

# A Brief Analysis of the Role of Internet of Things in Greenhouse Agriculture

-- Take Gaocheng District Modern Agricultural Science and Technology Park as an example

**Abstract:** With the development and popularization of science and technology, Internet of Things technology is gradually applied in the field of agriculture, and shows great potential and bright prospects. This paper takes the application of the Internet of Things technology in Gaocheng Modern Agricultural Science and Technology Park as an example, analyzing the specific functions of IOT in agriculture and the great benefits the technology brings, introducing the background of the application, and giving some solutions to the current problems. The Park focus its attention on the growing of cucumbers and tomatoes. The yield and quality of green plants represented by cucumber and tomato in greenhouses are improved, and the cost of planting and labor consumption are reduced. Thus, the technology provides new ideas and new methods for the development of greenhouse agriculture in the new era.

**Keywords:** Internet of Things, modern agriculture, Gaochen greenhouse agriculture

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## 1 Introduction

The third scientific and technological revolution of mankind has brought earth-shaking changes to the world, and the achievements of scientific research have penetrated into every field of social life. As the primary industry, agriculture plays a vital role in national development and people's happiness. Therefore, the organic combination of the Internet of Things and agriculture has attracted much attention.

The Internet of Things (IOT), as its name implies, is the "Internet where everything is connected"<sup>[1]</sup>, with cloud computing and sensor networks as its core technologies. Previously, the Internet of Things technology, which enables people to command specific objects over the Internet, has shown great advantages in many fields such as smart transportation and smart home. Greenhouse agriculture refers to agriculture operated in plastic greenhouses to obtain out-of-season fruits and vegetables. The application of Internet of Things technology in greenhouse agriculture will certainly bring about new changes in agricultural production.

Significant achievements have been made in the application of Internet of Things in greenhouse agriculture. On the one hand, the production efficiency is improved, the yield of fruits and vegetables is significantly improved, and the quality of fruits and melons is improved. On the other hand, it reduces the labor intensity of workers, makes the agricultural planting process more precise and precise, and reduces the waste of resources. In view of the above advantages of the Internet of Things, in order to better study the application of the Internet of Things in concrete practice, we selected Gaocheng Modern Agricultural Science and Technology Park, obtained visual data through investigation, and analyzed the role of the Internet of Things technology in greenhouse agriculture.

## 2. The background of Internet of Things in greenhouse agriculture

### 2.1 Problems of early application of Internet of Things technology

In the face of new development opportunities, the science and technology park actively introduces foreign advanced technology, and adapts and develops according to the actual situation of the park to meet the needs of practical development. However, due to the late start of the Internet of Things technology in China and the poor comprehensive market environment, there is still a gap between the international advanced level in this field.

The technology introduced from abroad also encountered some problems in application, such as high cost, lack of data model of some vegetables, no movement control version, etc. The technicians overcome the difficulties, reduced the cost of the equipment, established the mathematical model of some vegetables, developed the operation platform suitable for domestic application, and successfully solved these problems.

### 2.2 Scope of application of IOT technology

Combined with mechanization, the Internet of Things collects environmental data in greenhouses through sensors, including real-time information collection of soil temperature, moisture, salinity, pH and other information collection of ground temperature, humidity, light, rainfall, wind speed, wind direction, and air pressure. According to different varieties of plants to achieve air release, rolling curtain, water, heating, filling light, shading, carbon dioxide supplement a series of agricultural operations mechanized operation.

The following figure is the operation interface of the Internet of Things. It can be seen that the Internet of Things involves the monitoring of precipitation, lighting and other contents.

