



**DEVELOPMENT
STRATEGY OF
THE INSTITUTE OF SOIL SCIENCE
AND PLANT CULTIVATION – STATE
RESEARCH INSTITUTE IN PUŁAWY
UNTIL 2030**

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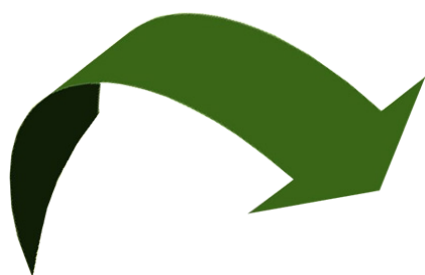
Puławy 2021

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*"A company's position is determined by its intellectual capital,
which is the difference between its market value and its book value"*

Jan Chadam



I. INTRODUCTION

The Institute of Soil Science and Plant Cultivation in Puławy was established in 1950. This institution, which currently has the status of a state research institute of the Ministry of Agriculture and Rural Development, refers to the rich tradition of the Puławy Centre of Agricultural Sciences, which dates back to 1862, when the Polytechnic and Agricultural-Forestry Institute was established in Puławy. It was replaced in 1869 by the Institute of Farming and Forestry which operated until 1914 and taught in Russian. The scientific research conducted by the Institute included soil science, agrometeorology, technology of soil and plant cultivation, and phytochemistry. In 1914, after the outbreak of World War I, the university was evacuated to Kharkov. In 1917, on the initiative of Professor Kazimierz Rogoyski, the Scientific Institute of Farming was established with its seat in Puławy, which started its activity in 1918. After the Polish-Bolshevik war in 1921, the name of the unit was changed to the State Research Institute of Rural Husbandry (PINGW), which was the only agricultural institute in Poland. However, PINGW had its organisational units all over the then territory of the Republic of Poland. During the Second World War II (1939-1944) by virtue of the decision of the occupying German authorities the Institute was transformed into the Agricultural Research Institute of the General Government. After the end of the Second World War, until 1950, the Institute continued to function as the PINGW, but in 1945, by a decree

of the Minister of Agriculture and Agrarian Reforms, it became the State Veterinary Institute. In 1950, the PINGW was divided into 10 agricultural institutes, i.e:

- ➔ Institute of Plant Breeding and Acclimatization in Puławy, later in Warsaw (Radzików);
- ➔ Institute of Soil Science and Plant Cultivation in Puławy;
- ➔ Institute of Land Reclamation and Grassland Farming in Falenty;
- ➔ Institute of Plant Protection in Poznań (with a branch in Puławy);
- ➔ Institute of Pomology in Skierniewice;
- ➔ Institute of Zootechnics in Kraków;
- ➔ Institute of Mechanisation and Electrification of Agriculture in Warsaw;
- ➔ Institute of Agricultural Economics in Warsaw;
- ➔ Institute of Inland Fisheries in Olsztyn;
- ➔ Central Agricultural Library in Warsaw with a branch in Puławy.

In addition, the Central Agricultural Institute in Warsaw was established to coordinate the activities of all the institutes, as well as to conduct comprehensive work of its own in certain fields.

In 2005, IUNG obtained the status of a state research institute, while in the parametric evaluation of scientific units in 2017, it was given the A category.

An integral part of IUNG-PIB are Agricultural Experimental Plants, which function as regional centres of innovation and progress in agriculture.

Currently, IUNG-PIB, in cooperation with agricultural advisory services, is taking on new challenges that include:

- ➔ regional differentiation of natural and organizational-economic conditions and the state of agricultural production;
- ➔ CAP principles and changes in agriculture;
- ➔ concept of bioeconomy;
- ➔ reduction of adverse impact of human activity on the environment;

- ➔ increase in innovation and competitiveness of agricultural production;
- ➔ implementation of biological and technological progress;
- ➔ improvement of effectiveness of the transfer of scientific results into agricultural practice;
- ➔ regionalisation of support policy and advisory activity;
- ➔ development of alternative activities in rural areas.

Recipients of the results of research and development work carried out at IUNG-PIB are widely understood to be the agricultural sector, government and local government administration and inhabitants of rural areas.



II. MISSION

- ➔ ACT EFFECTIVELY
- ➔ RESPOND TO NEEDS
- ➔ CREATE DEVELOPMENT



III. VISION

Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy is the main heir of the oldest centre of agricultural sciences in Poland. It was the second research unit of this kind in Europe, after Rothamsted (founded in 1843). Thanks to systematic and rational development, IUNG-PIB is a leading scientific institution in Poland. The Institute is also very well recognized in the European research area.

IUNG-PIB's ambition is to further strengthen its position on the national and international arena in the field of basic and utilitarian research. The Institute also intends to strengthen its position in terms of expert potential and opinion-forming influence. Bearing in mind the evolving model of financing science and the need to ensure conditions for its stable development, in the coming years, one of the key areas of activity will be the expansion of the commercial offer.

Rapid development of technical infrastructure and apparatus, necessary to conduct modern research, obliges IUNG-PIB to continuous modernization and

upgrading of its resources. This makes it possible to create attractive jobs for current and future employees. Ensuring appropriate employment conditions is and will be one of the main elements that determine the dynamics of IUNG-PIB's development. Successive enhancement of staff potential and competence is particularly important for the Institute as it bases its functioning on the products of human intellect and thought.

The dynamics of development of modern societies, the agricultural sector and rural areas, will determine the subject matter of the research undertaken. It is assumed that IUNG-PIB will be ahead of mainstream research and development, which involves modification and expansion of the scope of its work.

IUNG-PIB also strives to build the best possible relations with the recipients of the effects of its work and with the general public.



IV. EXTERNAL CONDITIONS

IUNG-PIB operates in a dynamically changing external environment. This process particularly concerns scientific research and the agricultural sector, which is the recipient of the Institute's results. However, the changes taking place are usually orderly and are sanctioned by documents of strategic and implementation nature.

On the international scale, the key document that will affect the work carried out by IUNG-PIB is the UN resolution "Transforming our world: The 2030 Agenda for Sustainable Development". It contains 17 goals of sustainable development, many of which refer to issues related to agricultural production and the impact of agriculture on the natural environment.

The principles of the UN resolution at the level of the European Union are reflected in the New Green Deal strategy. The strategy aims to transform the EU into a just and prosperous society within a modern, resource-efficient and competitive economy that achieves zero net greenhouse gas emissions by 2050 and decouples economic growth from the use of non-renewable natural resources. It also aims to protect, preserve and enhance the EU's natural capital and safeguard the health and well-being of citizens from the risks and negative impacts of environmental change. This transformation must take place in a fair and, at the same time, inclusive manner. A key element of the New Green Deal for the agricultural sector is the Farm-to-Fork strategy and the EU Biodiversity Strategy 2030.

