned to be introduced for the purpose of jointly applying biological basic research and innovative environmental friendly crop protection.

*Exploring the opportunities of integrating biorenewable energy resources into production and use (Climate KIC, ADMIT BIORENEWABLES PATHFINDER)*

Establishment of a production and consumption structure leading to a more optimal carbon cycle in Europe. By means of case studies, large scale models of certain locally determined opportunities were provided with simulation tools.

*Project BioGas2Market (EU, EIT Climate-KIC Pathfinder)*

Optimising biogas production processes, reducing GHG emission by applying the best available practices. Exploring processes facilitating the use of agricultural by-products and new, alternative biogas production methods. Determining the competitiveness of biogas as a potential bioenergy resource against other fossil resources.

*ADMIT BioSuccInnovate, EIT, Climate KIC, BioSuccInnovate*

The aim of WP8 of BioSuccInnovate is to economically produce Biosuccinim (succinic acid) from sustainable feedstock, resulting in considerable mitigation of GHG emission with the help of specific feedstock and supply chains.

*Cool Farm Tool – Space, EIT, Climate KIC, CFT Space*

Analysis of the online usability of near-real-time, modern remotely sensed data within the framework of the previously developed Cool Farm Tool (CFT) and their connection with precision farming methods, thereby providing farmers with a tool which they can use to measure and report the GHG emission resulting from their activities.

*Sustainable Campus Launching Customer, EIT, Climate KIC, SCLC*

Assisting European campuses in developing an outstanding ecosystem (universities, suppliers, start-ups, etc.) where new sustainable innovation can be developed, tested and used. The aim of the project is provide the campuses of the Climate KIC network with the opportunity to become the engine of regional innovation.



**Prizes, awards**

János Nagy: MTA RKK “Candle of Science” (2004), Doctor honoris causa of the University of Oradea (2005), Honorary citizen of Hajdúböszörmény (2005), Socrates prize (2006), Niveau prize for the books titled “Kukoricatermesztés”, “Földművelés és Földhasználat” (2007), Westsik Vilmos prize (2007), Doctor honoris causa of the University of Kaposvár (2009), Baross László medal (2009), Pázmány Péter Higher Education Prize (2010), Doctor honoris causa of the University of Kiev (2010), Hajdú-Bihar County Regional Prima Prize (2012), External member of the Ukrainian Academy of Sciences (2012), Honorary citizen of Debrecen (2013).

## Institute of Horticulture

### General structures

In the fruit production group, the main research topics focus on the intensification of the applied fruit production technology (apple, stone fruits) and comparison of the environmental friendly technologies (integrated and organic). Plantations and fruit cultivar collections of the Pallag Experimental Station serves for practical educations and research tasks, where 54 apple, 72 sweet cherry, 18 sour cherry, 43 apricot, 68 peach and 34 plum cultivars can be found. The Station has also an advisory function, as over 1000 producers visit the experimental orchards annually in order to get information related to new cultivars, new technological approaches and recommendations for orchard plantations.

The vegetable group is based on a 0.8 hectare experimental garden which located in the University Campus serving for practical educations, including more than 50 cultivated vegetable and 45 herbaceous species. Students in MSc and BSc courses take part in the propagation, cultivation and harvest works too.

Viticulture education and research are based on the cultivar collection of the Pallag Experimental Station including 50 table grapes, 73 white wine grapes, 29 red wine grapes cultivars, and 43 rootstocks in a 0.5 hectare plantation. Students can get practical experiences about production technology of table grapes (0.5 hectares).

### Research projects

- Effect of climate change on technological elements of fruit production and fruit quality.
- Improvements of phytotechnical elements in integrated and organic fruit production.
- Investigation of bioactive materials in vegetables.
- Improvements of environmentally friendly (integrated and organic) plant protection technology in Western-European apple production regions (EU7 PURE project).
- Biological control against fire blight (EU6 Craft project).
- Improvements of epidemiologic knowledge and forecasting models against apple diseases.
- Decision support systems against fungal diseases of stone fruits.