Internet of Things control interface<sup>ii</sup>



### 3. Analysis of the application of Internet of Things technology in Gaocheng Modern Agricultural Science and Technology Park

#### 3.1 Application background and data sources

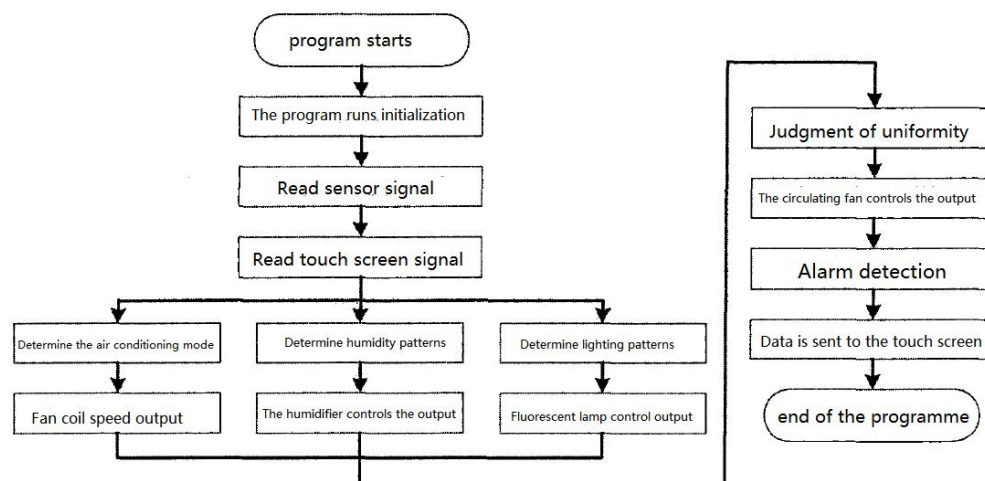
The science and technology park focusing on the development and demonstration of science and technology, carries out targeted research according to the local natural conditions and development status, and plays a certain guiding role in the development of local greenhouse agriculture.

As a traditional agricultural region, Gaocheng District of Shijiazhuang City has been vigorously promoting the deep integration of Internet technology and agricultural production in recent years. It has been promoting agricultural informatization and modernization through the promotion of Internet of Things application demonstration technology and other measures. Therefore, this paper chose Gaocheng Modern Agricultural Economic Park for research, to explore whether the Internet of Things technology can meet the needs of agricultural development, to achieve high yield, high quality, high efficiency, circulation, ecology, safety of agriculture.

#### 3.2 Operation process and parameter setting

##### 3.2.1 Operation process

The whole software system can be divided into three subsystems, the specific process is shown in the figure below. First, data acquisition and transmission. Through the deployment of a large number of sensor nodes in the park to obtain soil,



environment and other information and send to the remote host. Second, data storage and management, receiving, storing and processing the information transmitted by sensors. Third, it is the remote monitoring center software, which can analyze and query the data or give orders to the sensors to complete the corresponding tasks.

### **3.3.2. Parameter setting**

Through the description and analysis of the real phenomenon, the model is built on the Internet of Things. Finally, the model phenomenon is obtained through simulation to obtain the specific data of crop planting.

Taking tomato's demand for temperature as an example, relevant experts first put forward suggestions on the appropriate temperature at each stage of tomato growth, and the system background will match and analyze the expert's suggestions with the data of the Internet of Things, so as to obtain the amount of water, fertilizer and medicine suitable for crop growth conditions and growth cycle.

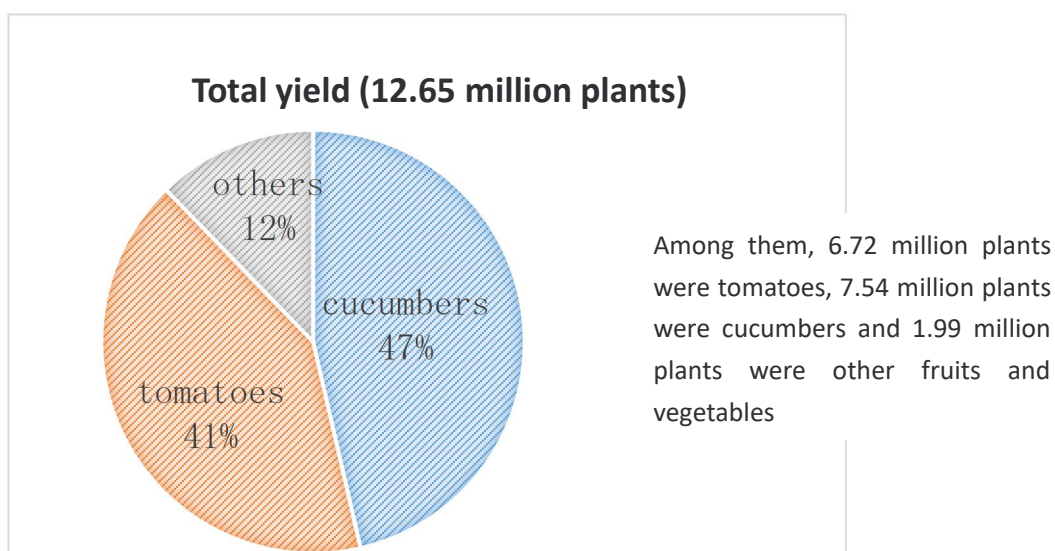
## 4. Benefit analysis of technology application<sup>iii</sup>