The assumptions of the New Green Deal will be implemented, among others, within the framework of the Strategic Plan, which in 2023–2027

will determine the scope and principles of support for agriculture under the Common Agricultural Policy.

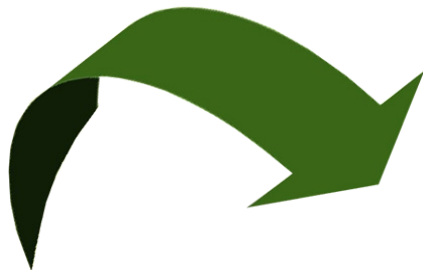
At the national level, the framework for the functioning of IUNG-PIB in the 2030 perspective is largely determined by the Strategy for Responsible Development to 2020 (with a perspective to 2030) adopted by the Council of Ministers on 14 February 2017. The medium-term national development strategy was the starting point for the development of sectoral documents, including the „Strategy for sustainable development of rural areas, agriculture and fisheries 2030“.

The activity and development possibilities of IUNG-PIB depend to a large extent on participation in international and national research projects. European projects are of particular importance in this context. The Institute participates in those, starting from the 5th Framework Programme to the Horizon 2020 Programme at present. However, within the timeframe covered by the strategy, the new Horizon Europe Programme (2021–2027) will be crucial. It was symbolically opened by the European Commission on 2 February 2021. The funds allocated to this programme will be 30% higher than in Horizon 2020. It can be said, therefore, that this will be the most ambitious research and innovation programme in the history of the EU. It will provide scientists with an opportunity to carry out interesting and pro-development research work.

The most important national strategic document, from the perspective of creating possibilities for conducting scientific research and implementing innovations, is the strategy for science and higher

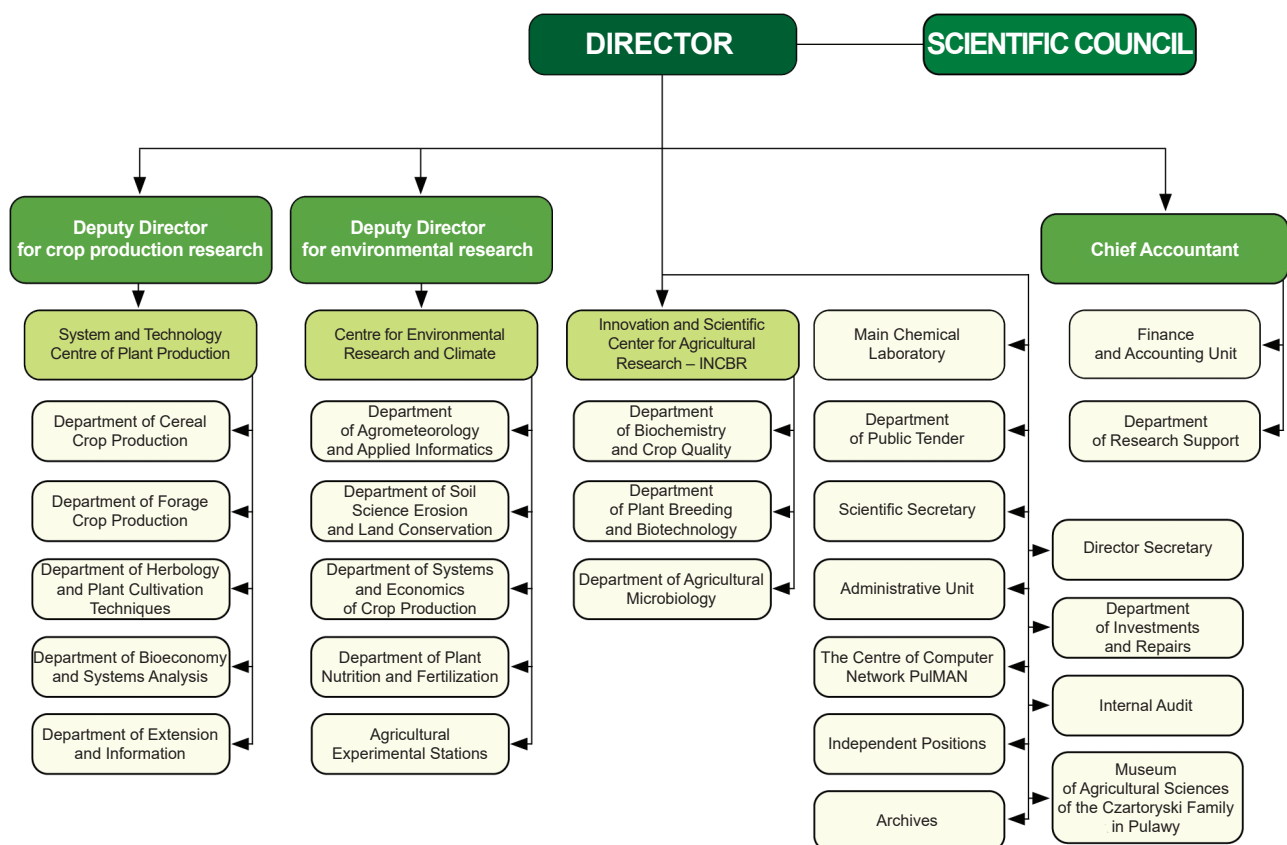
education prepared by the relevant Ministry of Science and Higher Education. It is based on three basic pillars. One of them is Constitution for Science, the next one is Innovation for Economy, which

combines commercialization of research and partnership for business. No less important is the programme of social responsibility of science called Science for You.



V. IUNG-PIB AT PRESENT

1. STRUCTURE



2. STAFF

One of the most important resources available to the Institute is the staff. In this area, the functioning of the "Strategy for the development of scientific staff at the Institute of Soil Science and Plant Cultivation – State Research Institute" of February 2016 is important. It is a guarantee of high quality of personnel employed in the unit.

Since 2016, the Institute has been awarded the „HR Excellence in Research" distinction by the EC based on the HR Strategy developed for the researchers working there. The HR distinction provides traceability to institutions and organizations that create favourable working conditions for researchers and stimulate their development.