### Obtained scientific results

- Elaboration of new technological elements for reducing the harmful effect of climate change on fruit production.
- Elaboration of new summer and winter pruning methods and implementation in the practice of fruit production.
- Determination of bioactive materials in various vegetable species.
- Elaboration of new, complex plant protection systems in integrated apple production.
- Selection, testing and formulation of effective *Bacillus* strains against fire blight.
- Determination of new epidemiological characteristics and introduction of PC-based forecasting models against apple scab.
- New decision support systems against brown rot of stone fruits in integrated and organic orchards

### Prominent persons:



Prof. Dr. Imre Holb, associate editor of European Journal of Plant Pathology (IF: 1.6) and associate editor of Agronomy for Sustainable Development (IF: 3.6). International expert in epidemiology, forecasting systems, integrated and organic fruit production.



Dr. Takácsné Mária Hájos, Domestic and international research performance for decades in improvements of inner content of vegetables.



Dr. József Nyéki, editor-in-chief of International Journal of Horticultural Science. Domestic and international research performance for decades in improvements of pomology and production technology.



Dr. István Gonda, Improvements and practical implementation of integrated and organic fruit production for decades.



## Institute of Crop Sciences

### Involvement in Hungarian and international research projects:

- The definition of crop rotation in the development of crop production
- Development of environmental protection and food safety in crop production under different agroecological conditions.
- Study of nutrient supply of winter wheat
- Complex development of agrotechnical elements in sunflower production (cooperation with KITE Zrt.
- Technological developments in winter rape production
- Hungarian-Croatian Intergovernmental S&T Cooperation project: „Reduction of yield limiting elements at field crops in East-Croatia and East-Hungary” (University of Debrecen-University of Osijek)
- Hungarian-Slovakian Intergovernmental S&T Cooperation „Development of variety and site-specific crop production technologies mitigating the effect of climate change under different agroecological conditions.” (University of Debrecen -Slovak University of Agriculture, Nitra)
- Hungarian-Ukrainian Intergovernmental S&T Cooperation. „Environmentally sound, sustainable crop production models under different agroecological conditions” (University of Debrecen-Kijevi National Agricultural University of Ukraine)
- Development of crop protection technology of winter wheat, maize and sunflower (crop protection companies) 1998-2014

- Interactive examination of agrotechnical elements in winter rape (KITE Zrt.)
- EU Green Cultivation Action (Grundtvig-Multilateral project 2010-4042/001-001). Partners: University of Bologna (Italy), University of Oradea (Romania), University of Debrecen (Hungary), Chamber of Trikala (Greece), Znanie Association Sofia (Bulgaria), MKV Uluslararası Danışmanlık Eğitim Hizmetleri Ti. Sti. Ltd. Ankara (Turkey)
- „GrainsSafety” (Researches regarding the influence of some technological elements over the wheat and corn grain quality stored in Bihor and Hajdu Bihar counties
- „Plant growth-promoting bio-effectors (microorganisms and active natural compounds) for alternative plant nutrition strategies in non-leguminous crops” (FP7-KBBE-2012-6) – Biofactor project. 2012-2017
- „Improved Nitrogen Use Efficiency in Wheat and Barley” Grain Research and Development Corporation (GRDC Project UWA00133)
- „Sustainable energetics with optimized integration of renewable energy sources” Denzero project.
- „Determination and comparison cyclic hydroxamic acid content of different maize hybrids and lines” Research contract, Pioneer Hungary Zrt. 2009-2012
- „Corn smut (*Ustilago maydis* Cd. Dca.) resistance researches” Research contract, Bátortrade Kft. 2013-2015.

### Research results:

- Crop models in cereal and in oil crops
- Development of sunflower’s agrotechnique, interactive examination of some production elements.
- Variety specific nutrient supply of winter wheat, testing of winter wheat varieties.
- Nutrition models, complex evaluation of different nutritional technologies of important field crops.
- Development of crop protection technologies in field, complex elaboration of integrated crop protection technologies.
- Development of maize’s agrotechnique, the hybrid specific nutrition and plant density of maize.
- Resistance breeding of sunflower (*Helianthus annuus* L.) against negative effect of climate change.
- Prospects of increasing antioxidant content in maize breeding.
- In vivo/in vitro breeding of cereals. Increasing adaptability, drought resistance and winter hardiness of wheat.
- Application of maize lines with high biodiversity in new trends of breeding. Integration of applied conventional methods applying to increase effectiveness.



