Development ways of industrial horticulture in Russia in the conditions of the economy digitalization

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Abstract. The paper considers the issues of introduction of digital technology to one of the key sectors of agriculture, horticulture, due to the need for a speedy increase in domestic fruit production, making high-tech jobs, and improving socio-economic development of rural areas. The main directions of digitalization in industrial horticulture are considered, which is defined as the use of automated systems, robotic equipment, remote control of technological processes at all stages of production, as well as the systematization of the data obtained using special programs. The achievements of Russian scientists in creating the “smart garden” system and the advantages of its implementation in industrial gardens are presented. It is noted that the development and implementation of information technologies will increase the efficiency of economic processes and the competitiveness of the industry as a whole.

1. Introduction

One of the main vectors of future changes in agriculture in the post-crisis economy will be through the introduction of digital and information technologies, which allows talking about global rethinking of agricultural production, especially industrial production, which is used throughout the world.

Industrial horticulture is one of the most promising and investment-attractive branches of agriculture. The modern feature is the intensive gardens, characterized by short fruit trees with compacted plantings and varieties, characterized by rapid fruit production. Such gardens allow getting high yield, profitability and return on capital investment already in the 2nd – 3rd year of planting.

The import substitution policy implemented in the country sets key tasks for the industry - to increase the production of fruit products and increase competitiveness in the domestic and foreign markets.

However, this issue can be solved not only by planting intensive gardens. If until now the main contribution to the growth of efficiency and productivity of industrial horticulture has been associated with the introduction of highly specialized agricultural technologies, special agricultural machinery, the use of fertilizers and herbicides of directed action, at the present stage, breakthroughs in this area are associated with the introduction of advanced technologies, where computer, intelligent, high-precision and information components integrated with the system of “smart” management of production processes are widely used [1].

As you know, the specificity of industrial horticulture complicates significantly the adoption of effective management decisions at each technological stage, which makes it particularly urgent to implement digital technologies as soon as possible.
2. Materials and methods
The theoretical basis of the research was the publications of domestic economists on the development of digital industrial horticulture. Monographic and analytical methods were used as research methods.

3. Results
Digital technologies in horticulture are the basis for the transition to the production concept of “Smart garden”, in which effective management decisions are made on the basis of multi-criteria analysis of multidimensional arrays of information about the objects of the production process (soil, plants, agricultural machines, etc.) and the use of patterns of their interaction [1,3].

The “Smart garden” system covers all aspects of the industry: preparation, execution and control of all technological operations for growing horticultural products using robotic, unmanned machines and aggregates (Fig. 1) [4].

![Figure 1. Block diagram of the intelligent control system of the “Smart garden” system.](image)

This system allows analyzing soil and climate conditions based on big data, determine the location and optimal crops for growing, perform intelligent application of organic and mineral fertilizers, conduct preventive measures to control pests and diseases, as well as conduct economic calculations of the profitability of production and the needs of the population of the region (country, territory, region) [5].

In domestic practice, there have already been examples of using the concept of “Smart garden”. The first pilot concept of “Smart garden” was presented by scientists of Michurinsky State Agrarian University in 2018. The project provides for the creation of a test site with the installation of microscopic sensors (sensors and chips) of contact and contactless action, which will ensure continuous comprehensive monitoring at the local level. This will allow monitoring the condition of each fruit plant (seedling or tree) throughout its life cycle, take into account its need for moisture, nutrition elements, and knowing about the presence of diseases, pathogens and viruses. The widespread use of robotic mobile platforms and manipulators will exclude human participation in most technological operations. Data exchange and management of local monitoring systems, as well as production processes, will be carried out on the basis of the Internet of things, through the use of artificial intelligence [6].

According to the program of the Ministry of Agriculture of Russia “Digital economy of agriculture”, Tambov region is a pilot region. There are 12 specialized horticultural enterprises and three farms in the region, the largest are: JSC “Nursery “Zherdevsky”, JSC “Dubovoe”, LLC “Snezhetok” and LLC AF “Michurinsky gardens”, JSC “Yagodnoye” and LLC “Tambov gardens” and LLC “Yurma+”. A horticultural cluster has been formed here, uniting agricultural producers engaged in the production of fruits and berries, planting material for fruit and berry crops, and processing organizations of the agro-industrial complex [7].

Scientists of the Federal Scientific Agricultural and Engineering Center VIM (FSAEC VIM) developed a system for intelligent management of industrial technologies for cultivating garden crops, which includes three units [8]:

- **Unit 1**: Monitoring the state of horticultural objects (soil, climate, terrain, planting, etc.)
- **Unit 2**: Information and analytical support of agricultural technologies of horticulture
- **Unit 3**: Implementation of control actions under GLONASS/GPS control
1. Unit for monitoring the parameters of the production process, including plant life monitoring systems with a set of sensors (precipitation, temperature and humidity of the surrounding air, soil, total radiation, juice flow sensor).

2. Information and analytical unit for processing and analyzing information received from detectors and sensors about production processes and plant parameters.

3. Unit for implementing control actions that provides for the use of automated and robotic technical means for performing technological operations, including fertilizing and local application of plant protection products that work with satellite positioning systems.

Thus, the adapted production, technological and management system is being created that allows taking the necessary measures timely to maintain the overall health of the garden, taking into account constantly changing conditions and, consequently, to reduce energy, financial and time costs, reduce crop losses and improve its quality.

4. Summary
Currently research on the use of digital technologies in modern industrial horticulture is conducted with varying degrees of intensity in the following areas:
- digital modeling of terrain, topography and preparation of electronic maps of crop yield (quantity and density of the fruit), condition of leaf surface and size of the trees;
- identification and certification of varieties using visual (graphical) parameters;
- high-precision positioning of agricultural units in unmanned mode when laying plantations and caring for plantings: tillage, mowing grass in rows, care for trunk strips, contour pruning, etc.;
- management of production processes of garden crops based on the use of automated control systems and precision farming technologies;
- use of unmanned aerial vehicles for digital monitoring of plantings and crop yields;
- use of robotic technologies in the implementation of technological processes.

Unfortunately, today there are very few high-tech garden farms that keep up with the times and technologies in Russia. Not every agricultural producer has the opportunity to invest heavily in the automation and development of garden farms using the latest technology. Of course, this is due to a lack of funding and investment in the industry. However, as the world practice shows, any innovative technologies will be economically justified as a result, although the costs will not pay off immediately [9 -11]. Our research has shown that the benefits of using digital technologies are expressed in the following indicators (Fig. 2.)

| Indicator                                      | Benefit Level |
|------------------------------------------------|---------------|
| Improving the efficiency of production        | 60%           |
| Cost savings                                  | 40%           |
| Efficiency of fertilizers and plant protection systems | 50%         |
| Reducing manual labor                         | 80%           |
| Reducing the harmful impact on the environment | 40%           |
| Increase in organic production                | 50%           |
| Increase yields                               | 70%           |
| Increased labour productivity                 | 50%           |

**Figure 2.** Advantages of using digital technologies.
Highly efficient, economically and environmentally sound digital technologies are widely recognized in the developed world. Research conducted by foreign expert companies Roland Berger, Goldman Sachs and the University of Nebraska–Lincoln has revealed a high interest among American and European farmers in the introduction of digital precision farming technologies and in the future, interest in them will accelerate. The most popular areas are: agrochemical soil analysis, crop monitoring, differentiated fertilization system, satellite and aerial images [12].

Thus, world practice shows that digitalization in the agricultural sector is becoming a trend and its rapid penetration confirms that this direction is the key to the effective development of modern industrial gardening.

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