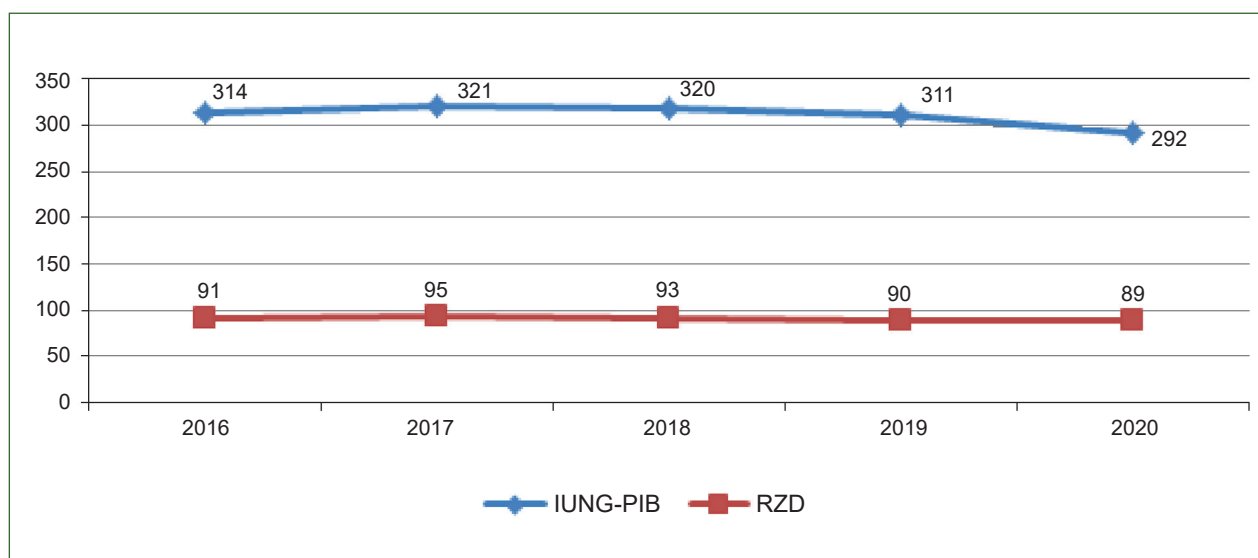


Figure 1. Employment at IUNG-PIB and AES in 2016–2020

From 2016 to 2020, the Institute employed about 300 people, 30% of whom were scientific and research and technical staff (Figure 1). In the AES, employment during this period was 90 persons. It should be emphasized that employment at IUNG-PIB has decreased in recent years.

An important advantage is the favourable age structure of employees employed in IUNG-PIB, 34% of whom are under the personnel employed 40 years of age, while 63% are under 50 years of age (Fig. 2). Employees over 60 years of age constitute 17% of the total. The above data indicate that in the coming years the staff substitution will be smooth and trouble-free.

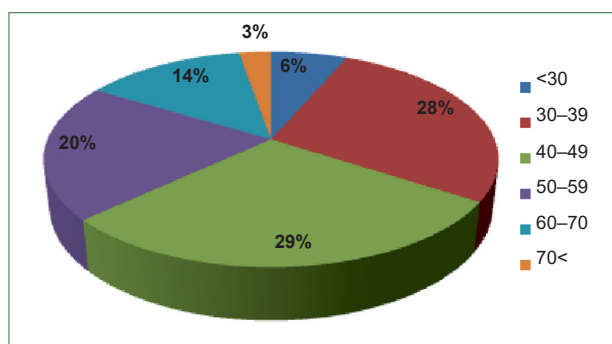


Figure 2. Age structure of IUNG-PIB employees in 2020

3. RESEARCH INFRASTRUCTURE

The Institute has a modern research infrastructure. In 2015, the Innovation and Scientific Center for Agricultural Research – INCBR in Pulawy was put into use. The Centre is equipped with state-of-the-art scientific and research apparatus that enables the scope of research conducted at the Institute to be extended and makes IUNG-PIB's offer more attractive. The purchase of specialist equipment has had a positive impact on the ability to carry out comprehensive studies and analyses and has significantly shortened the time needed to obtain results. The potential to

establish cooperation with other research units and businesses has also increased, which has created conditions for increased activity in applying for funds in international and national project competitions.

In addition, the Institute has infrastructure and advanced instrumentation for conducting vegetation experiments, which include phytotrons, specialized greenhouses, a vegetation hall, and apparatus for measuring and monitoring field experiments.