- Sorghum and maize breeding for quality.
- Application of Normalized Difference Vegetation Index (NDVI) and SPAD value measurements in maize breeding.
- Biological, genetic and biotechnological researches in herbaceous energy plants.
- Elaboration and development of conventional and in vitro propagation methods of winter-hardy, high-yielding Arundo and Sida, potential biomass plants.
- Evaluating the effect of plant nutrients with different NPK content in winter wheat and winter rape.
- Application of bionutrients in sunflower and maize production. Innovation in sustainable plant production.
- Plant biological effects of plant originated protein hydrolyzates in case of three vegetable species.
- Efficiency of nitrogen utilization in different wheat and barley genotypes.
- Role of cyclic hydroxamic acid in plant physiology.

#### **Infrastructural background of courses related to the Institute:**

The Institute of Crop Sciences educates students of almost all BSc and MSc courses at the faculty and participates in trainings in English language (Agricultural Engineer MSc, Food Safety and Quality Engineering MSc).

A modern laboratory accredited in the Hungarian and international system with excellent instrumentation is available to the faculty. There are also some other, smaller laboratories (soil science, chemistry, microbiology, zoology, plant physiology etc.).

Computers, softwares, projectors, laptops, printers are accessible in the institute. Auditoriums and seminars are available for students.

#### **Devices used by the Department of Agricultural Botany, Crop Physiology and Biotechnology:**

The laboratory of Group of Genetic Sciences provides: Laminar flow box, liquid nitrogen tank, electrophoresis apparatus, pH meter, analytical scale, UV transilluminator, autoclave, Isoelectric Focusing Apparatus, laboratory shaker, water bath.

#### **Crop production educational and experimental stations owned by the Institute of Crop Sciences:**

The theoretical and practical education of the Institute is based on the integrated utilization of educational and experimental activities of study farms and experimental stations of the Farm and Regional Research Institute of Debrecen (FRRID). The experiments and researches of the Institute are carried out at the Látókép Experimental Station and Hajdúböszörmény Experimental

Station. We can examine the interactive effect of agroecological, biological and agrotechnical elements in crop production under different ecological conditions.

The Show Garden at the Böszörményi street campus effectively supports the practical education of the Institute. The students can follow the development stages of field crops in the vegetation period.

#### **References:**

The principal of UD Faculty of Agricultural and Food Sciences and Environmental Management Institute of Crop Sciences is the vice-president of Committee on Soil Science, water Management and Plant Cultivation of the HAS, president of Committee on Plant Cultivation of the Debrecen Regional Committee of the HAS. Member of Crop Science Society of America (CSSA). President of the European Society of Agronomy (ESA), member of Soil Tillage Research Organization.



#### **Prominent performance of 3 colleagues of the Institute:**

Dr. Péter Pepó Professor, Head of Institute of Crop Sciences, UD Faculty of Agricultural and Food Sciences and Environmental Management, doctor of Hungarian Academy of Sciences. He is an acknowledged scientist in Hungarian and international professional circles with educational and research experience of over decades. He is the president of the Agricultural Doctoral Council, the president of the Council of Scientific and Outstanding Research University. He is the leader of several educational and research cooperation with foreign universities. He is the president of the European Society of Agronomy (ESA) from 2014.



Dr. Mihály Sárvári, Professor in the Institute of Crop Sciences. He is the leader of the Plant Production Engineering MSc. His research fields are the rationalization of nutrient supply of field crops and the development of hybrid specific maize production technologies.



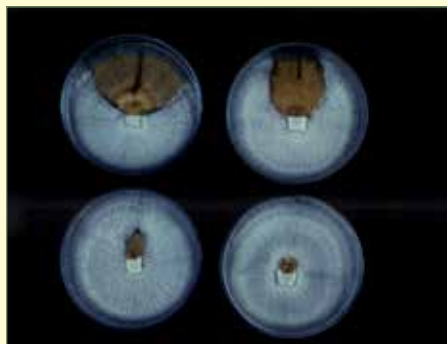
Dr. habil Szilvia Veres, Assistant Professor in the Department of Agricultural Botany, Crop Physiology and Biotechnology. She is the lecturer of courses connected with plant physiology. Her research area is the examination of environmental friendly nutrient management and photosynthesis depending on environmental factors.



