

# Improving the process of growing crops through the use of smart greenhouses

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**Abstract.** The article analyzes the use of smart greenhouses as an automated mechanism for growing crops. The article describes devices and digital solutions of the Internet of things used in agriculture, and their role in growing crops. The article specifies the methods that can be used to improve the process of growing crops through the use of smart greenhouses: automation, precision farming, management, protection against drops and temperatures in extreme conditions, and inventory control. The article identifies advantages of smart greenhouses which can improve the process of growing in agriculture: data collection with smart meters, alerting, analysis and prediction of the volume of crops, control of deviations. The methods and recommendations suggested by the authors can help automate the production cycle in agriculture.

## 1 Introduction

Currently, agriculture cannot exist without digitalization. The article deals with the issue of the Internet of Things which can improve and reduce manual labor in crops production. Smart greenhouses are automated structures which can improve the process of growing crops. They include microcontrollers, sensors and applications of the Internet of things (IoT) [1;3].

The Internet of Things in agriculture uses many sensors used to collect data in real time. Farmers rely on smart sensors to check soil moisture content, monitor livestock and crop health, and effectively control drones and farm machinery, mostly in remote areas without full broadband access.

Some inventions in sensor technology; the inclusion of low-power, scaled-down, and disposable tracking solutions, as well as 5G power, that promise better prospects for farmers to incorporate sensor technology into their exclusive environments. IoT technology can help farmers respond quickly to changing environmental conditions, regulatory, staffing, and demand situations, individual or collective.

The work of smart greenhouses consists in the technological process through automatic irrigation, heating, ventilation, air conditioning. In turn, automated sensors provide control

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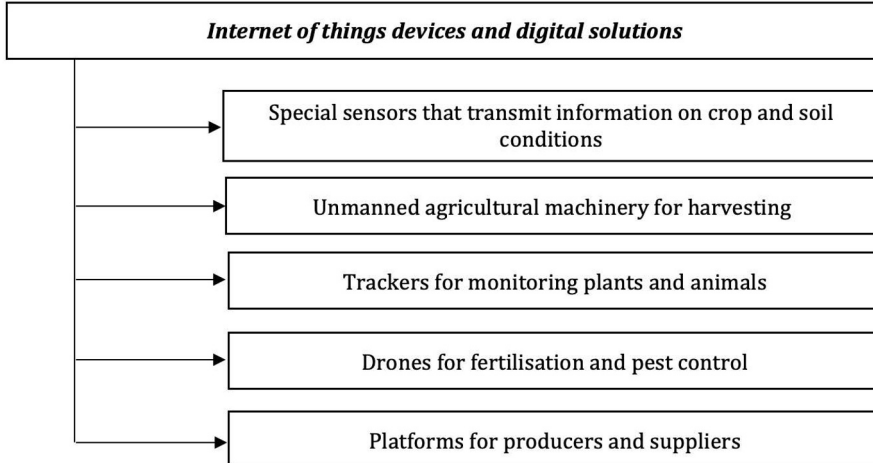
and processing of data on plant growth, watering, pests and lighting. All automated information is stored on local or cloud servers. [5]. The Internet of Things brings together objects and devices connected to the Internet. These devices collect, process and analyze data and transfer it to other applications. IoT devices work autonomously, but users can configure them and provide other users with access to the data they receive. In agriculture, the Internet of Things is useful: farmers use a large amount of data, information comes from different devices: sensors, drones, satellites and other stations included in the Internet of Things system. IoT sensors collect data on the connected devices and automate agricultural processes.

## 2 Materials and methods

Many people may not have noticed, but the IoT has a huge impact on the way we live. Smart cities, networked vehicles, and various innovative industries are all connected in one way or another to the IoT. But when it comes specifically to IoT in agriculture, the Internet of Things will have an even greater impact on the way we live our lives in this area.

After all, by using advanced IoT solutions, farmers will be able to cut their costs decently and increase their output. And it's not just about using fertilizer efficiently and monitoring animal health, but also about optimizing the movement of farm machinery and significantly improving precision farming technology. Let's take a closer look at these solutions.

In agriculture, a variety of devices and digital solutions of the Internet of things are used (figure 1).



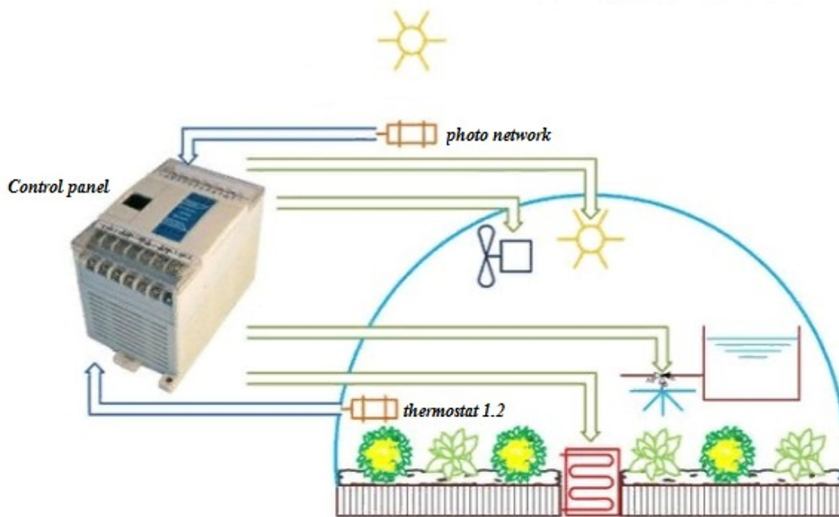
**Fig. 1.** Internet of things devices and digital solutions