4. AGRICULTURAL EXPERIMENTAL STATIONS (AES)

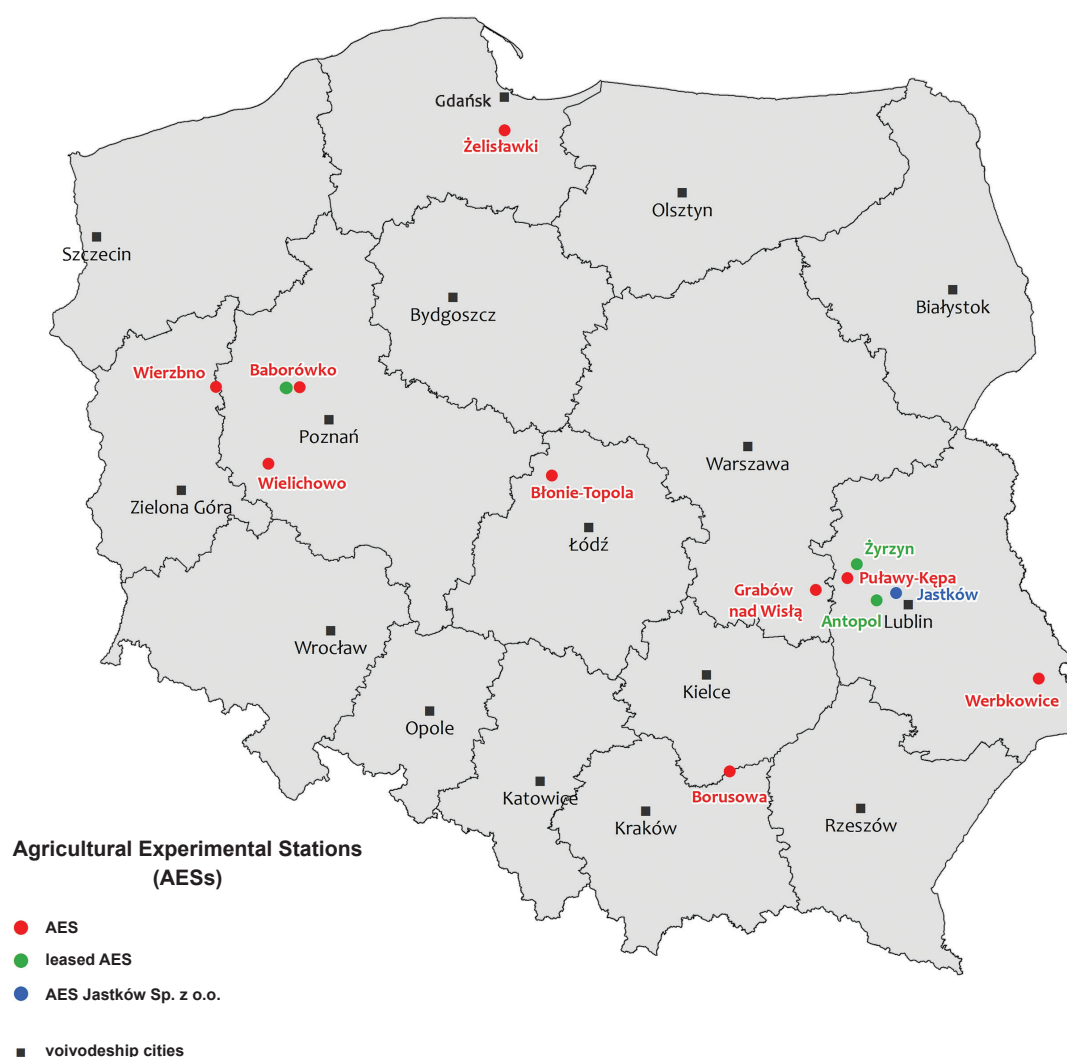


Figure 3. Location of Agricultural Experimental Stations of IUNG-PIB

Agricultural Experimental Stations (AES) are an integral part of the Institute. Currently, there are 11 AES within IUNG-PIB, including 2 leased and one operating as a commercial company. AES of IUNG-PIB are located in different regions of Poland (Fig. 3).

Agricultural Experimental Stations conduct agricultural production in different climatic and soil conditions and are diversified in terms of area. They also conduct field

experiments, adaptation and implementation work, and test new technologies and innovative solutions.

AESs fulfil the role of centres implementing the principles of good agricultural practice and disseminating achievements of agricultural science. Therefore, an important element of their activity is cooperation with agricultural advisory centres, farmers, branch organisations and local administration.

5. FINANCES

The Institute's financial management is based on the principle of maximising revenue while rationalising and optimising operating costs. In recent years, 60% of the Institute's operating income has been constituted by funds received from the Ministry of Education and Science and the Ministry of Agriculture and Rural Development. In financing the Institute's activities, a large share (20%) is covered by funds from EU projects, the National Science Centre and the National Centre for Research and Development. Funds obtained from orders placed by entrepreneurs are also a significant source of financing the Institute's

activities. IUNG-PIB is constantly making efforts to increase the share of external funding from projects and orders in its income.

The main component of the Institute's operating costs are salaries (40%) and the costs of consumption of materials and energy (24%). Due to the cost-cutting policy pursued, their amount in subsequent years shows a decreasing trend, which allows for redirecting significant resources to research and development activities.

6. ACTIVITY

a. Scientific and research

The scientific and research activity of IUNG-PIB is carried out within the framework of statutory research, research and research and development projects financed from domestic and international sources, as well as long-term programmes/target subsidies from the Ministry of Agriculture and Rural Development.

The Institute conducts research in laboratory conditions, in greenhouses, vegetation halls, on experimental plots and in fields located in Agricultural Experimental Stations and at individual farmers.

The basic directions of the scientific and research activity of the Institute include the following areas:

- ➔ Studies of the genetic basis and the processes and mechanisms that determine the importance and function of plants and microorganisms.
- ➔ Agricultural production technologies and systems.
- ➔ Development and improvement of monitoring systems used in agriculture.
- ➔ Basic functions, use and protection of soils.
- ➔ Support of bioeconomy development.

- ➔ Fertilizer management and assessment of environmental effects of fertilization.
- ➔ Dissemination of research results and implementation of innovations.

The scientific activity of the Institute has resulted in, among others: publications in international and national magazines, numerous popular science studies, dissemination instructions and decision-making support for state and local administration.

b. Expertise

The Institute's employees participate in many expert groups established by state authorities and foreign and international institutions, including: European Commission, World Meteorological Organization, Organisation for Economic Co-operation and Development (OECD), International Organization for Standardization (ISO), Agricultural Economics Institute, Hellenic Agricultural Research Organization „Demeter“, University of Geosciences, European Soil Partnership Eurostat, Wageningen University and Research Centre in the Netherlands, Fertilizer Europe, Ministry of Agriculture and Rural Development, Ministry of Environment, Inspectorate for Environmental Protection, National Centre for Research and Development, National Science Centre, Central Statistical Office, Polish Academy of Sciences, Federation of Agricultural Producers Branch Associations, Polish Association of Cereal Plant Producers, Polish Committee for Standardization.

c. Commercial and commercialization

Commercial activities of IUNG-PIB are mainly focused on laboratory analyses, conducting vegetation experiments, testing the suitability of various preparations for agricultural production and preparing expert opinions. Commodity crop and animal production carried out in AES is also an important element of the market activity.

Commercialization at IUNG-PIB is carried out mainly through technology transfer, which refers to both commercial and non-commercial transfer of technology and the results of R&D work to the economy. IUNG-PIB employs an innovation broker whose main task is to initiate and conduct the commercialization process and cooperation with external entities, particularly entrepreneurs and farmers. The subject of transfer to agricultural practice are research results obtained within the framework of statutory activity, long-term programmes and research projects financed from national and international sources.

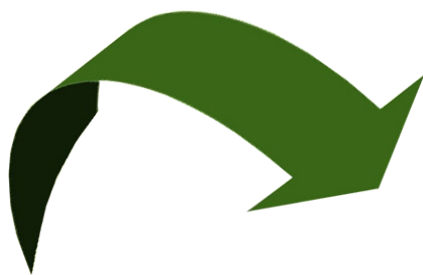
d. Educational

The Institute runs PhD School (jointly with UMCS and IA-PAN), post-graduate and doctoral studies related to the Institute's scientific research and development works, as well as other forms of education, including training and supplementary courses. Moreover, the Institute's employees provide numerous on-going consultations for a wide range of stakeholders. An important element of educational activity is also the participation of IUNG-PIB employees in preparing films, broadcasts and industry interviews.

The Institute conducts formalized cooperation in the field of improving knowledge and qualifications of students of agricultural schools supervised by the Ministry of Agriculture and Rural Development. It also cooperates with universities and higher vocational schools.

Education is also carried out in the form of workshops and conferences and through the dissemination of research results in publications and on the IUNG-PIB website, as well as in social media.