## Plant Protection Institute

### National and international research projects:

- Taxonomical reclassification of Phoma-like plant pathogenic fungi using traditional methods and molecular markers (by Amravati University, India).
- Cooperative research and development in chestnut blight management (causal agent *Cryphonectria parasitica*) on chestnut and oak species in China and Hungary (by Beijing Agricultural University, China).
- Integrated Pest Management practice and producer integration development (by national chestnut producers, Hungary).
- Research on insect pheromones and applications in pest forecasts (by Plant Protection Institute of Hungarian Academy of Sciences, Budapest, Hungary)
- Hungarian – Romanian joint databases and periodical issues under „Phyto-centre Project” (University of Oradea, Environmental Faculty, Oradea, Romania)



In vitro conversion of virulent (orange, dsRNA-free) isolate with hypovirulent (white, L-dsRNA-containing) strain of the chestnut blight fungus *Cryphonectria parasitica*



Sampling from abnormal canker, caused by the hypovirulent strain of the chestnut blight fungus *Cryphonectria parasitica* in China (Beijing-Miyun)

### Some relevant results:

- Description of new phytopathogenic fungus species (*Phoma sojicola* Kövics, Gruyter & Aa, Mycological Research 103(8): 1065-1070, 1999; moreover, its revision based on molecular markers (Mycological Research 113(2): 249-260., 2009). First observations and descriptions of numerous

plant pathogens in Hungary (*Puccinia xanthii*, *Puccinia gentianae*, *Boeremia exigua* var. *exigua*, *Diaporthe phaseolorum* var. *sojae*, *Phytophthora megasperma* var. *sojae*, *Rhizoctonia cerealis*, *Ascochyta /Phoma/ rabiei*, *Leptosphaerulina trifolii*, *Colletotrichum acutatum*).

- Practical resolution for the biological control of chestnut blight disease by hypovirulent strains of *Cryphonectria parasitica* pathogen fungus.
- Progress in identification, biodiversity and ecology of lacewings (e.g. common green lacewing, *Chrysoperla carnea* complex /*Chrysopidae*/), which are important participants in agro-ecological systems and biological control agents.
- Country-wide observations, collections and isolations of grey mould (*Botrytis cinerea*), studying its biology and genetic diversity, fungicide resistance on viticulture, sunflower and rape cultures to develop more relevant integrated pest management practices.
- Research on the aetiology of European stone fruit yellows (apricot, sour cherry and plum) in Trans-Tisza region, exploration of the role and control opportunities of 'Ca. *Phytoplasma prunorum*'.
- Development of environmentally-sensitive insect pheromone research in the management and forecast of different pests.



Abnormal canker caused by the hypovirulent (dsRNA-containing) strain of the blight fungus *Cryphonectria parasitica* on European chestnut tree

### Special infrastructure for Plant Protection Institute:

- Show Garden: a 3 ha-large open-field area to make small plot trials, to diagnose different diseases, to study the main pests and weeds.
- Herbaria to demonstrate disease symptoms, insect damages and weeds.
- Insect collection (consist of cca. 900 species).
- National Weed Seed Collection (about 150 species).
- Mycological Gene Bank (DU, about 150 items of different strains and fungal species).

## References:

- Wide-range international network collaboration in fields of education and publication.
- Existence of collaborative research projects.
- The highest standards in plant protection higher/ postgraduate education and examination (plant doctors, engineer-specialists) both in Hungarian and English languages.

## Prominent persons in Plant Protection Institute:



Kövics, György János MSc, PhD, Dr Habil., head  
Phytopathologist, expert of the ecology of papilionaceous plants, etiology and epidemiology of grain fungal diseases, taxonomy of Phoma-like fungi. Spread of European stone-fruit yellows phytoplasma (Ca. *Phytoplasma prunorum*) and alternatives in control.



Bozsik, András MSc, PhD, Dr Univ., Dr. Habil.  
Entomologist, ecologist, expert of biological control. Taxonomical delimitation of lacewings (e.g. *Chrysoperla carnea* complex), their diversity and ecology.



Radócz, László MSc, PhD, Dr Habil.  
Biological control applied hipovirulent strains of *Cryphonectria parasitica*, the causal agent of chestnut blight, applied integrated pest managements.