### 4.1 Economic benefits

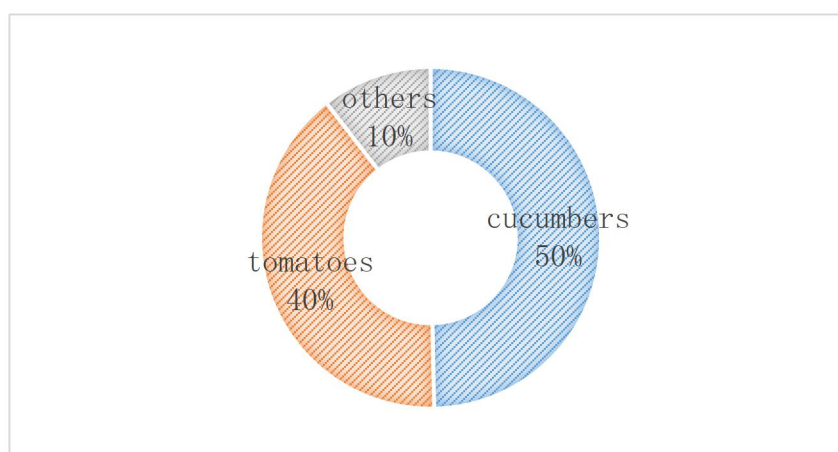
In this paper, 16.25 million seedlings cultivated from June 2018 to December 2020 in Gaocheng Modern Agricultural Science and Technology Park were used as data sources for analysis. The modern agricultural science and technology park in Gaocheng district is mainly planted with tomatoes and cucumbers, with a net income of 2.67 million yuan and a huge environmental benefit.