VI. PRIORITY AREAS OF ACTION

1. SCIENCE AND DEVELOPMENT BASED ON ADVANCED IT AND BIG DATA SOLUTIONS

The current development of information technology and electronics provides new opportunities for scientific research. In the field of agriculture, the technological revolution mainly concerns:

- ➔ the use of sensors monitoring the surveyed parameters in the so-called 'on-the-go' mode, i.e. in a fully automatic way during the movement of agricultural machinery. This allows the acquisition of information describing the entire studied site (e.g. field), and not just a random sample;
- ➔ remote sensing – contemporary methods allow for non-invasive monitoring of vast areas with high repeatability of measurements in time and space. Among these methods, satellite remote sensing stands out, which currently allows monitoring of the entire agricultural space of the country and identification of crops, and thus makes it possible, among other things, to forecast crop yield, support water resources management, support activities aimed at prevention of natural disasters or creation of agricultural policy;
- ➔ possibilities of analytical processing of spatial data with unprecedented speed. Technologies, which are used here, are among the fastest growing branches in the IT industry; these are: computing servers and data deposition servers – thanks to them it is possible to carry out calculations combining spatial observations with statistical

information, and the obtained results can be used, among others, in imaging of semi-real state of food production and environment (analyses based on the concept of Big Data and cloud computing);

- ➔ application of artificial intelligence and machine learning in the study of non-obvious relationships occurring in the environment and agricultural production space and detection of anomalies.

All the above solutions are to be applied in the planned Centre of Geomatics for Agriculture. The task of the Centre will be to monitor the entire agricultural production space by means of various methods of collecting and processing spatial and geostatistical information. The results will be made available for the state administration and for commercial purposes: food production and decision support in agriculture. The Geomatics Centre will be an institution mainly supporting research integrating work in scientific departments of IUNG-PIB and departmental research institutes, but also an institution cooperating with other scientific institutions in Poland and abroad. Therefore, priority will be given to establishing cooperation with leading institutions of the agricultural and IT industry, as well as with entities responsible for spatial data collection: ARiMR, KOWR, GUGiK, GUS, ESA(Copernicus), academic networks and supercomputer centres.

2. SMART FARMING/AGRICULTURE 4.0

Global trends indicate an increase in investment in the AgTech agricultural technology sector, including Smart Farming and its integral part – precision agriculture. Digitization of agriculture and automation of farm processes is becoming a necessity due to the escalating problems related to labor shortage in agriculture and the growing global demand for food.

Smart Farming involves the automation of farm processes, in particular the introduction of autonomous monitoring and control systems, giving the farmer the ability to oversee farm processes from a smartphone or computer. The leading ICT technologies in the Smart Farming sector are: Internet of Things (IoT), Big Data and, potentially, Blockchain, using data from direct measurement sensors, low-level remote sensing and extensive databases, including satellite. In the robotics and agricultural machinery sector, the key ICT technologies are machine learning and artificial intelligence (AI) on the software side, and on the instrumentation side, agriculture-specific mobile ground platforms and drones.

IUNG-PIB will actively support implementation of innovative solutions of Agriculture 4.0 in Poland

through involvement in research, implementation and dissemination. The Institute will create a large-scale Living Lab, based on 9 Agricultural Experimental Plants and innovative farms of individual farmers, where research using the latest technologies will be conducted. This research will serve, on the one hand, to evaluate technologies and, on the other hand, will make it easier for innovative companies to test their products in field conditions, which will enable the development of products well suited to the geographical conditions of Poland and to the specific nature of Polish agriculture. At the same time, IUNG-PIB will create a series of Show Fields where the best agricultural practices and technologies will be demonstrated. Show Fields will be available both physically and online for farmers and agricultural advisors.

The Institute will make every effort to create an agricultural innovation centre – AgriSmarHUB, which will be a bridge between innovative entrepreneurs, users of modern agricultural technologies and consulting and science. Moreover, it will stimulate the development of innovative solutions through a modern scheme of commercialization of research.

3. RESILIENT AND SUSTAINABLE AGRICULTURE

Contemporary agriculture undergoes a period of intensive transformations connected, among others, with the search for models of effective management compliant with the idea of sustainable development. In the context of food security and sustainable food systems, the concept of Resilient Agriculture appears. The essence of this approach to agriculture is to maintain balance between food production and responsible use of natural resources, which enables risk management, minimizing threats, ensuring high quality of life and

environment in rural areas. The directions of European Union development referring to these ideas have been outlined in key strategic documents. Their provisions respond to contemporary challenges facing the economy, including agriculture, and set directions for action. In implementing assumptions included in the above mentioned strategies, a significant challenge for the Polish agriculture will be to reconcile economic, environmental, climate and social objectives.

IUNG-PIB, in response to the challenges identified above, will increase activity in research areas focused on the following issues:

- innovative solutions related to the development and implementation of low-carbon in agriculture;
- development and improvement of crop management techniques in order to increase the efficiency of fertilization, plant protection, shaping high quality crops;
- optimisation of the use of environmental resources with the application of digitisation and satellite technologies;
- support of organic farming development.

IUNG-PIB's strategy regarding the discussed issues, apart from research activity, will include a wide range of dissemination activities. Its key element will be Agricultural Experimental Stations implementing new technologies and production systems (low-emission, ecological production methods, concept of sustainable management with closed nutrient cycle, precision agriculture, integrated farm management with the use of IT/digital methods).

Developing technological and organizational solutions corresponding to the assumptions of resilient and sustainable agriculture will require interdisciplinary cooperation of the Institute with other scientific institutions, state administration, agricultural advisors, entrepreneurs and farmers.

4. ENSURING SELF-SUFFICIENCY AND FOOD SECURITY

Agriculture is one of the few sectors of the economy that operates in a natural environment and is fundamental to food security, economic security – by maintaining competitiveness – and environmental security. As a branch of global production, agriculture is one of the initial links in the food chain and, at the same time, a fundamental element of the supply side of the agricultural market.

In the context of progressing trade liberalization and the resulting dangers (among others, sanitary-epidemiological threats), the aspect of ensuring food self-sufficiency of the country is becoming more and more important. Hence, the agricultural policy of many countries is aimed at maintaining agricultural production at the level guaranteeing sufficient supply and enabling agricultural producers to obtain decent incomes.

IUNG-PIB will conduct research and analyses to facilitate the monitoring of processes taking place in agricultural production and in the agri-food sector

in the context of ensuring Poland's self-sufficiency and food security. These analyses will refer mainly to the production potential of plant and animal husbandry. Polish agriculture, due to the diversity of natural, organizational, economic and environmental conditions, is not homogenous. Therefore, studies and analyses will be carried out taking into account regional aspects. The research and expert support will take into account the fact that in the last dozen or so years the agricultural production potential, to a large extent defined by the size of possessed resources of cultivated land and livestock, has been seriously limited.