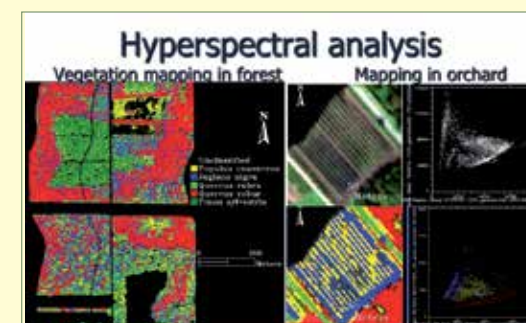
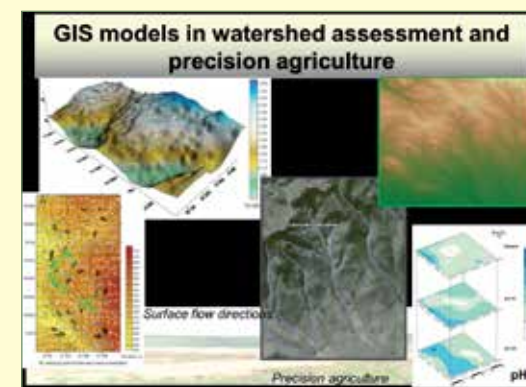
## Institute of Water and Environmental Management

At the Institute of Water and Environmental Management, the main research areas are water management and applied GIS.

In water management, mostly inland waterways research is outstanding. In this area our workshop has gained not only domestic but international reputation. The area of research involves the application of digital terrain models and time series analysis, statistical analysis of the frequency of inland flooding, accumulation processes in plains and inland water-vulnerability mapping. This issue is also linked to the hydrological and hydraulic analysis of surface water flows. Surface water hydrodynamic tests are closely linked to the water quality protection model analyses, which were the basis

of multiple domestic water stream risk assessments. With the sensitivity analysis of groundwater and the construction and development of monitoring networks, our staff helps to carry out methodological research in order to accomplish the EU's Water Framework Directive. The Global Water Partnership Central and Eastern Europe (GWP CEE) and the World Meteorological Organization (WMO) have just started an integrated draught management program working together with 10 Central and Eastern European countries, and the Hungarian tasks are coordinated by the Institute. Working with Romanian and Slovakian partners, a remote sensing methodology will be worked out for the Tisza region to forecast potential crop yield decreases. Recent projects are the following: Effect of weeds on soil humidity and material balance Integrated Drought Management Programme, WHO – GWP.

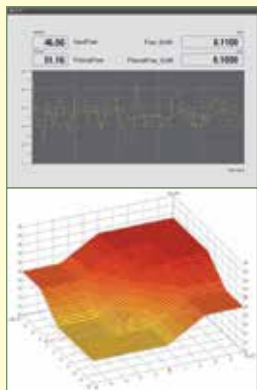
In the field of biotechnology, research includes basically two areas, one is biodegradation and bio-energy, while the other area contains rehabilitation of contaminated soils by bio and fitoremediation technology. For more than a decade our special research workshop has been engaged





with biodegradation processes of organic substances in laboratory and in operating conditions. To do this monitoring and control, we have a biodegradation test equipment which is suitable for establishing both aerobic and anaerobic conditions. In addition, a pilot biogas fermentation tank was also set, which is suitable for testing the technological parameters of biogas production. Not only plant materials, but food (e.g. abattoirs) waste biogas production ability is also going on, from the gas generated in the preparation of basic materials to the management of generated gas. In the Institute, by using field in-situ measuring devices, we can evaluate micro-contaminated soils and contamination of geological formations with high precision and high sampling density gauge. Collected information allows us to work out optimal sampling strategies and decision support by GIS, prior to the selection of technological alternatives. Our previous research carried out successfully developed an enzyme catalysed in-situ process, as well as a fitoremediation technology. The validation of technologies was carried out under the pilot projects.

Remote sensing research including low earth multispectral, satellite and hyperspectral remote sensing applications are outstanding. The application of aerial hyperspectral technology used by our workshop is currently the only one in Europe which has gained significant international recognition. The area of research involves the application of image classification and time series analysis, environmental protection applications, the area of agricultural land use in an analysis, the biomass of agricultural fields, plant health and weed examination. Our research group's aerial hyperspectral technology has also been used in many European countries since 2008,



Original and filtered methane gas signal and 3D surface of  $\text{CH}_4$ ,  $\text{CO}_2$ , temperature variables

in close cooperation with foreign research partners. The Research Group has its own DGPS base station, precision GPS equipment and software necessary for processing which are used in environmental condition survey research. The research group developing the agricultural applications of GPS technology has achieved considerable results, especially in the movement of grazing animals, recording GPS / INS system and related software development. Related ongoing projects are Network for Habitat Monitoring by Airborn – supported Field work – An innovative and effective process in the implementation of the Habitat Directive FP7-PEOPLE-2009-IAPP, CHANGEHABITATS 2; Applications of spectral information in precision fruit irrigation A2-ACSJD-12-0406, and Remote sensing methodology development in agro-hydrology.

