Study on the Construction of Smart Agricultural Demonstration Park

Yichuan Zhang, Kai Zhou and Xinzheng Li[*]

School of Horticulture and Landscape Architecture, Henan Institute of Science and Technology, Xinxiang 453003, China
lixinzheng@hist.edu.cn

Abstract

The implementation of the land circulation system has brought new opportunities for China's agricultural development, and building the agricultural demonstration park is an important measure to promote the efficient development of modern agriculture. Integrating the concept of smart into the construction of agricultural demonstration park can promote the sustainable development of the park. This paper takes an agricultural demonstration park as an example, which is located in Lankao County, Kaifeng City, Henan Province, and builds a development model of smart agricultural demonstration park through the combination of smart technology with park planning. Smart construction of this park is divided into four modules: the smart production module, the smart leisure module, the smart retrospect module and the smart trading module. Connect pre-production, production and post-production through smart construction, contact the government, administrators, technicians, experts, the public and markets and form a smart industrial chain. Applying information technology, cloud computing, Internet and wireless communication technology to the construction of smart agricultural demonstration park will effectively improve the production and management level of the park and facilitate sustainable development of the park.

Keywords: Smart, Agricultural demonstration park, Planning

1. Introduction

China is a large agricultural country, and agricultural production has an important impact on national food security. Compared with developed countries in the world, the area of farmland per capita is far lower than the average level in the world, and the production value per capita and land yield per unit are also on a lower level [1]. Besides, due to environmental pollution and the lack of strict control in the production process, the quality of agricultural products is hard to reach the requirement of high standard, so it has a weak international competence. Agricultural land system has a large impact on agricultural production. The implementation of "Household Contract Responsibility System" which started in 1978 in China has aroused the enthusiasm of farmers in a certain period and promoted the development of agriculture [2]. However, with the improvement of modern agricultural production technology worldwide, the agricultural production method with farmer household as the business unit has become the barrier of agricultural development. The implementation of agricultural land circulation system breaks this outdated production mode and brings opportunities to intensive, standardized and park-industrialized agricultural production, which is favorable to improve the scale benefit of agricultural production [3].

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[*] Corresponding Author

Modern science and technology play very important roles in enhancing agricultural production efficiency. Since IBM proposed the concept of "Smart City" in 2008, an upsurge of "Smart Construction" has risen around the world. Smart construction is to creatively apply new information technology in various industries, making production and life smarter through highly-integrated smart technology, and enables the resources to be used more efficiently. Smart construction will change people's behavior, economic growth mode and social management mode and operation mechanism, which has a wide application prospect in agricultural production.

Smart agriculture is the advanced stage of agricultural production, which integrates the emerging technologies such as Internet, mobile Internet, cloud computing and Internet of Things as a whole [4]. Relying on a variety of sensing nodes and wireless communication networks deployed in agricultural production region, the intellisense and smart early-warning of the agricultural production environment can be realized. At the same time, it can provide smart decision for agricultural production and management through smart analysis [5]. The research of smart agriculture has obtained wide attention in recent years. The technologies such as intelligent irrigation [6], intelligent greenhouse [7], digital agriculture [8], precision agriculture [9], *etc.*, have been widely applied in agricultural field. At present, digital technology, wireless sensing technology, virtual reality technology, *etc.*, have developed rapidly [10]. It is necessary to study how to improve the comprehensive efficiency of smart agriculture and to organically combine intelligence technology with planning.

2. Method and Research Area

2.1. Method

Agricultural Demonstration Park is an agricultural development mode supported by science and technology, generally with functions of production, demonstration and training of science and technology, leisure and entertainment and so on. At present, in order to reduce the market risk, running diversified business is a widely accepted way of development. The development orientation of agricultural demonstration park should be determined according to the market demand, investment amounts and technical level. On this basis, further determine the area, location and other parameters of each functional subarea and dispose the roads, production and service facilities and leisure and sightseeing facilities, *etc.*, to meet the demands for efficient production and leisure.

Combined with the planning of Demonstration Park, divide the smart technologies into smart production module, smart leisure module, smart retrospect module and smart transaction module. Combine the smart technologies with the process of pre-production, production and post-production, and set up efficient contact with the users such as the government, administrators, technicists, experts, the public and the market, *etc.*, through perceptive technologies, transmission technologies and processing technics (Figure 1).