IUNG-PIB's research and analysis of the production potential of primary and secondary raw materials will provide information that will form the basis for making rational decisions about activities in the bioeconomy area. Using the potential of bioeconomy, including ensuring self-sufficiency and food security, is part of a broad policy of stable economic development of Poland.

5. DEVELOPMENT AND EXPLOITATION OF BASIC RESEARCH

Many scientific works are based on fundamental research. According to the Act of 30 April 2010 on the principles of financing science, fundamental research is: „original experimental or theoretical research work undertaken primarily for the purpose of acquiring new knowledge about the fundamentals of phenomena and observed facts without orientation towards direct practical application or use“. In agricultural sciences, it is particularly important to learn new facts and regularities and to explore the relationships between them.

Basic research is the basis of development and applied research, which is the core of IUNG-PIB's activity. The main activities focus on genetics, biochemistry, biotechnology, microbiology and physiology. Learning and studying basic scientific truths allows us to understand and explain processes occurring both in plants and in the environment as a whole. It concerns plant yields, the selection of species and varieties for appropriate climate and soil conditions, method of soil tillage, and the direction or model of farming. Particularly important are issues of resistance to biotic and abiotic stresses, e.g. increasingly frequent water shortages. In this context, the Institute will develop physiological research combined with the recognition of the genetic background conditioning specific plant responses.

Basic research at the Institute is conducted using state-of-the-art research methods and techniques. This includes the use of cell and tissue cultures, cytometric studies and a wide range of molecular markers. An important and, at the same time, priority direction is sequencing, which provides the possibility of reading subsequent nucleotides in nucleic acid molecules. The most innovative method is the next generation sequencing (NGS), which together with bioinformatic methods is a tool used for sequencing genomes and transcriptomes, studying protein-DNA/ RNA interactions, checking the degree of methylation, and also for metagenomic studies. This work concerns plants, pathogens, microorganisms, especially soil microorganisms, and is a strategic direction of research carried out at the Institute.

Research conducted at the Institute in the field of phytochemistry, in which tools are used to identify plant compounds and to determine their structure and properties, allow direct translation of basic research into applied practices. Their results can be used in medicine, plant protection and food production.

Thus, basic research carried out at IUNG-PIB combines gaining new knowledge on the fundamentals of phenomena with their practical use to create progress in agriculture.

6. BIOLOGICAL AND TECHNOLOGICAL PROGRESS

Biological progress that consists in genetic improvement of plants in order to intensify agricultural production by increasing the utilization, nutritional, fodder or technological value of the obtained yield and by increasing resistance to biotic and abiotic stresses will be the research priority of IUNG-PIB.

Its implementation is connected with the development of bioinformatic methods. Breeding works carried out at IUNG-PIB concern mainly hops and tobacco but it cannot be excluded that this activity will be extended to other species of crops. Genetic potential of new varieties can be fully utilized only under optimal

conditions, therefore, it is necessary to maintain and develop research on agrotechnology of cultivated plants.

An important area of the Institute's research is the qualitative evaluation of plant raw materials for food and feed industry. The use of modern techniques of quality assessment, such as metabolomics, will allow us to understand the relationship between the chemical composition of plant raw materials and their pro-health properties. Knowledge of the full structure of bioactive compounds with health-promoting properties and their biosynthesis in plant varieties and species under different environmental conditions is and will be one of the research priorities.

The quality of plant raw materials is also related to plant protection. The drive to reduce the use of plant protection products has prompted increased work on the use of natural plant substances and microorganisms to control agrophages. Natural plant substances used in plant protection have a broad spectrum of action, but their effect is short-lived due to rapid degradation by microorganisms.

Particular attention should be paid to the study of metagenomes of various soil-climatic and cultivation environments and endophytic bacteria colonizing plant tissues, as well as mechanisms by which they interact with plants. These associations have a direct effect on the increase of soil fertility, production of growth stimulators and free nitrogen fixation, but also may be one of the factors of biological protection of crops.

Plant protection is connected with technological progress based on real-time monitoring of pest occurrence. In this respect, the Institute will begin cooperation with entities responsible for specific monitoring systems, and will also increasingly develop monitoring systems at its own experimental facilities. This involves the development of remote methods for crop condition monitoring and IT technologies. These tools will serve the state administration, agricultural advisory units, scientific institutions, trade organizations and farmers.

Works in the area of biological and technological progress will be carried out mainly through multi-sector scientific and research projects implemented in cooperation with all stakeholders.

7. RATIONAL USE OF NATURAL RESOURCES

From its beginnings, agriculture has been based on the use of natural resources, which, combined with human labor, have been the main factors limiting the volume of production. Agriculture makes use of resources such as land, water and air, but also affects them to some extent. Achieving high yields inevitably involves a decrease in soil macro- and micronutrient richness, as well as soil acidification and loss of organic carbon. Replenishing these elements of soil fertility and abundance requires the use of large amounts of fertilizers and other production inputs, which contributes to further exploitation of natural resources. Increasing average temperatures causes evapotranspiration to exceed precipitation totals, resulting in a lowering of the groundwater table and the occurrence of increasingly severe droughts. Agriculture is one of

the main consumers of water, which is becoming its key limiting factor. Also, changes in the atmosphere, mainly an increase in CO₂ content, are not indifferent to agricultural production. Therefore, a key aspect of agricultural production has become the need for its sustainability, primarily by reducing the negative impact of agriculture on the environment, but also by maintaining the productive potential of agricultural land.

The Institute will conduct scientific research and analysis that will enable sustainable development of agriculture, which will make more rational use of environmental resources. The greatest effort will be made to protect and maintain the quality and productive value of soils. It is particularly connected

with rational management of nutrients and maintaining the appropriate content of organic matter. Equally important will be the definition of principles and methods for effective use of scarce water resources. Another area of work conducted at IUNG-PIB will be to determine the possibility of using agricultural by-products for energy production, especially in the process of biogas and biocarbon production.

Taking into account the needs identified earlier, the rational use of environmental resources by agriculture will involve not only producing a satisfactory yield, but also exploiting the sector's potential

in carbon sequestration, storing and improving water quality, and improving air quality. The Institute's role here will not be limited to making recommendations for the best possible natural resource use practices. The research will also aim to identify practices that increase the potential of natural resources by enhancing and making better use of related ecosystem services. Long-term monitoring of the effects of the undertaken practices on soil, water and air quality, but also on production potential and biodiversity will also be implemented. It will also aim to assess the potential for rational resource use under changing climatic conditions.