One of the largest agricultural companies in the Russian Federation has been using special sensors that transmit information about the state of crops and soil at all stages of crop production (figure 1) [10]: from sowing and growing crops to harvesting [18]. They also control the consumption of fuel and chemicals. For example, a company can use these devices and digital solutions to manage the cultivation of crops without human intervention [2].

Agriculture also needs unmanned aerial vehicles (drones) which help monitor the condition of fields, the type of soil, crops, the amount of water or fertilizer. For example,

drones helped Danish farmers increase their yields by 50%, while Japan has been using software to monitor agricultural land using GPS sensors and webcams for many years [7].

The needs of farmers in agriculture are diverse, and depending on which area of activity different combinations of sensors are possible, such as temperature sensors, humidity sensors, light sensors, acidity and chemical composition sensors, etc. (figure 2) [8].



**Fig. 2.** Sensor control by means of a dedicated unit

Note. The main functions of the control unit:

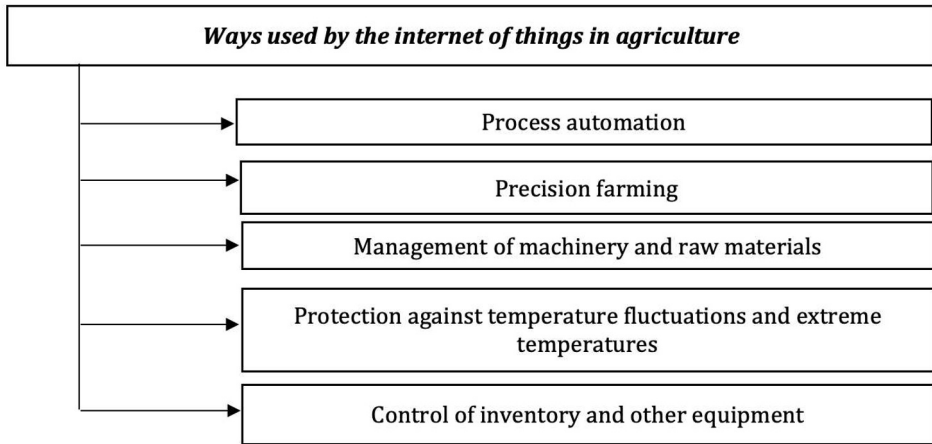
- Heating, ventilation, maintenance of set temperature settings.
- Automatic irrigation morning, evening, weekly, pulse.
- Lighting during dark time of day.
- Day, night mode.
- Flexible programming of any operating algorithms [11].

All of the listed sensors can be connected via wired or wireless networks. In turn, different networks may be used in remote areas, and unlicensed networks may be used for communication.

### 3 Results

At present, it is possible to predict the widespread use of Internet of Things technologies in the agricultural sector, which involves the creation of infrastructure for data transmission networks and the increase in computing resources for collecting, storing and processing data [4]. The IoT-based technologies can transform agriculture: the collected data will help obtain up-to-date information on climate change, product quality, find patterns based on these data, apply scientific processing methods, minimize risks and make business more profitable [6].

The Internet of Things can be applied at any stage: farmers have access to systems, mobile applications and devices that are used to predict the volume of crops and make recommendations. Applications of the Internet of Things in agriculture are presented below [9].



**Fig. 3.** Ways used by the internet of things in agriculture

In the more advanced sectors of the agricultural industry, sensors are used in every stage of the production process and have been incorporated into virtually all types of equipment. Agribusiness experts predict that modern technology could increase global agricultural productivity by more than seventy percent by 2050. [13].

Precision farming technology includes a whole range of techniques for planning and managing crops, monitoring its condition, preparing soil and controlling climate and temperature [12]. Sensors, drones, and GPS devices help farmers optimize operating costs and increase yields by 15-20% [15]. Using precision farming technologies, you can use the land more efficiently: with the help of special precision farming devices, you can determine which crop has the highest yield and which method of cultivation is better; the volume of fertilizers, agrochemicals and water can be reduced through the use of Smart Greenhouses; the number of employees can be reduced due to the recommendations of the system.

GPS and sensors can reduce fuel consumption by 20% and optimize routes and workload on personnel. They are helpful in preventing the rejection of raw materials, tracking their location and weight. They are also useful for businesses that want to prevent fraud [17].

Monitoring software can reduce waste of raw materials due to the suboptimal storage conditions. Special algorithms analyze the state of products in real time (e.g., the temperature regime of storage facilities, humidity levels, carbon dioxide content) and help farmers make decisions based on the data received.