2.2. Research Area

The agricultural demonstration park is located in Lankao County, Henan province, China, with a total area of 100 hectares, and it's a demonstration area of 400 hectares of agricultural park. The distance between the park and Kaifeng City of China is about 70 km, and the traffic is very convenient. Lankao County belongs to warm temperate continental monsoon climate, with four distinct seasons, sufficient sunlight, mild climate and moderate rainfall. The annual average temperature of the park is 14 ℃, and the average annual rainfall is 670 mm. The

landscape of the park is flat and the soil is rich without pollution. In a word, this park's overall conditions are suitable for agricultural production.
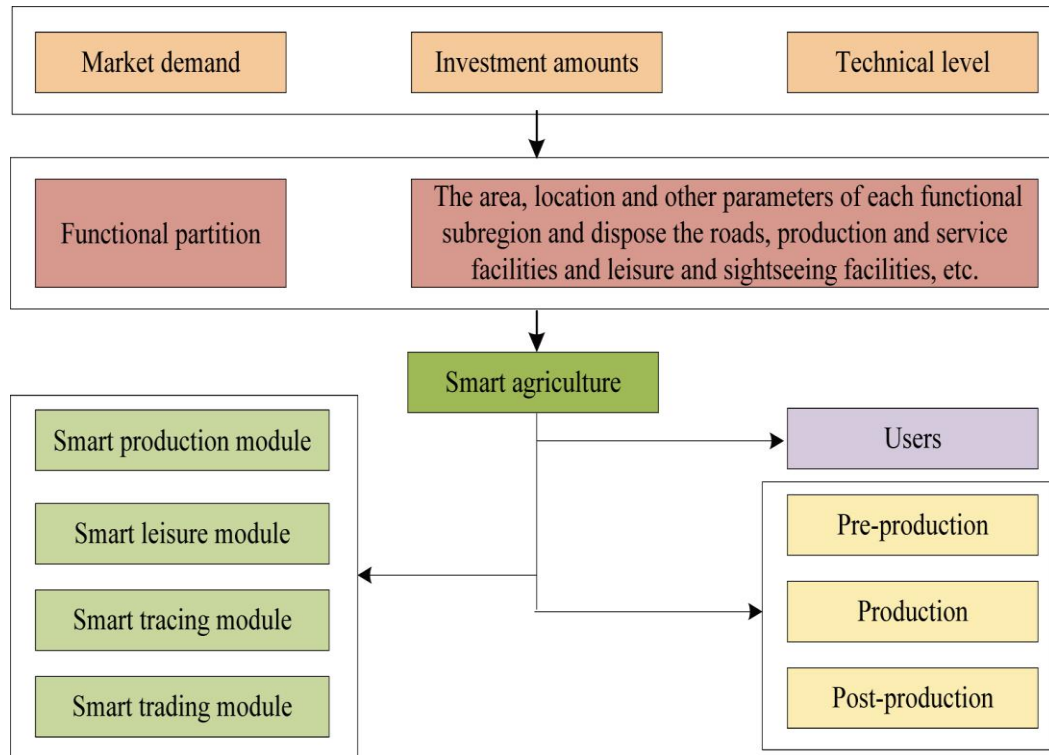

Figure 1. The Construction Framework of Smart Agricultural Demonstration Park

3. Results and Discussion

3.1. Overall Planning and Functional Partition

Accurate development positioning is the key to the park construction. According to comprehensive analysis, the development target of the park is: to build the park as a comprehensive agricultural scientific demonstration park integrating the introduction and demonstration of new species of fruit trees, vegetables and livestock, the training and exhibition of advanced agricultural technology, agricultural leisure tourism and the comprehensive utilization of waste. Taking "Demonstration Park+Base+Farmer" as the basic production model, enhance the driving effect of regional radiation and promote agricultural development of surrounding areas. Build recycling agriculture, combine planting and breeding closely together, realize organic planting and pollution-free output of the demonstration park through the cyclic use of organic fertilizer of animals. Actively develop modern sightseeing agriculture, provide a leisure facility integrating picking agricultural products and production experience, new agricultural technology and new achievement exhibition, science popularization education of agriculture, tourism and entertainment to the public. The function subarea and the main content of the park are mainly showed in Table 1 and the general layout and the function subarea are showed in Figure 2.

