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Modern Engineering and IT Methods in Agriculture

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The agro-industrial complex takes an important place in the economy of each country. It is a socially significant sector, which accounts for almost a fifth of the country's GDP, about 20% of fixed assets, almost 30% of all employees of the national economy.

It plays the leading role in supplying the population with food and in the production of raw materials for the food and partly light industry. Approximately 2/3 of the retail trade turnover in the Republic of Belarus is made of agricultural products and goods made from agricultural materials. Agriculture is designed to fulfill three major tasks: first, to provide the country's population with high-quality food; secondly, to supply the food and light industry in sufficient quantities with the necessary raw materials; third, to preserve attractive landscapes as a living space, a territory for resettlement of people, the creation of recreation areas, zones for the development of agritourism.

Analysis of the most important indicators of the development in modern agriculture indicates positive trends in the agro-industrial complex. Belarus has become not only self-sufficient in the food supply but also an export-oriented country. The amount of agricultural products in total exports increased from 13.4% in 2010 to 16.7% in 2015. Agriculture has become a high-tech area. Traditional peasant labour in countries with advanced agriculture is being replaced by the latest information technology and biotechnology. Automation

of the main technological processes of agricultural production in Belarus made it possible to increase labour productivity in agriculture by 1.4 times over the five years; 1,184 dairy complexes were commissioned and technically re-equipped. A large-scale modernization of industry and agriculture has been carried out. For these purposes for 2011–2015 more than $ 40 billion were invested. The modernization of production has made it possible to significantly reduce the costs of agricultural production. Also, new technologies will help increase yields and, as a result, increase revenue. Phenotyping methods can become one of the solutions in modern agriculture. Phenotyping or high- phenotyping (high-throughput phenotyping), shows significant progress and has great potential in recent years for all areas of fundamental and applied plant biology. Its development led to the formation of " plant phenomics " - a fundamental section of plant physiology, which concentrates on identifying the patterns of formation, organization and change of plant phenotypes (a set of phenotypes) in relation to the influence of external factors, characteristics of the genotype, patterns of gene expression and the functional manifestation of proteins [2].

The emergence and formation of plant phenomics are directly related to the progress in the registration of digital images and the development of computer and systems biology. Therefore, much attention of physiological researchers is directed to the improvement and further development of phenomic platforms, sensors, robotics, as well as software at all stages of phenotyping. The availability of obtaining, analyzing, storing and processing digital RGB images formed the basis for the creation of the first phenomic platforms – software and hardware systems adapted for specific experimental needs. Coming out of the RGB range, i.e. visible part of the spectrum of electromagnetic radiation, in recent years has further expanded the possibilities of phenotyping.

The most popular phenomic platforms are LemnaTec (Germany), The Photon Systems' Instruments' (Czech Republic), Qubit Phenomics (Canada), Phenomix (France), Phenospex (Australia), of Delta - T Devices' Ltd . (The United Kingdom), WPS (Netherlands), WIWAM (Belgium), and VBCF (Austria). They account for almost 100% of the phenomenal equipment. Phenotyping software is very diverse and constantly adapts to new tasks. An overview of software products and solutions for phenomics is provided by the Plant Image Analysis portal [1]. At the beginning of 2020 this Internet resource presents more than 200 computer programs and 30 databases for conducting phenomic research. Corporate systems of large manufacturers have their own closed-source software products. Currently there is an active development of machine learning systems (artificial neural networks) for applications in the field of plant phenomics, which, according to some estimates, in the near future will transform the market for phenomic software and determine the way for further developments in this direction. It is predicted that programs based on artificial neural network technologies will eventually replace classical image analysis systems. Nevertheless, there are no ready-made commercial products based on machine learning systems on the market so far. So at the moment we still need specialists to interpretate the data with “old style” software and make decisions about plant status.

At the moment this equipment is available, and the competitive market makes it possible to receive good offers for its purchase. Current market for basic phenomics hardware, a variety of phenotyping sensors and software is estimated at $ 318 million per year, with a projected increase to $ 2 billion by 2025. Currently the price of a high-performance conveyor-type platform is between $ 5 million and $ 50 million depending on installed sensors and throughput. Fixed platform prices start at $ 0.5 million. These figures are approximate. The real cost of

the complexes will depend on the specific tasks, the degree of automation of the enterprise and the volume of production [2].

As we can see, phenomic platforms are quite promising in terms of increasing farm productivity and cost savings in the long term. The experience of foreign enterprises and research groups can be applied in Belarus. Based on the foregoing, the application of modern technologies can bring to the Belarusian agriculture bigger volumes of production and higher quality products at lower fertilizer amount and personnel costs.

The degree of development of industrialization and the widespread introduction of new technologies unquestioningly lead to the transition of the world to a new digital era. This period is characterized by the rapid development of high technologies penetrating all spheres of our life. If at the turn of the century no farming enterprise around the world used sensor technologies, then by 2025 their use is expected to increase to more than 500 million sensors, and by 2050 – more than 2 billion smart agricultural sensors.

Considering the modern economy of the country and the development of the agricultural sector, the introduction of the technologies described above may be the right step for Belarus. In addition, it is possible to create your own phenomic systems and methods for data processing, which will open up markets for Belarus and make it even more accessible to local consumers.

References:

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