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MODERN ENGINEERING AND IT METHODS IN AGRICULTURE

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 fulfil 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 agrotourism.

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.

In this regard, as well as with the global trends in the consumption of agricultural products, the development of the agricultural area is one of the priority tasks of any developed country.

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 [3, p 191].

The purpose of this work is to assess the prospects for the application of modern engineering and IT developments in the field of agriculture in Belarus.

To achieve this goal, a number of tasks were put forward:

1) Consider modern engineering solutions in agriculture,

2) Consider IT data processing methods applicable in agriculture,

3) Consider the prospects for using these methods in Belarus.

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.

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.

Currently phenomic platforms use an integrated approach, a comb of various methods for obtaining information about the culture and each separate plant, followed by post-processing.

Now progress in the field of phenotyping is associated with the introduction of stationary systems, when plants and cameras are immobilized or only the recording equipment moves. Stationary systems are replacing the classic conveyor systems, in which plants move along a moving belt or rollers. Stationary systems minimize the mechanical impact of plant shaking during movement, which is critical for standardizing measurements. Robots with registration equipment make it possible to apply these methods in the fields. This expands the possibilities of using technical methods [2, p 125].

At the same time there is an improvement in software for the management of phenomic complexes and data analysis. In addition, the possibility of using drones and satellites to track crops at the population level is being actively explored. Fields depend on location, so GIS technology is becoming an incredibly useful tool for precision farming. And by using geographic information technology in agriculture, farmers can display current and future changes in rainfall, temperature, yield, plant health, and more. It also allows GPS-based applications to be used together with smart technologies to optimize fertilizer and pesticide application. Considering that farmers do not have to cultivate the entire field, but only cultivate certain areas, they can achieve savings in money, effort and time [4, pp 84-86].

The basic principle of the phenomic platforms is the collection of data characterizing the morphological and physiological parameters of the phenotype, their processing, and visualization.

Number of registered and analyzed measures depends on the saturation of the phenomic platforms with recording devices - RGB, hyperspectral and thermal /thermal cameras, fluorimeters, 3D scanners, lidars, X-RAY, magnetic resonance, positron emission tomographs, etc. There are both highly specialized platforms, such as DIRT or SmartGrain, and wider ones (LemnaTec or PSI lines) [1, p 105].

After receiving the primary data it should be processed. The purpose of software in this case is to make decisions about real physical objects and scenes based on perceived images.

For these purposes pattern libraries and special algorithms for recognizing specific objects are developed and used. One of the most perspective methods for this purpose is machine learning. The main advantage of using machine learning approaches for plant phenomics is the ability to simultaneously study a combination of numerous parameters and / or factors, instead of analyzing each of them separately.

In this regard, in modern phenomics there is an increasingly active introduction of machine learning approaches for image analysis. The algorithm trains itself to process the information received and on its basis make decisions about manipulating the culture, without writing code for each specific task and parameters [6, p 214].

One of the machine learning methods is neural networks and their narrower direction - convolutional networks used for high-precision image analysis. Machine learning methods are used to solve problems that were previously considered difficult to model. Thus, the system can independently make a decision on manipulating the crop, or give recommendations to personnel, depending on the degree of automation of the agricultural complex.

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) etc. 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 (www.plant-image-analysis.org).

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 interpret the data with “old style” software and make decisions about plant status [5, p 321].

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.

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.

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.

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