8. CLIMATE ACTION

The area of research related to climate action covers both the topics of mitigation and adaptation to climate change. These activities are based on many years of field experiments conducted at the Institute, model tests with the use of simulation models and climate scenarios, as well as survey research. IUNG-PIB has also significant potential in monitoring works for the benefit of climate actions. Another area of Institute's activity in this field is expert work connected with creating strategies of mitigation and adaptation to climate changes on different levels: local, national, European and global.

It is important to emphasize that in recent years the expectations and requirements for research related to the assessment of climate impacts on agriculture have increased significantly. Therefore, long-term field experiments providing data to feed simulation models will be retrofitted with new monitoring systems, and the observations made will be more detailed and enriched with elements such as measurements of greenhouse gas emissions.

Modeling the impact of climate change on agriculture requires the application of compiled simulation models and the use of large databases. Therefore, it is necessary to maintain personnel and equipment

capacity that ensures continuity in the implementation of modeling studies and the creation and updating of climate databases.

Climate research has a significant practical dimension arising from the need to adapt recommendations to the needs and opportunities of agriculture in Poland. Therefore, it is necessary to cooperate closely with advisory services, agricultural organizations and innovative farms. Another aspect related to the agricultural practice is supporting manufacturers of means of production for agriculture in the assessment of effectiveness of new solutions – both products and technologies – in the context of reduction of GHG emissions reduction and increasing the effectiveness of these means.

With the observed increase in agricultural losses due to climatic factors, the requirements for monitoring of adverse climatic events increase. Therefore, it is necessary to include satellite data into all monitoring programs of the Institute. Implementation of such works requires validation of the obtained data in the field, which will be connected with increasing of the Institute activity in this area.

In addition to research and development activities, it is very important to build up an expert capacity that will actively participate in the development of climate policies and their monitoring at both global and national levels. It is important to have econometric

models and multi-criteria evaluation of proposed climate regulations in order to continuously evaluate the effectiveness of the already implemented climate actions as well as those proposed for the future.

9. BIODIVERSITY CONSERVATION

Loss of biodiversity is one of the most important problems of the contemporary world and a threat to our civilization. The requirement to protect and sustainably use natural resources stems directly from the Convention on Biological Diversity, which Poland ratified in 1995. In addition, EU documents published recently: The European Green Deal, the EU Biodiversity Strategy 2030 and the Farm-to-Fork Strategy aim to restore Europe's biodiversity for the benefit of the people, the climate and the planet. Agriculturally used areas in Poland, covering about 60% of the country's area, are an important refuge for many valuable species of flora and fauna, including those threatened with extinction. This is facilitated by the varied landscape and low-intensity farming on a considerable area of our country. Maintaining a high level of biodiversity makes agricultural production and related activities more sustainable.

Strengthening the position of IUNG-PIB in the national and international arena in terms of research supporting organic farming and the transfer of knowledge from science to consultancy and agricultural producers is one of the priority actions of the unit in the perspective of 2030. It will be implemented by acquiring new projects on organic farming, expanding cooperation with

the socio-economic environment and implementing research results into agricultural practice. The Institute will provide substantive support for farmers farming in the organic system, e.g. by developing the network of Organic Varietal Experimentation (EDO), participating in the creation of demonstration and pilot farms and conducting training. The Institute will also continue work on quality assessment of plant raw materials from the organic system, which is one of the elements of food security.

One of the main factors affecting the biodiversity of agricultural ecosystems is the way in which land is managed and used. It has been shown that intensive agriculture, using significant amounts of industrial inputs, contributes to the reduction of species diversity and abundance of flora and fauna. Therefore, the Institute will work on sustainable agricultural production systems that aim to reduce the use of industrial inputs (mineral fertilizers, plant protection products). In response to the challenges of the EU Biodiversity Strategy 2030, we will monitor the diversity of selected groups of organisms on agricultural land and study soil microbial diversity. Testing of biological preparations for organic and integrated farming will also be an important research activity of IUNG-PIB.

10. PUBLIC GOODS

An important research topic undertaken at IUNG-PIB is public goods related to agriculture and methods for their valuation. Therefore, greater involvement of the Institute in conducting research in the field of valuation of biodiversity and ecosystem services (public goods) is assumed. Agriculture, apart from its production functions connected with food production, also fulfils non-production functions consisting in providing society with public goods. Contemporary agriculture faces the necessity of reconciling production and ecological goals. In line with the European Green Deal, the EU Biodiversity Strategy 2030, and the farm-to-fork strategy, agricultural production should take place in harmony with nature. Agricultural ecosystems are the basis of life and all human activities. The products they provide and the functions they perform are essential for maintaining human well-being as well as future economic and social development. Agriculture that applies environmentally friendly farming methods contributes to the preservation of ecosystems of great diversity, which provide many so-called ecosystem services of a supplying, regulating, supporting and cultural nature (e.g. provision of drinking water, pollination of crops, biological control of agrophages, prevention of erosion and

extreme phenomena). IUNG-PIB will conduct comprehensive research on environmentally friendly agricultural production systems in terms of their fulfilment of productive, economic and social goals (provision of public goods).

Until recently, ecosystem services were public goods that were not considered market products and had no price. The lack of valuation has been a major cause of ecosystem degradation and biodiversity loss. On the other hand, the economic valuation of public goods is complex, subject to error, and requires improvements in methodology. Reports published by the EC indicate negative trends over time in EU countries regarding the quantity and quality of ecosystem services provided. This clearly indicates the importance of the problem and the need for research in this area at different levels and scales and the implementation of standardized valuation techniques. IUNG-PIB will conduct work on these issues in interdisciplinary teams, in cooperation with other institutions, taking into account the indicators proposed by the European Environment Agency (The Common International Classification of Ecosystem Services - CICES).

11. BIOECONOMY AND CIRCULAR ECONOMY

Bioeconomy, or biomass resource management, like other areas of the human economy is to strive for circularity, low-carbon in the overall model of implementing environmental, social and economic sustainability of processes. An important element of the bioeconomy is the implementation of circular economy principles. Research related to the bioeconomy has, so far, focused at the Institute on the issues of assessment of production potential and logistics of biomass utilization for food and feed production, as well as for non-food purposes. The development of research potential to support the development

of the bioeconomy is linked to the implementation of the BioEcon project between 2015 and 2020. This project aimed to bring together competencies related to research in support of the bioeconomy in different scientific departments of the Institute and to gain the ability to conduct research using econometric models for decision-making using multi-criteria methods. The project was carried out in an international team, which built a network of institutional links at different levels and established collaborations with many scientific units.