The Institute is responsible for agri-environmental engineering assistant, BSc and MSc courses, and takes role in the environmental engineering MSc course. Research results and experience are directly built into our education through relevant subjects to provide up-to-date knowledge for graduates. For this, adequate infrastructural background is given, and it is continuously developed by using available project resources.

### Prominent persons:



The head of the Institute is Prof. Dr. János Tamás professor, previously vice-dean of the Faculty. He is responsible for research activities, he supervises agri-environmental engineering BSc and the environmental engineering MSc courses. His main areas in education and research are environmental and spatial informatics, remote sensing and precision agriculture.



Dr. habil. Csaba Juhász is the vice-dean of the Faculty; he is responsible for education. He supervises the Waste manager assistant and the agri-environmental engineering MSc courses and takes part in several educational programs. His main areas in education and research are environmental management and water management.

# AGRÁRTUDOMÁNYI EGYETEM







Please write in block capitals!

### Personal details

Family name: \_\_\_\_\_ Title: Mr. ☐ Ms. ☐

First name: \_\_\_\_\_ Sex: Male ☐ Female ☐

Date of birth: (day/month/year): \_\_\_\_\_

Place of birth (city/country) \_\_\_\_\_

Nationality: \_\_\_\_\_

Mother's maiden name: \_\_\_\_\_

Level of English: basic ☐ intermediate ☐ advanced ☐

Language exam if any: \_\_\_\_\_

### Home address (in your country)

Address: \_\_\_\_\_

City: \_\_\_\_\_ Country: \_\_\_\_\_

Post/Zip code: \_\_\_\_\_ Telephone: \_\_\_\_\_

Email: \_\_\_\_\_ Fax: \_\_\_\_\_

### Contact address (if different)

Address: \_\_\_\_\_

City: \_\_\_\_\_ Country: \_\_\_\_\_

Post/Zip code: \_\_\_\_\_ Telephone: \_\_\_\_\_

Email: \_\_\_\_\_ Fax: \_\_\_\_\_

### Passport

Passport number: \_\_\_\_\_

Valid till: \_\_\_\_\_ Issued by: \_\_\_\_\_



Please write in block capitals!

### How did you first hear about University of Debrecen?

- ☐ Newspaper advertisement    Name of paper: \_\_\_\_\_
- ☐ Internet    University of Debrecen website: \_\_\_\_\_
- ☐ Representative/Agency    Name of representative/agency: \_\_\_\_\_
- ☐ Other    Please specify: \_\_\_\_\_

### Education History

High School:    From (year): \_\_\_\_\_ To: \_\_\_\_\_

Grade completed: \_\_\_\_\_

University/College: \_\_\_\_\_

From (year): \_\_\_\_\_ To: \_\_\_\_\_

Degrees/Diplomas: \_\_\_\_\_

### Program of study you would like to apply for

- ☐ Agricultural Engineer B.Sc.    ☐ Environmental Management M.Sc.
- ☐ Agricultural Engineer M.Sc.    ☐ Animal Science M.Sc.
- ☐ Food Safety and Quality M.Sc.

I affirm the completeness and truthfulness of my responses to the above questions.

\_\_\_\_\_

Date

\_\_\_\_\_

Applicant's signature

A filled copy of the application form and the necessary documents must be sent by post to the University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management, 4032 Debrecen, Böszörményi út 138. or by e-mail to our e-mail address: [juhasz@agr.unideb.hu](mailto:juhasz@agr.unideb.hu), until 15<sup>th</sup> of May each academic year.

For more information visit: <http://www.edu.unideb.hu>  
More information can be given on [info@edu.unideb.hu](mailto:info@edu.unideb.hu)

Make all payments to:

Name: University of Debrecen

Address: H-4032, Debrecen, Egyetem tér 1, Hungary

Account No.: HU13 1003 4002 0028 2871 0000 0000

Bank: Magyar Nemzeti Bank, 4026 Debrecen, Hatvan street 15., Hungary

SWIFT code: MANE HUHB, Please write your name and „Tuition Fee” in the comment

Payments are accepted in the form of Bank Transfers. Personal cheques, travelers cheques and cash payments are not accepted. All bank expenses should be paid by the applicant.