Table 1. The Function Subarea of Agricultural Demonstration Park

| Function subarea	Main content
Orchard planting area	Mainly plant new varieties of fruit tree and introduce new technologies of cultivation and management.
Vegetables planting area	Mainly plant new varieties of vegetables and introduce new technologies of cultivation and management.
Cultivation area	Mainly breed new varieties of beef, pig, the introduction of new technology of breeding, using standardized cultivation.
Greenhouse production area	Consists of sun room temperature and intelligent temperature for the seedling raising and special vegetable production.
Information area	Composed by the smart information center and the quality monitoring center, responsible for the park information platform construction and quality control.
Leisure area	Including items, such as ecological restaurant, leisure fishing, folk experience, leisure picking and green shopping, etc.
Ecological preservation area	Mainly focus on the landscaping and greening to provide the park with ecological protection and ornamental landscape.
Entrance area	Provide parking area and flow distribution site; provide green products shopping and agricultural material sale, and other services.
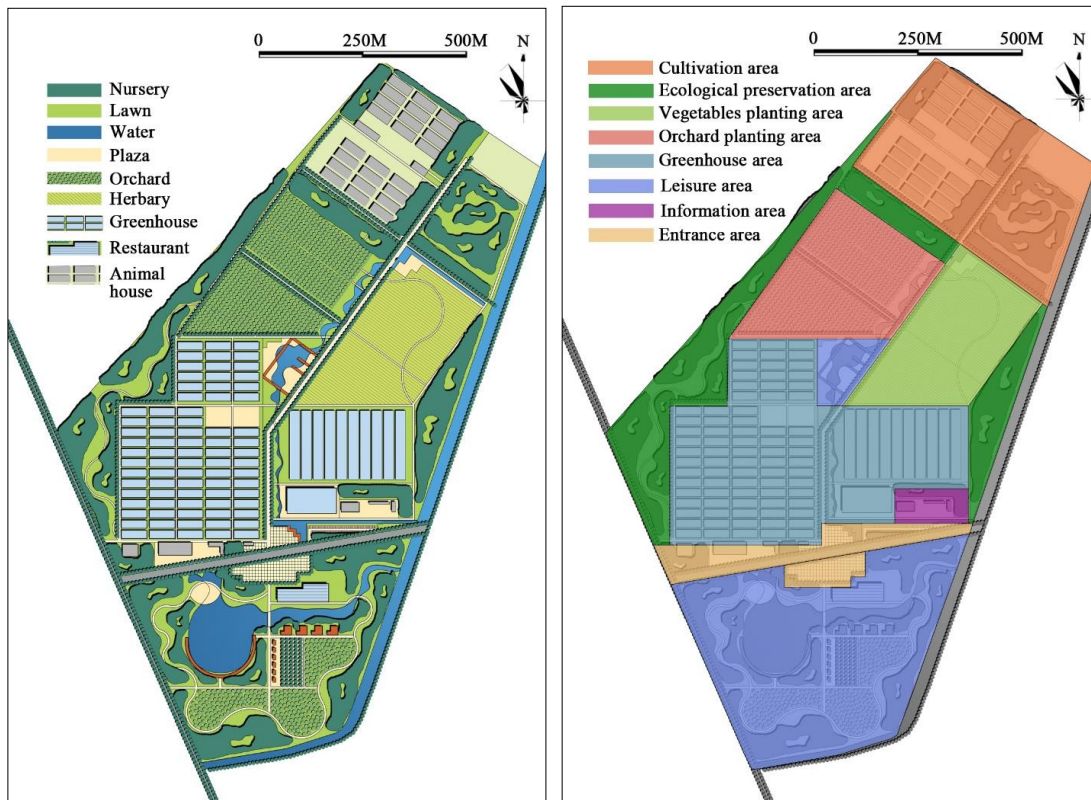
Figure 2. The Overall Plan and Function Subarea of Smart Agricultural Demonstration Park

3.2. Smart Agriculture System Module Design

Smart agricultural demonstration park is a complicated system, therefore, the modular design is the basic method to solve this problem. Modular design is to divide smart system into a few parts, and each part has corresponding independent function and shares the data with other modules. Meet the needs of different users through module combination. Modules are designed according to the comprehensive impact of production, management, users, technological means and economic investment, and they follow the basic principles of simple and convenient, easy to use and complete (Table 2).

