Justification

of the position of the Committee on Agronomic Sciences of the Polish Academy of Sciences on modern plant phenotyping

The Committee of Agronomic Sciences of the Polish Academy of Sciences, in its position of April 2, 2021, proposes **the creation of a national infrastructure for phenomic research for modern plant phenotyping**. The justification below is intended to extend this position to include information on the technical and application aspects of this infrastructure. The study of the phenotype of plants, i.e. of traits shaped as a result of the interactive action of the genotype and the environment, is necessary both for understanding plant processes and systems, and for selecting the best breeding creations for agricultural production. It is used to describe the final effect of molecular mechanisms and to evaluate plants in terms of their adaptation to environmental conditions, including their interactions with other organisms. The current rapid development of biological sciences and the growing needs of breeders resulting from the changing consumer needs and progressing climate change require the observation of a wider spectrum of plant characteristics and an increase in the size of the studied populations. This forces the development of new measurement methods, changes in the method of conducting experiments and increasing the capacity of the instruments. On the other hand, phenomics is more and more closely related to genomics and molecular biology as well as to environmental research (including meteorology and climatology), which results from the necessity to interpret certain phenotypes against the genotype and plant environment. All this means that technologically advanced tools are increasingly used for plant phenotyping. The new solutions are used to conduct experiments in controlled environmental conditions or in carefully monitored natural conditions. Phenotyping is carried out by non-invasive methods, which allows the observation of the course of natural development processes over time. Thanks to the introduction of modern devices that allow the detection of physico-chemical parameters, it is also possible to monitor processes that were previously impossible to observe.

Technological progress in the field of plant phenotyping devices concerns, among others, experimental fields, which, in accordance with modern requirements, should be equipped with environmental conditions monitoring systems, and some of them also with devices allowing for the simulation of biotic and abiotic stresses or phenotyping of root systems. Research infrastructure is also being developed for greenhouses and breeding chambers, in which it is possible to provide programmed plant growth conditions independent of the external environment. Both fields and closed installations are equipped with

phenotyping instruments using imaging and remote sensing methods as well as sensors and systems for automatically treating plants with the desired stress factors. Imaging (visible or thermal, fluorescent, spectroscopic, 3D or computer tomography), under closely monitored environmental conditions, in modern greenhouses or fields, concerns above-ground or underground parts of plants. It is possible to precisely determine the growth dynamics, morphology, anatomy, biomass, the degree of tissue damage under the influence of stress factors (biotic and abiotic), physiology (including photosynthesis efficiency) and many other properties. Information is obtained about the tested plants throughout the growing season, at each stage of development, avoiding their destruction - unlike traditional observation methods.

The cost of the equipment required for the phenotyping of plants in modern terms generally exceeds the capabilities of individual research units or enterprises. Therefore, the cooperation of individuals interested in phenotyping is very important. National cooperation may be developed within a network or consortium of scientific and industrial units established for this purpose; international cooperation should be carried out within the ESFRI EMPHASIS infrastructure (European Infrastructure for Plant Phenotyping, https://emphasis.plant phenotyping.eu).

It should be noted that the activities covered by the opinion of the KNA PAN are consistent with strategic documents such as the Strategy for Responsible Development until 2020 (with a perspective until 2030) and the list of National Smart Specializations (NSS 2. Innovative technologies, processes and products of the sector agriculture and forestry, Division I.2. Genetic research, breeding works, molecular and biotechnological methods as well as alternative production directions allowing to obtain high-quality plant and animal raw materials). The issue of the development of plant research, and in particular modern phenotyping as important part of these activities, is important both for basic research and for applied research aimed at providing plant products of appropriate quality and in quantities expected by the state economy. Direct recipients of knowledge about plants are such sectors of the economy as plant breeding and seed production, and indirect recipients are sectors of agriculture, food and biotechnology, environmental protection and engineering, landscape architecture, renewable energy production, pharmacy, construction and textiles. Therefore, the activities will be conducive to increasing the innovation of scientific research and the knowledge-based development of many branches of the economy. They will also stimulate progress in the field of robotization, sensorization, automation and digitization of research in various areas. They will force the development and implementation of solutions ensuring the possibility of automatic data collection, analysis and interpretation, including bioinformatics solutions for the processing of large data sets operating in the Internet environment. Thus, they will contribute to ensuring that both science and food production in Poland can effectively compete with highly developed economically countries.