## 4 Discussion

It is advisable to consider the benefits of smart greenhouses for the process of growing crops.

Firstly, it is the collection of data from smart meters [14]. Different sensors transmit information about weather, climate change, soil and crop quality, and livestock health in different parts of the field. The information obtained helps monitor production processes, and evaluate the effectiveness of the technologies and tools.

Secondly, IoT device alerts allow farmers to analyze and predict the volume of crops and plan the distribution of products.

Thirdly, if all devices are correctly configured, they can control deviations at the crops growth stage, which makes it possible to reduce their costs and the amount of waste.

Fourth, today's IoT technology in agriculture aims to fully automate production processes, improving the quality of goods. [16].

Thus, let us specify what we should expect from the listed benefits of the application of Internet of Things technologies for agriculture.

The application of IoT technologies for agriculture primarily increases greater crop yields; better quality of grown crops; identification of factors that affect crop growth and yields; food security. Also through the use of IoT technologies for agriculture reduces transportation costs (human intervention only when necessary); reduces the time spent; the number of dead plants due to diseases or adverse weather conditions; reduces costs by reducing the use of fertilizers, pesticides and consumables.

## 5 Conclusion

Currently, the Internet of things is mainly implemented by large agricultural enterprises: they can deploy a network of IoT devices that help automate the production process and make products better.

It is necessary to emphasize the role of government support: the government should develop and popularize agricultural science and contribute to the mechanization of agriculture.

It is worth emphasizing that one method of solving the problem is the large-scale implementation of IoT in agriculture. In other words, the use of special software and high-tech devices to increase the volume of production and the quality of food. The Internet of Things in agriculture will make the agricultural industry as "intelligent," controlled, efficient, and cost-effective as possible.

## References

- [1] Cherepenin V A, Romanenko I V and Sinyavtsev V V 2022 Systemic design of the information system within the framework of the "Smart greenhouse" biotechnology. *Social Studies and Social Psychology* **8(38)** 449-454
- [2] Nechaev A and Rasputina A 2020 Theory of tax variation calculation. *IOP Conference Series: Earth and Environmental Science* **421(3)** 032010
- [3] Kovaleva V V, Utkina O A and Andrianov A A 2022 "Smart greenhouse" as one of the solutions for growing agricultural plants in closed systems. *Youth vector of agrarian science development. materials of the 73rd national scientific-practical conference of undergraduate and graduate students. Voronezh State Agrarian University* 148-152
- [4] Kokieva G E and Sidorova L V 2022 Creating a smart greenhouse. *Scientific and Technical Bulletin of the Volga Region*. **8** 87-89
- [5] Rasputina A V Nechaev A S and Ilina E A 2021 An analysis of the construction industry and the impact of taxation on its development in the Baltic and Scandinavian countries. *IOP Conference Series: Earth and Environmental Science* **751(1)** 012168
- [6] Giliev S A, Nizamieva A R, Selkov D A and Fomina M E 2021 Device for an automated plant life support system "Smart greenhouse". *Collection of Selected Articles from Scientific Session of TUSUR*. **3** 162-165
- [7] Cherepenin V A 2022 Smart greenhouse biotechnology support information system.

- Science Education. **1(14)** 15-18
- [8] Nechaev A, Antipin D and Antipina O 2014 Financial and tax instruments for stimulation of enterprises innovative activity. *Problems and Perspectives in Management* **12(2)** 173–180
- [9] Grief M G, Belgibaev B A and Umarov A A 2020 Development of a "Smart greenhouse" based on the "Plant-environment-situation-management" model. *Collection of scientific papers of Novosibirsk State Technical University* **3 (98)** 49-64
- [10] Nechaev A and Schupletsov A 2021 Methods for Improving Efficiency of the Innovative Logistics System. *Transportation Research Procedia* **54** 628-636
- [11] Kulmamirov S A and Kalabaev A A 2021 Results of the analysis of the state of development of the smart greenhouse climate control system. *Synergy of Sciences* **59** 224-239
- [12] Krasovskaya O A and Vyaznikov V E 2021 The lending efficiency in the construction industry. *IOP Conference Series: Earth and Environmental Science* **751(1)** 012152
- [13] Zyukin V and Kovacs A A 2021 IoT ("internet of things") technology as an example of assembling and programming a "Smart greenhouse" system. *Sakhalin Education XXI Century* **1** 69-74
- [14] Zakharov S V Ivanov M Y Zakharova E S and Hang L Y 2021 Justification of the need to subsidize small innovative businesses for renting real estate in the context of a new coronavirus infection "Covid-19". *IOP Conference Series: Earth and Environmental Science* **751(1)** 012188
- [15] Kurinka V S 2013 System analysis of the process of temperature control in the "Smart greenhouse" to build a computer model. *Electronic means and control systems. Proceedings of the International Scientific and Practical Conference* **1** 182-185
- [16] Zakharov S V Ivanov M Y Rebrikova A V and Shuiyao X 2021 Special economic zones and the role of construction industry enterprises in their creation. *IOP Conference Series: Earth and Environmental Science* **751(1)** 012187