Table 2. Smart Agriculture System Module Design

Module	Component	Main function
Smart production module	Smart sunlight greenhouse	Using information collection sensors to collect water, fertilizer, temperature, air, light and other external environment variables that plants need, processing through information platform for managers, technicians, experts and other users to make decisions as the basis.
	Smart greenhouse	
	Smart cultivation	
	Smart orchard	
	Smart kaleyard	
Smart leisure module	Three-dimensional simulation	Apply GIS, GPS, the virtual simulation technology and the animation roaming technology to establish the 3D digital park and the guide system.
	Smart tour guide	
	On-line landscape	
	Happy farm	User can see the growth of farm through web cam.
	Smart restaurant	Through the guest self-ordering system, service call system, kitchen interactive system, cashier system, reservation queuing system and information management system to realize the restaurant smart operation.
Smart retrospect module	Smart test	Detection such residuals as pesticides, hormones, heavy metal, etc. of seedlings, animal products and agricultural products.
	Retroactivity inquiry	By using automatic code identification technology, we achieve the goal of tracing full life cycle of the product based on the attached codes on them and the raw materials.
Smart trading module	Product information distribution	Issuance and trading of agricultural and sideline products type, yield, specifications, quality and other information based on web technology; the wisdom of the logistics distribution system based on Web technology, the best logistics planning.
	Electronic trading system	
	Smart logistics	

3.3. Smart Agriculture Demonstration Park Service Composition Structure

Smart service framework of agricultural demonstration park is composed of the following levels: perception layer, transport layer, processing layer, user layer and application layer. Perception layer is composed of various sensors and a monitoring system. The transport layer, which is composed of WLAN, 3G, and WIFI and so on, transmits the data obtained from the perception layer [11]. Processing layer is composed of two parts: hardware and software, the

hardware includes the storage server and computing server, software mainly is the information management system, responsible for the transport layer data analysis, processing and handling, and the results through the platform for publishing. Users include government, administrators, markets, technicians, experts, public personnel, etc. Smart systems provide different information for different users, those users can use information can through the application of terminals such as mobile phone, computer or display screen and feedback through these terminals. To increase the quality and efficiency of production and management, high efficient connections (Figure 3) among all levels have been constructed.
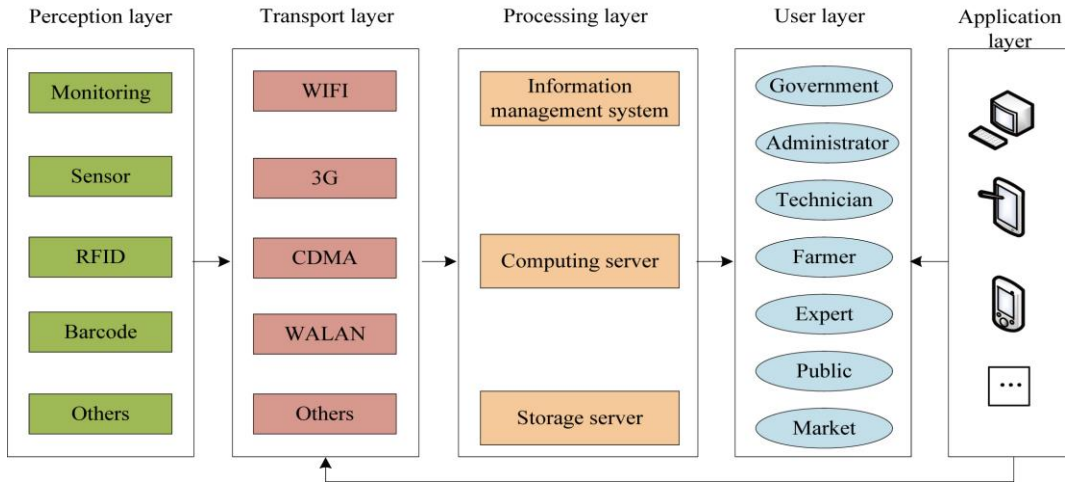