#### 4.1.1 Total output and income

##### 4.1.1.1 production



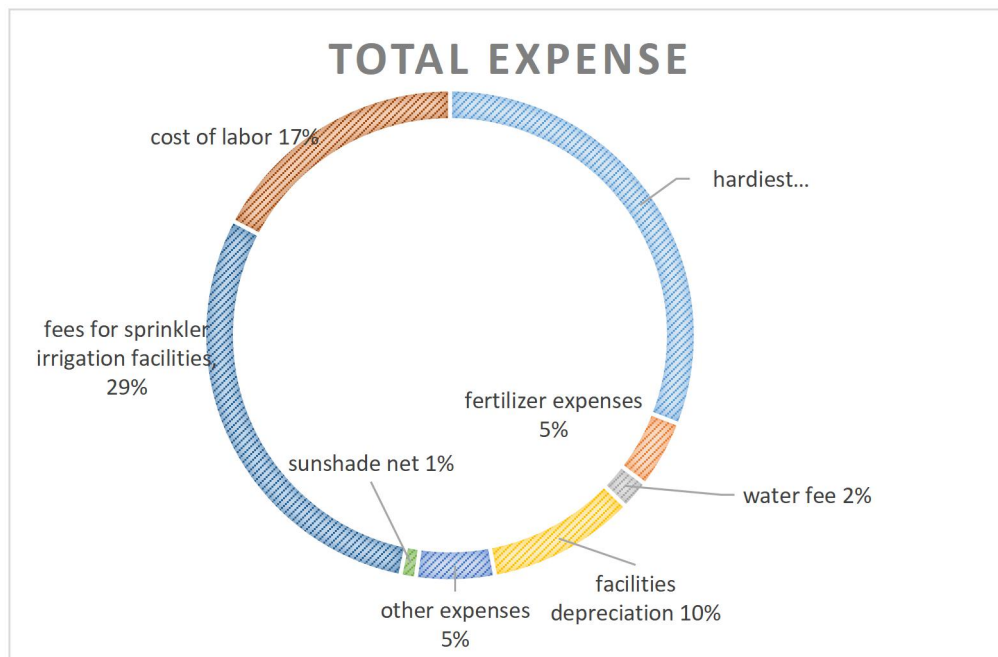
##### 4.1.1.2 Sales revenue



(Note: The main varieties of seedlings are cucumber and tomato. The market price is 0.5 for cucumber, 0.55 for tomato, and the average unit price for other varieties is 0.45)



#### 4.1.1.3 net income



The total net income was RMB 2.67 million.

The number of seedlings is 16.25 million, equivalent to the applied area of mu (2200 plants/mu) of 5125 mu, saving the cost of 350 yuan per mu, a total of 1,793,700 yuan

#### 4.2 Environmental benefits

Agricultural Internet of Things is a new type of agriculture that combines information technology with agricultural production. It has the following main advantages: First, it reduces and saves water resources. Second, save labor and time, reduce labor intensity and labor costs. Third, we will increase the output and quality of agricultural products. Fourth, we will protect the ecological environment. Agricultural production and management through precise and scientific digital control means can avoid excessive and abuse of drug use, fertilization, irrigation and other behaviors.

The modernized agricultural science and technology park of Gaocheng District has obtained the huge benefit in the environmental protection respect: the soily-transmitted disease on the nursery bed is reduced to 2%, while the cost of using pesticide is reduced by 70%, the standardized management system has reduced the cost of water and fertilizer by 45%, the seedling rate has reached 97%, the saving of the species is 24%, and the strong seedling rate has reached 89%.

## 5.The application of Internet of Things technology

Gaocheng agricultural science and technology park enterprises execute a test run of IOT technology, at the same time to participate in the demonstration site construction of park enterprises including Shijiazhuang Runyu Seedling Planting.Ltd, Gaocheng District Agricultural Development Vegetable Professional Cooperative, Hebei yongmei agricultural science and technology.LTD and other 11 enterprises,Effectively expand the scope of agricultural informatization application in science and technology parks within the demonstration zone. Finally, the precision management of agricultural production in the park can be realized to improve labor efficiency, reduce production costs and improve the production quality of products.

The construction of cloud platform for intelligent management of agricultural parks is a system project, which is a process of continuous enrichment and improvement in the construction process. Moreover, the information construction of agricultural parks involves many kinds of contents, and various types of information management are constantly enriched and improved with the improvement of the quality and needs of park managers. Gaocheng modern agricultural science and technology park is currently in the process of construction mainly meet the following problems.<sup>iv</sup>

1. After the rapid development in recent years, the agricultural Internet of Things and intelligent control technology has gradually improved its performance in all aspects, but it still faces some key technologies to be improved and breakthrough.
2. The Internet of Things technology plays an important role in cloud manufacturing applications, but the equipment in agricultural parks is relatively old, and most of them are managed by human. It is difficult to digitize and virtualize.
3. The quality of staff in agricultural science and technology parks is relatively low, so it is difficult to accept this new thing.
4. The informatization level of agricultural science and technology parks is weak, so it needs to be further improved from hardware and software equipment to management personnel.

## **6 Conclusion and discussion**

The remarkable achievements of Gaocheng Modern Agricultural Science and Technology Park show that the Internet of Things technology is promising in greenhouse agriculture. Although there are still some problems to be solved in the practical application process, the combination of IoT technology and agriculture is still promising, and we should be full of confidence in its development.

Facing the current agricultural problems, we should actively take measures to integrate modern science and technology into agricultural development, which can save time and effort, save resources, reduce waste and pollution, and ensure the yield and quality of crops at the same time.

In view of the existing problems, the following suggestions are put forward:

1. Cultivate high-quality talents and attract talents to return to agricultural development
2. Continue to research and develop key technologies, and increase the popularization and promotion of technologies
3. The school offers courses related to the application of Internet of Things technology

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