As the internal and external conditions of agricultural operations change, further refinement of analyses of biomass production potential is necessary. Information services maintained by the Institute that present research results through geographic information systems have and will continue to play a special role. A new research direction developed in the BioEcon project is the tracking of biomass flows and values between sectors and the monitoring of the entire bioeconomy sector.

As the bioeconomy is characterized by a sustainable and holistic approach to agricultural production processes, there is a need to maintain and develop a team dedicated to models for describing biomass flows, sustainability, and the carbon footprint of processes and products. In order to conduct this

research, detailed data on farms in Poland as well as data from other market sectors are needed.

The development of bioeconomy and circular economy determines spatial relationships in the environment, therefore it is important to conduct research related to rural land use. In these studies it is necessary to use both satellite methods and monitor changes using to land use in rural areas methods. The concept of bioeconomy includes the development of agroecology, both in terms of rural spatial planning and new production systems in agriculture, such as agroforestry. A comprehensive approach to the development of bioeconomy and circular economy requires the use of multi-criteria methods in the process of decision-making about the directions of development of this sector.

12. SUPPORTING PUBLIC POLICIES

The dynamic development of contemporary societies results in the emergence of new challenges that require collective action. This problem is answered by public policies that are created at the national or international level. An example of this is a number of public policies implemented by the European Union. As a rule, their creation should be based on the current state of knowledge and their design and implementation should be a systematic a well-structured process.

Therefore, the aim of IUNG-PIB is to use research results, know-how and expert potential of the unit to support and coordinate activities aimed at improving the quality and effectiveness of public policies. The scope of Institute's activities will mainly refer to creating, designing, implementing and evaluating strategic, program and legislative solutions concerning agricultural sector. The Common Agricultural Policy of the European Union is of particular importance

in this context. Scientific and development work undertaken by IUNG-PIB will focus on the needs and problems connected with planning and implementing this policy both at the national level and for the entire EU. The Institute will also support other public policies such as: climate and energy policy, environmental policy, cohesion policy, regional policy or innovation policy (smart specialisations). The support provided by IUNG-PIB will refer to all stages of public policies implementation, starting from ex-ante evaluations, through on-going to ex-post evaluation. Using its potential, the Institute will evaluate the relevance, efficiency, effectiveness, usefulness and sustainability of public policies.

The aim of the work will be to increase the use of research results and the expert potential of IUNG-PIB in creating public policies in accordance with standards of *science informed policy making and evidence based policy*.

13. EDUCATION AND IMPLEMENTATION OF INNOVATIONS

Education is one of the Institute's statutory activities. IUNG-PIB employees carry out all types of education: formal, informal, self-education and incidental education. Educational activities favour the presentation of IUNG-PIB achievements and the perception of its employees as professionals and experts in their fields. The Institute conducts higher education at third level as well as postgraduate studies and thematic courses. It also carries out a number of scientific and development projects related to education. The key forms of knowledge dissemination are conferences, seminars, symposia and publishing activities. Institute employees participate in local, regional, national and international events, sharing their knowledge and achievements. This type of IUNG-PIB activity is in high demand, so it will continue.

One of the main goals of education carried out at IUNG-PIB is, and will be, the implementation of innovations, which in turn are a driving force for development. This is possible thanks to the high qualifications of the Institute's staff. Innovations will be implemented, among others, through projects involving multi-sectoral cooperation, e.g. the „Cooperation” measure of RDP 2014-2020 and its successors in the CAP Strategic Plan. IUNG-PIB's educational activities will respond to the needs of the market and the recipients of its research and will be closely related to the challenges of agriculture and

natural resources protection. Very good cooperation with IUNG-PIB partners in Agricultural Knowledge and Innovation System (AKIS) stimulates processes of creating innovative solutions.

An important role in stimulating the innovation process, as well as in developing and strengthening the Institute's network of contacts, is played by the interdisciplinary Technology Transfer Office (TTO) and innovation brokers.

The key units through which the innovations are implemented are the 9 Agricultural Experimental Plants of IUNG-PIB and the company AES „Jastkow”. Their decades-long activity in various regions of the country makes it possible not only to conduct field experiments, but also to establish relations with local authorities and local stakeholders. Cyclical events presenting the Institute's and AES' activities have become a permanent feature in the calendar of industry events, and for this reason, they will be continued.

Agricultural activities of the AES and the innovative agricultural practices they implement provide a basis for effective educational and dissemination activities. Its inseparable element is close cooperation with, among others, public administration units, agricultural consultancy, enterprises, farmers, schools and universities.

14. EFFECTIVE MANAGEMENT ADAPTING TO CHANGING CONDITIONS

Management of IUNG-PIB will be focused on the balanced development of basic and utilitarian research and implementation of innovations. Equally important will be appropriate management of the processes

of commercialization of research results and market activity of the Institute. Internal management processes of the unit will be primarily focused on people. The Institute's goal is to create and develop the best

possible working and pay conditions for its employees. An important element in this aspect is access to the latest research equipment and knowledge resources. Management processes will also focus on improving the recognition and competitiveness of the IUNG-PIB brand as a scientific unit, think-tank and business partner. Implementation of the above objectives will be combined with efficient financial management of IUNG-PIB based on optimization of the relationship between costs and income. Effective management will be supported and improved by using the latest achievements in IT and artificial intelligence.

The management of IUNG-PIB will be based on the 3W model, the elements of which are: demanding, supporting and linking activities on the basis of feedback. Therefore, employee participation in the management of the unit is assumed. This will be achieved by increasing the efficiency and capacity of communication channels. Equally important will be the mutual support of employees in the implementation of the established objectives. The adopted model of management is connected with broader delegation of authority, but in connection with responsibility for decisions taken and effects of task realization. Therefore, the Institute's functioning will be based on Management by Objectives (MBO),

where a constant process is defining new, important tasks. Once they are submitted for realization, they will be monitored and their realization will be evaluated. The assessment of the effects of achieving the objectives will be the basis of the motivational system implemented mainly through the payroll policy. The effectiveness of work will also determine the direction and dynamics of the professional career advancement promotion path.

According to the adopted system of organisational styles, IUNG-PIB will be a „green“ unit. Despite maintaining a hierarchical structure, employees will be constantly motivated to develop and strengthen their responsibility for carrying out the tasks entrusted to them. The key elements of such an organization will be respect, equality and good social relations. It is assumed that in the second half of the period covered by the Strategy, the Institute's model will evolve towards a „turquoise“ style. The main features of this style are self-organization and self-management, which are based on full trust, responsibility and partnership.

The main objective of improving the management model is to improve the efficiency of work and its quality.