Figure 3. Service Structure of the Smart Agriculture Demonstration Park

3.4. Matching of Smart Technology and Production Process

Agricultural production process is divided into 3 stages of pre-production, production and post-production, among which combination of smart technology and production process can enhance increasing of production efficiency (Figure 4). Pre-production stage is an early-stage
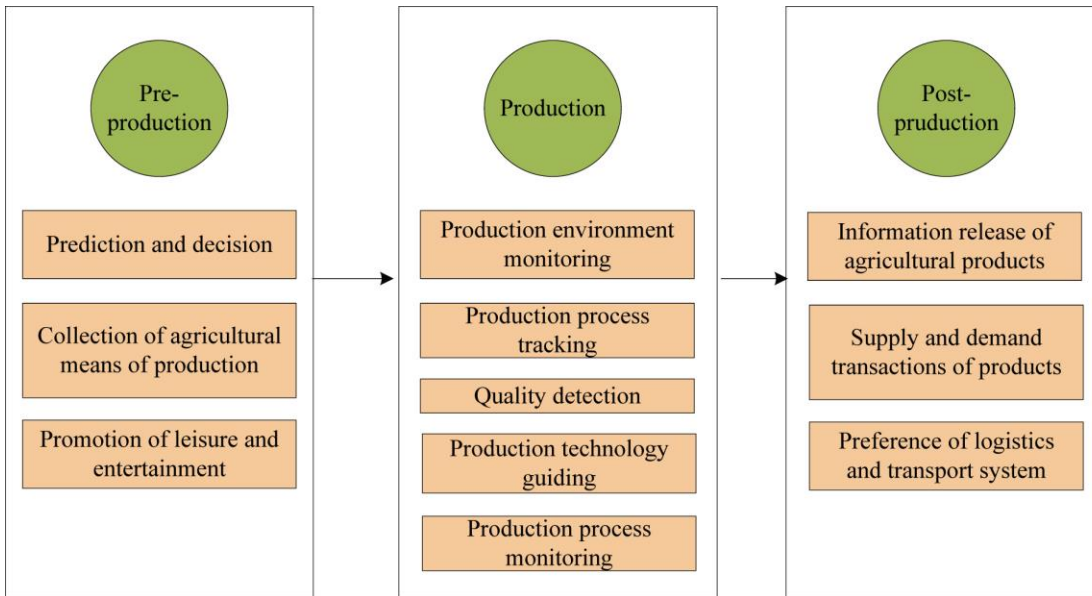

Figure 4. Matching of Smart Technology and Production Process

preparation for production and leisure through prediction and decision, collection of agricultural means of production and promotion of leisure and entertainment. In the production, the main target is to ensure efficient and qualified output, including production environment monitoring, production process tracking, quality detection, production technology guiding, production process monitoring *etc*. The stage is mainly applied in the smart technologies such as sensing technology, monitoring technology, tracking technology etc., and collect the ecological and physical parameters of agricultural production site in real time through various wireless sensors; Using video surveillance equipment to acquire such crop growth information etc., then the system according to the indicators of crop growth requirements, accurate remote agricultural facility to automatically open or close down, the realization of smart agricultural production; use the RFID tag, build the traceability system for agricultural products, sharing and transparent to strengthen the management of agricultural production, processing, transporting and selling the whole process data, realize the whole process safety traceability of agricultural products, to promote the brand building of agricultural products, and to enhance the added value of agricultural products. For the stage after production, it is mainly to solve the relevant problems of agricultural products entering circulation field, including the information release of agricultural products, supply and demand transactions of products and preference of logistics and transport system.

4. Conclusion

Smart agricultural demonstration park construction is an important measure to promote the development of modern agriculture, improvement of production and management efficiency and economic benefits. Smart construction of this park is divided into four modules: the smart production module, the smart leisure module, the smart retrospect module and the smart trading module. Connect pre-production, production and post-production through smart construction, contact the government, administrators, technicians, experts, the public and markets and form a smart industrial chain. Applying information technology, cloud computing, Internet and wireless communication technology to the construction of smart agricultural demonstration park will effectively improve the production and management level of the park and facilitate sustainable development of the park.

Acknowledgements

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Authors

Yichuan Zhang, male, he received a M.S. degree from Central South University of Forestry and Technology, Changsha, China, in 2008, now he is an associate professor in the School of Horticulture and Landscape Architecture, Henan Institute of Science and Technology, Xinxiang, China. His current research interests include the landscape evaluation and the application of mathematical models in landscape optimization. E-mail: zhangyichuan2002@gmail.com.

Kai Zhou, male, he received a doctor's degree from South China Botanical Garden, Chinese academy of sciences, Guangzhou, China, in 2007, now he is an associate professor in the School of Horticulture and Landscape Architecture of Henan Institute of Science and Technology, Xinxiang, China. His current research interests include the landscape ecology and urban ecology. E-mail: kzhou89@126.com.

Xinzheng Li, male, professor, School of Horticulture and Landscape Architecture, Henan Institute of Science and Technology, mainly engaged in the research about planning of Agricultural Demonstration Park. E-mail: lixinzheng@hist.edu.cn.