THE PHYSICS SIDE OF FARMING

Josef Horabik, director of the Institute of Agrophysics at the Polish Academy of Sciences in Lublin, outlines the growing importance of the agrophysical sector

The Institute of Agrophysics at the Polish Academy of Sciences was established in 1968 by Professor Bohdan Dobrzański, Rector of Maria Curie Skłodowska University. The institute has employed over 150 scientists, conferred 25 professors, 35 Doctorates of Sciences, and 60 PhDs, in the field of agronomy-agrophysics. The institute also has longstanding co-operation with over 70 scientific partners all over the world, as well as co-operation with small and medium Polish enterprises, industry and local administration, which is an additional and important part of the institute activity.

The institute conducts four-year postgraduate studies to prepare students of natural sciences for writing a PhD thesis in agronomy-agrophysics. We have realised over 100 national projects and participated in 30 of the European Union's Fifth and Sixth Framework Programme projects, including domestic projects founded by the EU, all of which are related to environment and food research.

The still relatively new direction of scientific research on renewable energy sources, both in the use of traditional forms of biomass as well as the production and use of algae for energy purposes, is something we are closely involved with.

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Important features of the institute's study are aspects of the sustainable development of the renewable energy industry. In this area, the institute has extensive facilities created by the Renewable Energy Laboratory project. The Institute of Agrophysics at the Polish Academy of Sciences is also open to the establishment of research partnerships in the three key areas: food, environment and renewable energy.

Overall, institute researchers published over 5,000 scientific papers and 100 monographs, organised over 50 international and 50 domestic conferences, as well as a number of workshops, seminars and schools. We also publish two journals: International Agrophysics and Acta Agrophysica.

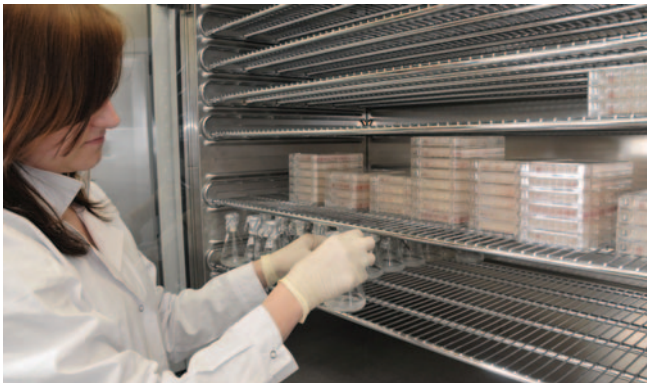
THE INSTITUTE IS DIVIDED INTO SIX DEPARTMENTS:
Natural Environment Biogeochemistry; Metrology and Modelling of Agrophysical Processes; Physical Chemistry of Porous Materials; Microstructure and Mechanics of Biomaterials; Physical Properties of Plant Materials; Soil and Plant Systems.

There are also 13 specialist laboratories: Gas Chromatography; Natural Environment Monitoring; Thermography; Surface and Structural Properties of Soil and Plants; Dielectric Spectroscopy; Microscopy; Mechanics of Granular Materials; Plant Root Systems; Physical Properties of Fruits and Vegetables; Applied Optical Measurement Techniques; Sensory Analysis and Mechanical Properties; Assessment of Grain and Oil Materials Quality; Regional Laboratory of Renewable Energy.

The scientific research of the institute has been highly acclaimed by the international scientific societies and it was bolstered by being awarded the status of Centre of Excellence "Applied Physics in Sustainable Agriculture – AGROPHYSICS" in 2003, as a part of the EU Framework Programme Five.

Modern processing technologies

At present, 50 researchers and 30 students representing various disciplines of science work in the institute, solving problems related to quality of environment and food with particular attention directed on sustainable plant and animal production and modern processing technologies. The chances for producing solutions for both theoretical science and practical applications are provided by the development and improvement of specialistic



THE INSTITUTE OFFERS VARIOUS SERVICES:

- Monitoring physical and chemical parameters of soil with internet access to acquired data especially moisture, temperature and salinity of porous materials, by time-domain reflectometry;
- Static and dynamic hydraulic characteristics of porous materials;
- Measurement of zeta potential with optical and electrochemical methods;
- Determination of mechanical properties of soil and its aggregates: susceptibility to compaction, penetrometric resistance, compressive strength;
- Determination of pore characteristics by mercury porosimetry;
- Determination of specific surface area of solids using water vapour or nitrogen absorption;
- Estimation of solid phase density using helium pycnometry;
- Measurement of reflectance of solids and liquids with a UV-Vis spectrophotometer;
- Measurement of the emission and absorption of greenhouse gases by gas chromatography;
- Measurement of surface temperature distribution by IR imaging camera;
- Determination of biological activity of soils: microbial groups, enzyme activity;
- Estimation of charge and surface properties of plant roots;
- Microscopic observations of materials structure including specimen preparation;
- Image analysis: microscope images, X-ray images, thermal images;
- Recording and analysis of acoustic emissions and mechanical tests of various materials;
- Determination of early stages of materials cracking;
- Testing of materials strength: compressive tests, tensile tests, bending tests, fatigue tests;
- Dynamic testing;
- Measurement of multi-ring aromatic carbohydrates and mycotoxins by near-IR spectrometry;
- Determination of limit conditions of storage of plant materials;

agrophysical measuring methods applicable to gain data from micro to macro scale as dielectric spectroscopy, mechantronics, full range electromagnetic waves spectroscopy (from thermography to X-ray imaging and microtomography) linked with image analysis, electrometric methods (potentiometry, amperometry, ionometry), porosimetry, acoustic emissions measurement, adsorption measurements and many others.

All of these serve for characteristics of plants and plant materials (biotic and abiotic stresses, damage identification, assessment of pigmentation, firmness, microstructure and texture of fruits and vegetables), soil environment (degradation processes including organic matter lost, acidification, heavy metal pollution, salinisation, structure destruction and alkalisation, biological activity, greenhouse gases emission, water retention, heat and mass transfer, structure formation and stability), as well as for model processes of safe food production, harvesting, transport and storage.

Increasingly close links arise with biology, genetics, chemistry, mathematics, informatics, electronics, food engineering, automation and other sciences increasingly used by advanced and modern agriculture.

The main tools for solving these problems are: metrology (elaboration of measuring methods and equipment for description of parameters and processes, creation and improvement of methods of data interpretation), monitoring (gathering datasets concerning actual state and history of processes) and modelling (creation of simulation and prognostic models: physical-mathematical, statistical, phenomenological; the application of mathematical methods in model procedures; using monitored datasets for calibration and verification of models).

Renewable energy

Recently, as a result of the funds received from the European Regional Development Fund and the Polish national budget, the institute has built a new high-tech regional laboratory of renewable energy that has allowed us to introduce a new general field of research connected to the newest technologies of renewable energy and biomass acquiring and environmental microbiology. The studies deal with methane fermentation, biogas analysis, molecular biochemistry, evaluation, treatment and the utilisation of post-fermentation sludge and use of algae for oil and biomass production.

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